B-HIN100 : Communicative Hindi

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-HIN100.1	3	3	3	3	2	2	2	3
B-HIN100.2	3	3	3	3	2	2	2	3
B-HIN100.3	3	3	3	3	2	2	2	3
B-HIN100.4	3	3	3	3	2	2	2	3
Average	3	3	3	3	2	2	2	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-HIN100.1	2	2	2	2	2
B-HIN100.2	2	2	2	2	2
B-HIN100.3	2	2	2	2	2
B-HIN100.4	2	2	2	2	2
Average	2	2	2	2	2

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-HIN100.1	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.2	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.3	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.4	3	3	3	3	2	2	2	3	2	2	2	2	2
Average	3	3	3	3	2	2	2	3	2	2	2	2	2

B-PPT 201– FOOD PACKAGING (THEORY)

Time: 3 Hrs. Total Marks: 100
Credits :4 Theory: 80
Internal Assessment : 20

Course objectives: This course is designed for theoretical understanding of food packaging, its type, utilization and innovative technique used for development of food packaging.

Course Learning Outcomes: Upon successful completion of this course, the students learned about the Food Packaging Technology and the student will be able to:
B-PPT201.1: Develop the knowledge of Food Packaging
B-PPT201.2: Understand the function of food package, types of food packaging.
B-PPT201.3: Develop the knowledge of sterilization
B-PPT201.4: Recognize the Innovative Packaging Techniques.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT-1

Introduction

- Food packaging: Definition,
- Functions of food packaging,
- Need of food packaging
- Role of packaging in extending shelf life of foods
- Safety assessment of food packaging materials
- Different forms of packaging.
- Rigid, semi-rigid, flexible forms of packaging in food industries..
- Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods.

UNIT 2

Aseptic packaging of foods

- Principles of sterilization,
- sterilization of packaging material,
- verification of sterilization processes,
- aseptic packaging systems: carton systems, can systems,

- bottle systems, sachet and pouch systems, cup systems

.

UNIT 3

Active and Smart packaging

- Definition
- Smart packaging systems
- intelligent packaging systems: Quality Indicators, Time-temperature
- indicators, gas concentration indicators, RFID;
- Safety and Regulatory issues

UNIT 4

Properties & selection of packaging materials

- Tensile strength, bursting strength, tearing resistance, puncture
- resistance, impact strength, tear strength,
- Barrier properties of packaging materials,,
- prediction of shelf life of foods,

References :

Gordon L. Robertson, Food Packaging: Principles and Practice, Third Edition,2013.

Gordon L. Robertson, Food Packaging and Shelf Life: A Practical Guide,2010.

Ruben Hernandez, Susan E. MSelke, John Culter, John D. Culter,

Plastics Packaging: Properties,Processing, Applications, and Regulations,2000.

Walter Soroka, Fundamentals of Packaging Technology-Fourth Edition,

B-PPT 201: FOOD PACKAGING(THEORY)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 201.1	3	3	3	3	3	3	3	3
B-PPT 201.2	3	3	3	3	3	3	3	3
B-PPT 201.3	3	3	3	3	3	3	3	3
B-PPT 201.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 201.1	3	3	3	3	3
B-PPT 201.2	3	3	3	3	3
B-PPT 201.3	3	3	3	3	3
B-PPT 201.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 201.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 201.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 201.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 201.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-PPT 202– FOOD PACKAGING (PRACTICAL)

Time: 3 Hrs. Total Marks: 100
Credits :2 Practical : 40
Internal Assessment : 10

Course objectives: This course is designed for Practical understanding of food packaging material, testing and development.

Course Learning Outcomes: After completing the Course, the student will be able to:
B-PPT 202.1: Identify various food packaging material.
B-PPT 202.2: Check the strength of packaging material with various testing instrument.
B-PPT 202.3: Enhance the practical knowledge about packaging industry.
B-PPT 202.4: Use innovative Packaging Techniques.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

LIST OF EXPERIMENTS

1. Identification of different types of packaging and packaging materials

2. Determination of tensile strength of given material

3. Determination of tearing strength of paper

4. Determination of bursting strength of packaging material

6. Determination of drop test of food package

7. Visit to relevant industries

8 Introducing the students with the latest trends in packaging consulting the web sites and magazines

B-PPT 202: FOOD PACKAGING(PRACTICAL)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 202.1	3	3	3	3	3	3	3	3
B-PPT 202.2	3	3	3	3	3	3	3	3
B-PPT 202.3	3	3	3	3	3	3	3	3
B-PPT 202.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 202.1	3	3	3	3	3
B-PPT 202.2	3	3	3	3	3
B-PPT 202.3	3	3	3	3	3
B-PPT 202.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 202.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 202.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 202.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 202.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-PPT203: PRINTING & PACKAGING MATERIALS (THEORY)

Time: 3 Hrs. Total Marks: 100
Credits :4 Theory: 80
Internal Assessment : 20

Course objectives: This course is designed for theoretical understanding of printing and packaging material with their properties, application and advantages and disadvantages.

Course Learning Outcomes: Upon successful completion of this course, the student will be able to:
B-PPT203.1: Recognize different types of papers and ink used in printing and packaging.
B-PPT203.2: Learn about various materials like films ,emulsions and developers etc used as photographic matrials.
B-PPT203.3: Learn about the physical and chemical properties of various printing and packaging materials.
B-PPT203.4: Recognize different type metals used in packaging and categories and be able to apply them to the proper design situation.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit – I

Metals

Type of metals and characteristics of metals used for type alloys for foundry types, , Physical and chemical properties of aluminum, zinc, copper, nickel, chromium, magnesium in relation to printing applications.

Photographic Materials

Main kinds of films and photographic papers used in graphic orgination Films positives, mainbase, stripping, thickness, right and wrong reading, negatives; paper positive materials. Developers, Reducers, Intensifiers.

Unit - II

Light Sensitive Materials

Various sensitized materials, used and relationship with processes Silver halide emulsions-classification according to speed, contrast and spectral sensitivity.

Paper and Ink

Fibrous and Non-fibrous materials, Paper and paperboard types, Recycling paper, Properties of paper, General characteristics and requirements of printing inks formulations pigments, vehicles, and additives, Drying mechanism, ink properties.

Unit - III

Adhesives

Classes and characteristics of adheisves used in binding and warehouse work and their range of applications selection for specific purpose.

Miscellaneous Materials

Cushioning Materials, Ancillary Materials, rexine, threads, tapes, stitching wire, metal foils and covering materials used for binding and print finishing.

Unit – IV

PACKAGING MATERIALS

GLASS: Manufacture, Properties, Applications and Testing

PLASTICS: Polymer Chemistry, Classification of Polymers, Properties, Processing of Plastics, Special Plastics used in packaging and Their applications.

METAL CONTAINERS: Tins, Cans, Formed Containers, Steel Drums, Cushioning Mechanism, Fragility Assessment, Cushion Design, Testing,

Wooden Container: Textile bags

References:

- Advances in plastic packaging technology - **John Briston**.
- Packaging design an introduction **- Laszlo Roth**.
- Packaging Technology - Volume I, II, III - II

B-PPT203: PRINTING & PACKAGING MATERIALS (THEORY)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 203.1	3	3	3	3	3	3	3	3
B-PPT 203.2	3	3	3	3	3	3	3	3
B-PPT 203.3	3	3	3	3	3	3	3	3
B-PPT 203.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 203.1	3	3	3	3	3
B-PPT 203.2	3	3	3	3	3
B-PPT 203.3	3	3	3	3	3
B-PPT 203.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 203.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 203.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 203.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 203.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-PPT204: PRINTING & PACKAGING MATERIALS (PRACTICAL)

Time: 3 Hrs. Total Marks: 50
Credits :2 Practical: 40
Internal Assessment : 10

Course objectives: This course is designed for practical understanding of printing and packaging material paper, ink, adhesives and different types of plastic used for printing and packaging.

Course Learning Outcomes: Upon successful completion of this course, the student will be able to:
B-PPT204.1: Understand about types of papers
B-PPT204.2: Understand use of different types of ink.
B-PPT204.3: Learn about the physical and chemical properties of various printing and packaging materials.
B-PPT204.4: Get practical knowledge of the materials used in basic operations of Binding & finishing department,.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

LIST OF PRACTICALS

1. Different samples of paper and their study.
2. Different samples of Ink and their study.
3. Study of various metals used in printing.
4. Study of different types of adhesive used in printing.
5. Study of various types of Plastic and metal containers used in packaging.

B-PPT204: PRINTING & PACKAGING MATERIALS (PRACTICAL)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 204.1	3	3	3	3	3	3	3	3
B-PPT 204.2	3	3	3	3	3	3	3	3
B-PPT 204.3	3	3	3	3	3	3	3	3
B-PPT 204.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 204.1	3	3	3	3	3
B-PPT 204.2	3	3	3	3	3
B-PPT 204.3	3	3	3	3	3
B-PPT 204.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 204.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 204.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 204.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 204.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-PPT205: GRAPHIC DESIGN (THEORY)

Time: 3 Hrs. Total Marks: 100
Credits :4 Theory: 80
Internal Assessment : 20

Course objectives: This course is designed for thorough understanding of graphic designing concepts and their application in printing & packaging.

Course Learning Outcomes:
Course outcomes: After completing the Course, the student will be able to:
B-PPT 205.1: Understand about the basic concepts of graphic elements
B-PPT 205.2: Know the functioning of basic colour aesthetics
B-PPT 205.3: Develop the capacities to elaborate the process of graphic design
B-PPT 205.4: Design various real world graphic applications

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT –I

INTRODUCTION

Graphic Design, Visual Art, Communication Art, Graphic Art, Components of Graphic Communication, Functions of Graphic Communication

Elements of design: point line, shape, size, tone, value, weight, texture space, etc. Principles of design-balances, proportion, rhythm, unity, contrast.

UNIT –II

Types of Letterforms: Typography- Structure Design and Function, Typefaces, Type families, Function of Type Composition.

Visual Images: Functions, Categories of Visuals, Originals, Visuals on Printed page, Editing of Illustrations

Layout Planning: Thumbnail Sketches, Rough Layout, Comprehensive Layout

UNIT –III

Colour in Design: Introduction, Functions of Colour, Colour Vision. Colour Combination, Colour Schemes, Colour Perspective, Reproduction of Colour: Fake colours, Spot Colours, Process Colours

Copy for Printing: Verbal Copy,Copy Marking, Copy Fitting,Typesetting Proofreading

Visual Copy: Cropping and Scaling,,Sizing and Marking,Reproduction of Illustrations

UNIT –IV

DESKTOP PUBLISHING

Capabilities, Users of Desktop Publishing System,Equipment Required for Desktop Publishing,Features of Some Specific Software Programmes:Corel Draw,Photoshop,PageMaker,QuarkXpress

Design management: Definitions in advertising art, modern art abstract art, applied art, advertising, publicity, public relations, sale promotion, sales manager

References:

1. The Designer's Handbook by Alistair Campbell
2. Design & Technology by Van No strand
3. Handbook of Advertising Art Production by schelmmer.
4. Art & Production by Sarkar.
5. Advertising, Art & Production by J. Nath.

B-PPT205: GRAPHIC DESIGN (THEORY)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 205.1	3	3	3	3	3	3	3	3
B-PPT 205.2	3	3	3	3	3	3	3	3
B-PPT 205.3	3	3	3	3	3	3	3	3
B-PPT 205.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 205.1	3	3	3	3	3
B-PPT 205.2	3	3	3	3	3
B-PPT 205.3	3	3	3	3	3
B-PPT 205.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 205.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 205.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 205.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 205.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-PPT206: GRAPHIC DESIGN (PRACTICAL)

Time: 3 Hrs. Total Marks: 50
Credits :2 Theory: 40
Internal Assessment : 10

Course objectives : This course is designed for practical understanding of graphic designing and menus, tools and its applications and production formats.

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Course Learning Outcomes:
After completing the Course, the student will be able to:
B-PPT 206.1: Understand the use of graphic elements
B-PPT 206.2: Demonstrate the concept of image retouching, smoothing.
B-PPT 206.3 Design ad banners for websites and digital campaigning banners.
B-PPT 206.4: Design different logos.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

LIST OF PRACTICALS

1. Introduction to computers, various software used for designing purpose – Demonstration (Manipulation of same design)
2. Logo designing
3. Color wheel
4. Designing of visiting card. Letterhead,
5. Envelop, Bill form, Receipt, Invitation card, Posters,
6. Title page of a Book, Magazine Cover page.

B-PPT206: GRAPHIC DESIGN (PRACTICAL)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 206.1	3	3	3	3	3	3	3	3
B-PPT 206.2	3	3	3	3	3	3	3	3
B-PPT 206.3	3	3	3	3	3	3	3	3
B-PPT 206.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 206.1	3	3	3	3	3
B-PPT 206.2	3	3	3	3	3
B-PPT 206.3	3	3	3	3	3
B-PPT 206.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 206.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 206.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 206.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 206.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-PPT 207: SHEET FED OFFSET TECHNOLOGY (THEORY)

Time: 3 Hrs. Total Marks: 100
Credits :4 Theory: 80
Internal Assessment : 20

Course objectives :This course is designed for theoretical understanding of Sheet fed offset machine with various components and controlling devices.

Course Outcomes: Upon successful completion of this course, the students learned about the sheet fed offset printing process and the student will be able to:
B-PPT 207.1: Know about the Sheet Fed Offset Printing Process in printing industry.
B-PPT 207.2:Develop the basic knowledge of Sheet fed Offset printing machine various mechanisms.
B-PPT 207.3 Understand the Feeding units different parts -pile table, pile board, Sucker, separator and double sheet detector,
B-PPT 207.4 Understand the Printing unit different parts- Plate cylinder, Blanket cylinder and Impression cylinder.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing short notes covering the entire syllabus. All questions carry equal marks.

Unit – I

Basic principles in planography printing:
Lithography and Offset Printing Process, History, Principle, advantages, limitations, types and their uses. Press configurations. Various Required and auxiliary elements, Requirements and Needs of production room

Unit - II

Infeed unit –
Function of feeding unit, pile table, air blast nozzles, Sucker, separator brushes & fingers. Sheet control devices-conveyor assemblies, conveyor tape, hold down rods, Sheet feeding system, Sheet register- Front lay & Side lay, Sheet detectors

Unit - III

Printing unit

Plate Cylinder- parts of plate cylinder, plate punching & mounting Blanket cylinder- Types of blanket cylinder, Care of blanket, blanket cleaning device, Impression cylinder, inking system-Introduction, types of inking system, Dampening system, Types of dampening system, Ingredients of fountain solution, Ph& Conductivity of dampening system,.

Unit - IV

Delivery unit-

Gripper, Types of gripper, Sheet transfer, Delivery unit components, Anti set-off spray equipment. Extended pile delivery, Continuous pile delivery. Pre make ready, make ready, Sheet control devices.

References:

Manual For Lithographic Press Operation - **A. S. Porter**

Modern Lithography Introduction to Printing Technology - **Hugh M Speirs**.

Sheetfed Press Operation-**GATF**.

Offset Technology – **C.S.Mishra**.

Lithographers Manual Lithographic Technology - **Erwin A Dennis, Olusegun Odesina**.

B-PPT207: SHEET FED OFFSET TECHNOLOGY (THEORY)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 207.1	3	3	3	3	3	3	3	3
B-PPT 207.2	3	3	3	3	3	3	3	3
B-PPT 207.3	3	3	3	3	3	3	3	3
B-PPT 207.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 207.1	3	3	3	3	3
B-PPT 207.2	3	3	3	3	3
B-PPT 207.3	3	3	3	3	3
B-PPT 207.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 207.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 207.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 207.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 207.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-PPT208: SHEET FED OFFSET TECHNOLOGY (PRACTICAL)

Time: 3 Hrs. Total Marks: 50
Credits :2 Practical : 40
Internal Assessment : 10

Course Objectives :This course is designed for practical demonstration of Sheet fed offset machine with various components and controlling devices.

Course Learning Outcomes: Upon successful completion of this course, the students learned about the sheet fed offset printing process and the student will be able to:
B-PPT208.1: Understand the Delivery units and different components of delivery unit.
B-PPT208.2: Develop the practical skill of Sheet fed Offset printing machine.
B-PPT208.3: Identify various printing defects
B-PPT208.4: Learn various components parts used in sheet-fed offset machine

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

LIST OF PRACTICALS

1. One colour printing.
2. Four colour printing.
3. Study of the various mechanisms.
4. Study of the fountain solution ingredients
5. Study of the lubrication system.
6. Setting the feeder, feed board, lays and delivery.
7. Identification of printing faults in the given samples-reasons and remedial actions.

B-PPT208: SHEET FED OFFSET TECHNOLOGY (PRACTICAL)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-PPT 208.1	3	3	3	3	3	3	3	3
B-PPT 208.2	3	3	3	3	3	3	3	3
B-PPT 208.3	3	3	3	3	3	3	3	3
B-PPT 208.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-PPT 208.1	3	3	3	3	3
B-PPT 208.2	3	3	3	3	3
B-PPT 208.3	3	3	3	3	3
B-PPT 208.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-PPT 208.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 208.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 208.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-PPT 208.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

Learning Outcomes-based Curriculum Framework (LOCF)

for

B.Sc. (Multimedia)

A Three Year Bachelor Degree Programme

under

Choice Based Credit System (CBCS)/Learning Outcomes-based Curriculum Framework(LOCF)

w.e.f. Academic Session 2020-21.
Eligibility : 10+2 in any discipline

Institute of Mass Communication & Media Technology
Kurukshetra University, Kurukshetra

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc. MULTIMEDIA PROGRAMME

Semester	CORE COURSE (CC) @ 6 Credits	Ability Enhancement Compulsory Course (AECC) @ 2 Credits	Skill Enhancement Course (SEC) @ 2 Credits	Discipline Specific Elective DSE @ 6 Credits
I	CC- 1 CC- 2 CC- 3 CC- 4	(English/MIL Communication)/Environ mental Studies		
II	CC- 5 CC- 6 CC- 7 CC- 8	(English/MIL Communication) / Environmental Studies, Hindi		
III	CC- 9 CC- 10 CC- 11 CC- 12		SEC-1	
IV	CC- 13 CC- 14 CC- 15 CC- 16		SEC -2	
V			SEC -3/MOOC*	DSE-1 (Elective Subject)
				DSE-2 (Elective Subject)
				DSE-3 (Elective Subject)
	Internship/Industry Training **			
VI			SEC-4	DSE-4 (Elective Subject)
				DSE-5 (Elective Subject)
				DSE-6 (Elective Subject)

AECC will be offered according to the time table adjustments in the Institute/Department.

*MOOC Course from Swayam Portal.
** SEC can be offered in 3rd/4th/5th semester according to the time table adjustments in the institute.

****Internship/Industry Training** A candidate must complete industry training of 4 to 6weeks after completion of theory examination of 4th semester. The internship report will be submitted in 5th semester.

General instructions:

- One credit equivalent to 1 hour of teaching/2 hours of Practical work

- Teaching workload will be calculated on the basis of teaching contact hours of the course
- One credit (theory /Practical) equivalent to 25 marks

Total No. of Courses, Credit and Marks

Course	No. of Courses	Credits Teaching/Week	Credits Practical/ Week	Credits Tutorials/Week	Total Credits	Marks
Core Courses	16	3x5=15 13x4=52 Total=67	13x2=26	3x1=3	15+52+26 +3=96	16x150 =2400
AECC	3	3x2=6	--	--	6	3x50=150
SEC	4	4x2=8	--	--	8	4x50 =200
DSE	6	6x4=24	6x2=12	--	24+12=36	6x150 =900
Industrial Training	--	--	--	--	2	1x50 =50
Total	**29**	**105**	**38**	**3**	**148**	**3700**

Scheme of Examination of B.Sc Multimedia under CBCS/LOCF for Institute of Mass Communication & Media Technology (IMC&MT, KUK) w.e.f. Academic Session2020-21

Semester-I

Course Code	Course Title	Course Type	Contact Hours per Week				Credits	Total Credits	Marks				Duration of Exam
			L	T	P	Total			T	P	IA	Total	
AECC-100	Communicative English	AECC-1	2	-	-	2	2	2	40	-	10	50	2 Hours
B-MMT 101	Art & Creativity (Theory)	CC-1	4	-	-	4	4	6	80	-	20	100	3 Hours
B-MMT 102	Art & Creativity (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-MMT 103	Fundamentals of Computer (Theory)	CC-2	4	-	-	4	4	6	80	-	20	100	3 Hours
B-MMT 104	Fundamentals of Computer (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-MMT 105	Computer Programming (Theory)	CC-3	4	-	-	4	4	6	80	-	20	100	3 Hours
B-MMT 106	Computer Programming (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-MMT 107	Fundamentals of Multimedia	CC-4	5	1	-	6	6	6	120	-	30	150	3 Hours
							Total Credits	**26**	**Total Marks**			**650**	

Semester-II

Course Code	Course Title	Course Type	Contact Hours per Week				Credits	Total Credits	Marks				Duration of Exam
			L	T	P	Total			T	P	IA	Total	
B-EVS 100	Environmental Studies	AECC-2	2	-	-	2	2	2	40	-	10	50	3 Hours
B-HIN 100	Communicative Hindi	AECC-3	2	-	-	2	2	2	40	-	10	50	2 Hours
B-MMT 201	Graphic Design (Theory)	CC-5	4	-	-	4	4	6	80	-	20	100	3 Hours
B-MMT 202	Graphic Design(Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-MMT 203	Audio Production (Theory)	CC-6	4	-	-	4	4	6	80	-	20	100	3 Hours
B-MMT 204	Audio Production (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-MMT 205	Basics of Animation	CC-7	5	1	-	6	6	6	120	-	30	150	3 Hours
B-MMT 206	Web programming using HTML (Theory)	CC-8	4	-	-	4	4	6	80	-	20	100	3 Hours
B-MMT 207	Web programming using HTML (Practical)		-	-	2	4	2		-	40	10	50	3 Hours

Total Credits	28	Total Marks	700	

List of Total Subjects in B.Sc. Multimedia:

Sr. No.	Course Type	Number of Subjects
1	CC	16
2	AECC	03
3	SEC	04
4	DSE	06
	Total	**29**

	Course Type	Number of Subjects
Semester I		
	CC	4
	AECC	1
Semester II	CC	4
	AECC	2
Semester III	CC	4
	SEC	1
Semester IV	CC	4
	SEC	1
Semester V	SEC	1
	DSE	3
Semester VI	SEC	1
	DSE	3
Total		**29**

List of Abbreviations

L -Lecture
T- Tutorial
P- Practical
IA – Internal Assessment
CC- Core Course
AECC- Ability Enhancement Compulsory Course
SEC- Skill Enhancement Course
DSE- Discipline Specific Elective

PROGRAMME OUTCOMES

On successful completion of the programme, the student will be able to:-

PO1 Acquire knowledge related to the discipline under study.

PO2 Communicate and reflect effectively and efficiently on the issues related to the discipline.

PO3 Exhibit the professional skills and competencies acquired during the Programme of study.

PO4 Apply the knowledge and skills acquired in planning, organizing, evaluation and decision making.

PO5 Explore, analyze and provide solutions to the problems related to the discipline and life.

PO6 Develop exposure to actual working environment leading to employability and entrepreneurship.

PO7 Exhibit scientific & research capabilities in academic, professional and general life pursuits.

PO8 Recognize, appreciate and follow ethical issues relating to the discipline and society.

Programme Specific Outcomes:

After completion of under graduate programme in Multimedia, the learner will be able to :

PSO1 Acquire fundamental knowledge of the field of multimedia as a mass communication tool.

PSO2 Analyze usage/applications of the multimedia components in various real life situations.

PSO3 Develop competency for employability and entrepreneurship by practicing techniques and tools for creating interactive multimedia applications.

PSO4 Demonstrate both theoretical and practical aspects in designing multimedia applications.

PSO5 Create interface between teacher and learner using new media tools in the virtual learning /e-learning systems.

AECC-100: Communicative English

Time:2 Hrs. | Total Marks: 50
Credits: 2 | Practical: 40
Internal Assessment: 10

Course objectives: The paper is designed to enhance proficiency in English Language. It seeks to develop the basics of English Language through different modules. Each unit will enable and capacitate the learner to have communication competence which is required in the present-day world. The basic knowledge of communication will enable the learners to share and enliven ideas, experience and know-how ubiquitous in the world.

Course Learning Outcomes:
After completing the Course, the student will be able to:
AECC 100.1:Learn the rhetorics of presentation
AECC 100.2: Learn, comment and respond to correspondence .
AECC 100.3: Learn the basics of grammar and composition.
AECC 100.4: Acquaint with verbal and non-verbal communication.

Note : All questions are compulsory.

Q.1. The paper setter will set two question from unit-II. The student shall attempt one out of the given two. (10)

Q.2. This question shall be based on unit-III. The student shall attempt one out of the given two. (10)

Q.3. There will be 25 grammatical items based on unit-IV. The student shall attempt any 20 items. (10)

Internal Assessment: The students shall be required to make presentation /PPT based on unit-I.

Unit-I

Listening and Speaking skills

Listening skills (Active-passive, Accent)
Speaking Skills (Accent, Stress ,Intonation, Assertion, Rhetorical questions, Pause, Pitch)
Oral presentation, Debates, Elocution and Extempore

Unit-II

Writing skills

Report writing
Paragraph writing
Letter writing

Unit-III

Technical and Modern communication

Resume writing
E-mail
Blogs and comments on social media

Unit-IV

Grammar

Noun, Pronoun, Verb, Adverb, Adjective, Preposition, Conjunction and their uses
Common errors in the use of English (Noun ,Pronoun, Adjective, Adverb, Conjunctions)
Correct use of verbs and Articles
Vocabulary: Homonyms, Homophones, Pair of words

References:

- Communicative English, Dr. Jimmy Sharma, Arihant Parkashan Pvt. Ltd.
- Strengthen Your English, Bhaskaran and Horsburgh, Oxford University Press
- Basic Communication Skills for Technology, and area J Rutherfoord, Pearson Education Asia.
- Murphy's English Grammar with CD, Murphy, Cambridge University Press
- English Skills for Technical Students by Orient Longman
- Everyday Dialogues in English by Robert J. Dixson, Prentice-Hall of India Ltd., 2006.

AECC-100: Communicative English

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
AECC 100.1	2	2	2	2	2	2	2	2
AECC 100.2	2	2	2	2	2	2	2	2
AECC 100.3	2	2	2	2	2	2	2	2
AECC 100.4	2	2	2	2	2	2	2	2
Average	2	2	2	2	2	2	2	2

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
AECC 100.1	2	2	2	2	2
AECC 100.2	2	2	2	2	2
AECC 100.3	2	2	2	2	2
AECC 100.4	2	2	2	2	2
Average	2	2	2	2	2

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
AECC 100.1	2	2	2	2	2	2	2	2	2	2	2	2	2
AECC 100.2	2	2	2	2	2	2	2	2	2	2	2	2	2
AECC 100.3	2	2	2	2	2	2	2	2	2	2	2	2	2
AECC 100.4	2	2	2	2	2	2	2	2	2	2	2	2	2
Average	2	2	2	2	2	2	2	2	2	2	2	2	2

B-MMT 101: Art & Creativity (Theory)

Time:3 Hrs.	Total Marks: 100
Credits: 4	Theory: 80
	Internal Assessment: 20

Course Objectives: This course is designed for theoretical understanding of aesthetics of arts and creating sense of creativity, colours, and design for making artistic content for multimedia composition.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 101.1: Understand art aesthetics including Indian concept of aesthetics.
B-MMT 101.2: Acquire skills to create interesting and interactive components for multimedia.
B-MMT 101.3: Develop the capacities to design, assess, enact with creative projects.
B-MMT 101.4: Develop the ability to link art theory with using creative practices.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit-I

Art: Meaning and Definition of Art
Indian Aesthetics : Ras, Bhav, shadaang, Auchitya, Alankaar, Rasa Nispatti
Elements of Art: Point, Line, Form, Shape, Space, Colour, Texture, Value
Understanding of Light and Shadow
Perception of Color and Color Wheel

Unit II

Principles of Art: Balance, Rhythm, Harmony, Contrast, Proportion, Dominance, Unity
Perspectives on the Creative Process
Landscapes and Composition
Technique of different Art styles: Watercolor, Acrylic painting, pencil color, spray painting, pastel color

Unit –III

Design: concept, 2D shape design,
Character Designing: Creating appealing characters with a distinctive personality, creating a range of characters that work together as a “Cast”
Typography and its types
Calligraphy

Unit IV

Music Theory: History of Indian Music, Vedic Period to 12th century, general discussion on the sangeet, swar, saptak, shruti, thath, raag. naad, gamak, taan and alankar
Chord Progression: basic theory of chords, uses of chords and application of chords for music production
Learn to make chords from ten (10) Thath to all scales

References:

- Jansen, Charles R. *Studying Art History*, Prentice Hall Engle word cliffs, M.J.07632, 1986
- Dhawan, A. K., Dhawan's *Hand Book of History of Art*, Tip Top Trading Co., B-N-1076, HenrySally, *Clay Modeling*,2008
- Huguette Kirby, *Crafts from Modeling Clay*,2006
- Ghertner, ed. *Layout and Composition for Animation*, Focal Press, New York Dennis, H.J., *Elementary Perspective*, BailliereTindall and Cox,
- Ghertner, ed. *Layout and Composition for Animation*, Focal Press, New York
- Srivastav, Harish Chandra, *Raag Paricha;* Sangeet Sadan Prakash*;1971*
- Fox, Dan; *Chord Progression theory and practice;*Alfred Music*;2013*

B-MMT 101: Art & Creativity (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 101.1	3	3	3	3	3	3	3	3
B-MMT 101.2	2	3	3	2	3	3	3	3
B-MMT 101.3	3	2	3	3	3	3	3	3
B-MMT 101.4	3	3	3	3	2	3	3	3
Average	2.75	2.75	3	3	2.75	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 101.1	3	3	3	3	3
B-MMT 101.2	3	3	3	3	3
B-MMT 101.3	3	3	2	3	2
B-MMT 101.4	3	3	3	3	3
Average	3	3	2.75	3	2.75

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 101.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 101.2	2	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 101.3	3	2	3	3	3	3	3	3	3	3	2	3	2
B-MMT 101.4	3	3	3	3	2	3	3	3	3	3	3	3	3
Average	2.75	2.75	3	3	2.75	3	3	3	3	3	2.75	3	2.75

B-MMT 102: Art & Creativity (Practical)

Time:3 Hrs.
Credits: 2

Total Marks: 50
Practical: 40
Internal Assessment: 10

Course Objectives: This course is designed for practical understanding of arts and creating sense towards creativity and design for making artistic contents for multimedia composition.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 102.1: Understand Drawing anatomy and Pencil shading techniques.
B-MMT 102.2: Understand various 2D design patterns
B-MMT 102.3: Demonstrate about 3D textures
B-MMT 102.4: Identify and produce different styles of calligraphy

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Drawing anatomy
Pencil shading techniques
Analogous Colors and Color Wheel
Composition in Art
Landscape drawing
Cartoon character sketch
Patterns and 2D design
Textures and 3D design
Calligraphy
living and non living objects.
Basic concepts in music – pitch, melody, harmony, rhym. ,
Types of musical instruments– string, wind
Percussion and electronic instruments
Indian Classical Music
Western Music: orchestra, instrumentation. Form – song, concerto, symphony, sonata, opera, dance, music
Jazz, country music, rock and roll, blues and heavy metal – Indian Film Music

B-MMT 102: Art & Creativity (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 102.1	3	3	3	3	2	3	2	3
B-MMT 102.2	3	3	3	3	2	3	2	2
B-MMT 102.3	3	2	3	3	3	3	2	2
B-MMT 102.4	3	3	3	3	2	3	2	2
Average	3	2.75	3	3	2.25	3	2	2.25

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 102.1	3	2	3	3	3
B-MMT 102.2	3	2	3	3	3
B-MMT 102.3	3	2	3	3	3
B-MMT 102.4	3	2	2	3	3
Average	3	2	2.75	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 102.1	3	3	3	3	2	3	2	3	3	2	3	3	3
B-MMT 102.2	3	3	3	3	2	3	2	2	3	2	3	3	3
B-MMT 102.3	3	2	3	3	3	3	2	2	3	2	3	3	3
B-MMT 102.4	3	3	3	3	2	3	2	2	3	2	2	3	3
Average	3	2.75	3	3	2.25	3	2	2.25	3	2	2.75	3	3

B-MMT 103: Fundamentals of Computer (Theory)

Time: 3 Hrs. | Total Marks: 100
Credits: 4 | Theory: 80
Internal Assessment: 20

Course Objectives: This course is designed for theoretical understanding of computer system and its components, functioning and its application software exposure.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 103.1: Understand the basic knowledge of computer system.
B-MMT 103.2: Know about the functioning of different parts of computer.
B-MMT 103.3 Understand the basic concept of Internet and computer networks .
B-MMT 103.4: Understand the basics of Application Software.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit - I

Computer- Origin, Evolution and Generation of Computer
Types of Computer
Basic Components of a Computer- Input Devices, Output Devices, Storage Devices
Introduction to Software
Types of Software - System software, Application software
Introduction of Windows and its various versions

Unit- II

Introduction to Internet and Its applications
Browser, Search Engine, FTP, URL
Email and Blog
Introduction to Network- LAN, WAN, MAN,
Network Topologies - Ring, Bus, Star, Mesh and Tree topologies
Hardware requirements for Network

Unit - III

Introduction to MS Word and its uses
Various Menus, Toolbars & Buttons
Paragraph and Page Formatting
Creation & Working with Tables, Mail Merge

Unit - IV

Introduction to MS Excel and its uses
Creating Spreadsheet
Creating Tables and Charts
Use of basic arithmetic formulas
Introduction to MS PowerPoint and its uses
Creating a New Presentation
Slide transition and Custom Animation

References:

- Ram, B. 4th ed New Age; ***Computer Fundamentals: Architecture & Organization***
  Sinha, P. K. BPB; ***Computer Fundamentals: Concepts, Systems & Applications***
- Sinha, P. K/ Sinha, P. 3rd ed BPB; ***Computer Fundamentals: Concepts, Systems & Applications***
  Data Communications and Networking by Behrouz A. Forouzan, Sophia Chung Fegan; Published by Huga Media.2011
- **Goel, Anita Pearson;** *Computer Fundamentals*

B-MMT 103: Fundamentals of Computer (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 103.1	3	3	3	3	3	3	3	3
B-MMT 103.2	3	3	3	3	3	3	3	3
B-MMT 103.3	3	3	3	3	3	3	3	3
B-MMT 104.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 103.1	3	3	3	3	3
B-MMT 103.2	3	3	3	3	3
B-MMT 103.3	3	3	3	3	3
B-MMT 103.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 103.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 103.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 103.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 103.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-MMT 104: Fundamentals of Computer (Practical)

Time: 3 Hrs.	Total Marks: 50
Credits: 2	Practical: 40
	Internal Assessment: 10

Course Objectives: This course is designed for practical understanding of commonly used application software and its functioning to the students.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 104.1: Use MS-Word
B-MMT 104.2: Use MS-Excel
B-MMT 104.3: Use Powerpoint
B-MMT 104.4: Create Email account, compose & send emails for personal and professional communication.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
To create a new document, save, open an existing document
Typing and editing texts in a document (*.doc) file.
Apply formats on Texts like Bold, Italics, Underline, font type, colour and size etc.
Apply features like bullet, numbering, breaks, hyphenation
Indentation, leading and kerning using space bar and TAB
Insert images, symbols and mathematical equations
Create and manipulate tables.
Page layout, Page Setup, Paragraph setting
Page Break, Page Numbering, Find & Replace Text, Header & Footer
Designing Resume, timetable of a class, mail merge
Print a document
Create a Spread Sheet, Cell formatting, Basic arithmetic formulas, Freeze Pane and Sort & Filter, Inserting the chart
Basic operations of Power point, Create PPT and inset and delete slides.
Use of Mater Slide in Presentation.
Apply basic formatting features in presentation like font, font size, font colour, text fill, spacing and line spacing Formatting text boxes, word arts, styles bullet and numbering.
Working with drawing tools, Applying shape or picture styles, Applying object borders, object fill, object effects
Adding slide transition, animation effect, adding custom animation
Working with video, Link to video and sound files.
Creating Email- composing and sending a mail, attachment a file, forwarding the email, changing and setting the password

B-MMT 104: Fundamentals of Computer (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 104.1	3	3	3	3	2	3	3	3
B-MMT 104.2	3	3	3	3	2	3	3	3
B-MMT 104.3	3	3	3	3	2	3	3	3
B-MMT 104.4	3	3	3	3	2	3	3	3
Average	3	3	3	3	2	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 104.1	3	3	3	3	3
B-MMT 104.2	3	3	3	3	3
B-MMT 104.3	3	3	3	3	3
B-MMT 104.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 104.1	3	3	3	3	2	3	3	3	3	3	3	3	3
B-MMT 104.2	3	3	3	3	2	3	3	3	3	3	3	3	3
B-MMT 104.3	3	3	3	3	2	3	3	3	3	3	3	3	3
B-MMT 104.4	3	3	3	3	2	3	3	3	3	3	3	3	3
Average	3	3	3	3	2	3	3	3	3	3	3	3	3

B-MMT 105: Computer Programming (Theory)

Time:3 Hrs. Total Marks: 100
Credits: 4 Theory: 80
Internal Assessment: 20

Course Objectives: This course is designed for theoretical understanding of computer programming terms and concepts for creating an interface between a computer system and users.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 105.1: Understand the keywords and syntax of C programming.
B-MMT 105.2: Write the C code for a given algorithm.
B-MMT 105.3: Understand and trace the execution of programs written in C language.
B-MMT 105.4: Write program that perform operations using various data types.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit-I

C fundamentals: Problem definition, algorithms, flow charts and their symbols
Variables, C Expressions, C Tokens, Constant
Data Types
Standard library: Input / output

Unit-II

Operator and Expressions: Precedence of Arithmetic Operations,
Type Conversion in Expression, Operator Precedence & Associability
Managing Input and Output Operations
Decision Making Statements

Unit-III

Array: One Dimensional Array, Declaration and Initialization of One Dimensional Array, Two Dimensional Array, Multi-dimensional Array
String: Declaring and Initializing Variables, String Handling Functions,

Unit-IV

Functions: Definition of Functions, Elements of user Defined functions,
Return values and their types, Function calls, Function Declaration, Recursion
Structures and Union: Defining structures, declaring structure variables,
Accessing Structure variables, Structure initialization, union

References:

- *Kernighan, Brian; Ritchie, Dennis (1988). The C Programming Language (2 ed.). Prentice Hall.*
- *Plauger, P.J. (1992). The Standard C Library (1 ed.). Prentice Hall.*
- *Banahan, M.; Brady, D.; Doran, M. (1991). The C Book: Featuring the ANSI C Standard (2 ed.). Addison-Wesley.*
- *Harbison, Samuel; Steele Jr, Guy (2002). C: A Reference Manual (5 ed.). Pearson.*
- *King, K.N. (2008). C Programming: A Modern Approach (2 ed.). W. W. Norton.*

B-MMT 105: Computer Programming (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 105.1	3	3	3	3	3	3	3	3
B-MMT 105.2	3	2	3	3	3	3	3	2
B-MMT 105.3	3	3	2	3	3	3	3	2
B-MMT 105.4	3	2	3	3	2	2	2	2
Average	3	2.5	2.75	3	2.75	2.75	2.75	2.25

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 105.1	3	2	3	3	2
B-MMT 105.2	3	2	3	3	2
B-MMT 105.3	3	2	3	3	2
B-MMT 105.4	3	2	3	3	2
Average	3	2	3	3	2

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 105.1	3	3	3	3	3	3	3	3	3	2	3	3	2
B-MMT 105.2	3	2	3	3	3	3	3	2	3	2	3	3	2
B-MMT 105.3	3	3	2	3	3	3	3	2	3	2	3	3	2
B-MMT 105.4	3	2	3	3	2	2	2	2	3	2	3	3	2
Average	3	2.5	2.75	3	2.75	2.75	2.75	2.25	3	2	3	3	2

B-MMT 106: Computer Programming (Practical)

Time: 3 Hrs.	Total Marks: 50
Credits: 2	Practical: 40
	Internal Assessment: 10

Course Objectives: This course is designed for those who want to advance structured and procedural understanding and to improve c programming skills.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 106.1: Implement the algorithms and draw flowcharts.
B-MMT 106.2: Demonstrate an understanding of computer programming language concepts
B-MMT 106.3: Define data types and use them.
B-MMT 106.4: Use the concepts of arrays, functions and structure.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Sum of three Number
Simple interest
Find Even/odd number
Largest among two numbers
Largest among three number using control statement
Fibonacci Series.
Prime number
Factorial.
Sum of Digits.
Reverse Number.
Swap two numbers
Table of a number
Create and initialize array
Create student records using structure and union.

B-MMT 106: Computer Programming (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 106.1	3	3	3	3	3	3	3	3
B-MMT 106.2	3	2	3	3	3	3	3	2
B-MMT 106.3	3	3	2	3	3	3	3	2
B-MMT 106.4	3	2	3	3	2	2	2	2
Average	3	2.5	2.75	3	2.75	2.75	2.75	2.25

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 106.1	3	2	3	3	2
B-MMT 106.2	3	2	3	3	2
B-MMT 106.3	3	2	3	3	2
B-MMT 106.4	3	2	3	3	2
Average	3	2	3	3	2

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 106.1	3	3	3	3	3	3	3	3	3	2	3	3	2
B-MMT 106.2	3	2	3	3	3	3	3	2	3	2	3	3	2
B-MMT 106.3	3	3	2	3	3	3	3	2	3	2	3	3	2
B-MMT 106.4	3	2	3	3	2	2	2	2	3	2	3	3	2
Average	3	2.5	2.75	3	2.75	2.75	2.75	2.25	3	2	3	3	2

B-MMT 107: Fundamentals of Multimedia

Time: 3 Hrs.
Credits: 6

Total Marks: 150
Theory: 120
Internal assessment: 30

Course objectives: This course aims to introduce the fundamental elements of multimedia. The emphasis will be on learning the representations, perceptions and applications of multimedia.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 107.1 Understand the basic concepts of Multimedia.
B-MMT 107.2 Differentiate the various features and capabilities of different application software.
B-MMT 107.3 Communicate ideas and concepts by using the multimedia.
B-MMT 107.4 Identify and describe the function of the general skill sets in the multimedia industry.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit-I

Introduction to multimedia
Key elements of multimedia: text, audio, video, graphics, animation
Hardware and software requirements for multimedia
Multimedia equipments
Applications of multimedia

Unit-II

Desktop publishing
Basic design concepts
User interface design
Hypermedia authoring concepts

Unit-III

Process of multimedia production
Various file formats of text, audio, video, graphics and animation
File compression techniques
Creating web based multimedia

Unit-IV

Introduction to animation
Basic audio and video integration techniques
Animation effects
Production process of animation

References:

- Multimedia Basics, Volume 1 by Andreas Holzinger, Firewall Media.
- Fundamentals of Multimedia, Ze-Nian Li, Mark S. Drew, Pearson Prentice Hall, 2004
- Multimedia Basics, Suzanne Weixel, Jennifer Fulton, Karl Barksdale, Cheryl Morse, Bryan Morse, Thomson/Course Technology
- Malik and Agarwal, S. and A. (October 2012). "Use of Multimedia as a New Educational Technology Tool–A Study"(PDF). *International Journal of Information and Education Technology*.

B-MMT 107: Fundamentals of Multimedia

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 107.1	3	3	3	3	3	3	3	3
B-MMT 107.2	3	3	3	3	3	3	3	3
B-MMT 107.3	3	3	3	3	3	3	3	3
B-MMT 107.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 107.1	3	3	3	3	3
B-MMT 107.2	3	3	3	3	3
B-MMT 107.3	3	3	3	3	3
B-MMT 107.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 107.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 107.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 107.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 107.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-EVS 100 : Environment Studies

Time: 3 Hrs.
Credits: 2

Total Marks: 50
Theory: 40
Internal Assessment: 10

Scheme of paper: Total number of questions will be nine. Students have to attempt five questions in all. Questions no. 1 is compulsory. All questions carry equal marks. Each question is of 8 marks.

Course objectives: The aim of this course is to aware the students about the environmental problems and current global issues related to environment. It provides knowledge about the topics like ecosystem and biodiversity and develops interest in the students about their role in conservation of environment and reducing pollution and waste generation in their surroundings. By understanding the environmental problems, their causes and solutions, the students can apply it to their daily lives also.

Course Outcomes:

COs	On successful completion of the course, the students will be able to:
1	Understand the definition of environmental studies, its scope and importance in the conservation of environment.
2	Understand the concept of ecosystem and different types of natural and artificial ecosystems in the world, the biogeochemical cycling and energy flow in an ecosystem.
3	Describe the various renewable and non-renewable natural resources and their over-exploitation due to increasing demands of rising population.
4	Become aware about our biodiversity, its importance and the various threats that are a problem for the biodiversity. They will understand the endangered species and their conservation measures that are needed to be adopted at different levels.
5	Have understanding about the types of pollution and how to reduce those pollution levels in air, soil, water, land and from marine bodies as well. They will develop interest in reducing the solid waste generation as well as its management at household level.

6	Gain knowledge of various global environmental issues like climate change, global warming and ozone depletion and also about different environmental laws implemented to conserve the environment.
7	Explain the concept of population growth and drug abuse.

Unit 1: Introduction to environmental studies

Multidisciplinary nature of environmental studies;

Scope and importance; Concept of sustainability and sustainable development. (2 lectures)

Unit 2: Ecosystems

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.

Case studies of the following ecosystems :

a) Forestecosystem
b) Grasslandecosystem
c) Desertecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (6 lectures)

Unit 3: Natural Resources: Renewable and Non-renewable Resources

Land resources and landuse change; Land degradation, soil erosion and desertification.

Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

Energy resources: Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 lectures)

Unit 4: Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots

India as a mega-biodiversity nation; Endangered and endemic species of India

Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

(8 lectures)

Unit 5 : Environmental Pollution

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution

Nuclear hazards and human health risks

Solid waste management: Control measures of urban and industrial waste.

Pollution case studies. (8 lectures)

Unit 6 : Environmental Policies & Practices

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

(7 lectures)

Unit 7: Human Communities and the Environment

Human population growth: Impacts on environment, human health and welfare.

Resettlement and rehabilitation of project affected persons; case studies.

Disaster management: floods, earthquake, cyclones and landslides.

Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.

Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi)

Drugs and their effects; Useful and harmful drugs; Use and abuse of drugs; Stimulant and depressant drugs. Concept of drug de-addiction. Legal position on drugs and laws related to drugs.

(6 lectures)

Unit 8: Field work

Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.

Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.

Study of common plants, insects, birds and basic principles of identification.

Study of simple ecosystems-pond, river, Delhi Ridge, etc.

(Equal to 5 lectures)

Suggested Readings:

1) Carson, R. 2002. Silent Spring. Houghton MifflinHarcourt.
2) Gadgil,M.,&Guha,R.1993.ThisFissuredLand:AnEcologicalHistoryofIndia.Univ.ofCalifor niaPress.
3) Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London,Routledge.
4) Gleick,P.H.1993.WaterinCrisis.PacificInstituteforStudiesinDev.,Environment&S ecurity. Stockholm Env. Institute, Oxford Univ.Press.
5) Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates,2006.
6) Grumbine,R.Edward,andPandit,M.K.2013.Threats fromIndia's Himalayadams.Science,339:36-37.
7) McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). ZedBooks.
8) McNeill,JohnR.2000.SomethingNewUndertheSun:AnEnvironmentalHistoryoftheTw entieth Century.
9) Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia:Saunders.
10) Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science.Academic Press.
11) Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
12) 12.Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
13) Rosencranz,A.,Divan,S.,&Noble,M.L.2001.EnvironmentallawandpolicyinIndia.Tripat hi1992.
14) Sengupta, R. 2003. Ecology and economics: An approach to sustainable development.OUP.
15) Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, NewDelhi.
16) Sodhi,N.S.,Gibson,L.&Raven,P.H.(eds).2013.ConservationBiology:VoicesfromtheTro pics.John Wiley &Sons.
17) Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
18) Warren, C. E. 1971. Biology and Water Pollution Control. WBSaunders.
19) Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York:Norton.
20) World Commission on Environment and Development. 1987. Our Common Future. OxfordUniversity

B-HIN 100 : Communicative Hindi

Time: 2 Hrs. Total Marks: 50
Credits: 2 Theory: 40
Internal assessment: 10

Course Objectives: The Paper is designed to enhance proficiency in Hindi Language. It seeks to develop the basic of Hindi Language through different modules. Each unit will enable the learner to have the communication in Hindi and to share and express ideas and experiences.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-HIN 100.1: Develop the knowledge of basics of Hindi language.
B-HIN 100.2: Improve vocabulary in Hindi language.
B-HIN 100.3: : Inculcate the knowledge of grammar in Hindi language
B-HIN 100.4: Learn correct uses of Hindi language in media writing

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

bdkb ¼1½

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Hkk"kk rFkk lekt dk ikjLifjd vUrj&lc/k
fgUnh Hkk"kk dk bfrgkl ,o vk/kfud Áofr;kA

bdkb ¼2½

Á;ktu eyd fgUnh % fo'k"krk, ,o vko';drk
fgUnh Hkk"kk dh Ae[k ckyh ,o egÙo
tUklpkj ek/;e vkj fgUnh Hkk"kk A
fgUnh Hkk"kk ,o {k=h; ÁHkko
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bdkb ¼3½

fgUnh 0;kdj.k % 'kCn d :i] Hkn vkj okD; jpuk
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fgUnh dh Á;kxkred =fV;k

bdkb ¼4½

efnr ek/;e vkj fgUnh Hkk"kk] lekpkj y[ku
jfM;k dh Hkk"kk ,o y[kuA
Vyhfotu dh Hkk"kk vkj y[ku
foKkiu dh Hkk"kk vkj y[ku
Lkk'ky ehfM;k dh Hkk"kk vkj y[kuA

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lekpkj y[ku] :id y[ku] dl'ku y[ku

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- HkkfV;k] M, dyk'kpUn] vuokndyk] fl)kr vkj ç;kx] r{kf'kyk çdk'ku] ub fnYyh
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- frokjh] HkkykukFk] fgUnh Hkk"kk dh lkekftd Hkfedk] nf{k.k Hkkjr fgUnh çpkj lfefr] eækl
- >kYV] M,- nxy] ç;ktueyd fgUnh fl)kr vkj ç;kx] ok.kh çdk'ku] ub fnYyh
- xknj] M,- foukn] ç;ktu eyd fgUnh] ok.kh çdk'ku] ub fnYyh
- jk.kk] egUæ flg] ç;ktu eyd fgUnh d vk/kfud vk;ke] g"k çdk'ku] vkxjk
- dekj pn] tulpkj ek/;ek e fgUnh] Dykfldy ifCyf'kx dEiuh] fnYyh

B-HIN100 : Communicative Hindi

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-HIN100.1	3	3	3	3	2	2	2	3
B-HIN100.2	3	3	3	3	2	2	2	3
B-HIN100.3	3	3	3	3	2	2	2	3
B-HIN100.4	3	3	3	3	2	2	2	3
Average	3	3	3	3	2	2	2	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-HIN100.1	2	2	2	2	2
B-HIN100.2	2	2	2	2	2
B-HIN100.3	2	2	2	2	2
B-HIN100.4	2	2	2	2	2
Average	2	2	2	2	2

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-HIN100.1	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.2	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.3	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.4	3	3	3	3	2	2	2	3	2	2	2	2	2
Average	3	3	3	3	2	2	2	3	2	2	2	2	2

B-MMT 201: Graphic Design (Theory)

Time:3 Hrs. | Total Marks: 100
Credits: 4 | Theory: 80
Internal assessment: 20

Course Objectives: This course is designed for thorough understanding of computer graphic designing software concepts and their user interface and for learning the graphic tools using that interface.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 201.1: Understand the basic concepts of graphic elements
B-MMT 201.2: Know the functioning of basic colour aesthetics
B-MMT 201.3: : Develop the capacities to elaborate the process of graphic design
B-MMT 201.4: Develop ability to design various real world graphic applications.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit-I

Introduction to graphics, tools of graphics
Uses & Types of graphics
Meaning, definition, Elements and principles of graphic design
Study of vector images- its advantage and application areas,
Difference between vector and raster images

Unit-II

Introduction to Photoshop Tools and Menus
Layers and blending modes
Color theory; saturation, tint, shades, tones
Color modes, editing a Swatch, using patterns,
Working with brushes

Unit-III

Working with texts: Threading text, using text effects and styles, wrapping text
Introduction to Logo: types, elements and purpose of logo
Process of logo designing
Introduction to poster and types

Unit-IV

Social media posts:
Pamphlets, ad banners,
Designing Photo Collage, Black & White images to Color
WebBanner with different sizes for Websites

Facebook covers, Magazine covers designing
E-mailers design

References:

- Computer Graphics, C Version By Hearn & Becker, Pearson Education, India
- Computer Graphics by Sinha & Udai, Tata McGraw Hill, India
- Fundamentals of Computer Graphics By Peter Shirley, Michael Ashikhmin, Steve Marschner, CRC Press
- Fundamentals of Computer Graphics And Multimedia by D. P. Mukherjee, PHI Learning Pvt. Ltd.
- Graphic Designers : Occupational Outlook Handbook:U.S. Bureau of Labor Statistics

B-MMT 201: Graphic Design (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 201.1	3	3	3	3	3	3	3	3
B-MMT 201.2	3	3	3	3	3	3	3	3
B-MMT 201.3	3	3	3	3	3	3	3	3
B-MMT 201.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 201.1	3	3	3	3	3
B-MMT 201.2	3	3	3	3	3
B-MMT 201.3	3	3	3	3	3
B-MMT 201.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 201.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 201.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 201.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 201.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-MMT 202: Graphics Design (Practical)

Time:3 Hrs.	Total Marks: 50
Credits: 2	Practical: 40
	Internal Assessment: 10

Course Objectives: This course is designed for practical understanding of graphic designing and menus, tools and its applications and production formats.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 202.1: Make use of graphic elements
B-MMT 202.2: Demonstrate the concept of image retouching, smoothing.
B-MMT 202.3: Design ad banners for websites and digital campaigning banners.
B-MMT 202.4: Design different logos.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Selection and cutting of objects
Creating backgrounds and textures
Image retouching, Smoothing skin & wrinkles
Photo Manipulation
Working with texts and paragraph styles
Creating of logo
Working with colours
Designing ad banners for websites
Creating digital campaigning banners

B-MMT 202: Graphic Design (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 202.1	3	3	3	3	3	3	3	3
B-MMT 202.2	3	3	3	3	3	3	3	3
B-MMT 202.3	3	3	3	3	3	3	3	3
B-MMT 202.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 202.1	3	3	3	3	3
B-MMT 202.2	3	3	3	3	3
B-MMT 202.3	3	3	3	3	3
B-MMT 202.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 202.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 202.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 202.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 202.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-MMT 203: Audio Production (Theory)

Time: 3 Hrs.
Credits: 4

Total Marks: 100
Theory: 80
Internal assessment: 20

Course Objectives: This course is designed for the understanding of sound engineering concepts, audio recording and editing console and its work flow and reproduction formats..

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 203.1: Understand the principles of editing and enhancing film sound.
B-MMT 203.2: Identify the different stages of sound production.
B-MMT 203.3: Discuss the strategies used for the editing of audio production.
B-MMT 203.4: Demonstrate the initial steps to set up a control room mixing board for a multitrack.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit I

Principles of Sound- Quality, Intensity, Frequency, Noise, Amplitude, Velocity

Audio Equipments- Microphones, Monitors, MIDI, Audio Sound Card, Headphones, Signal Processing, Mixing Console

Unit II

Sound Interface: Panel, Track & Edit, Channel Setting, Tools, Snap Functioning, VST Fundamentals, Key Editor, Inspector Window, Zones, Strategies in Designing Sound

Unit III

Mix Console Fundamentals: Chords & Scale, Beat Designing, Uses of Automation, MIDI Programming, Layering and Arrangement, Equalization, Compressor, Understanding Frequency Bands

Unit IV

Audio Channel Output - Mono, Stereo, Dolby, Surround, Woofer, Tutor

Creative Uses of Sound - Studio, Live Speech, Music, Live Show, Interview, Audio Editing, Dubbing

Sound Isolation, Room Dimension, Acoustic Treatment, Control Room Design

References:

- Senior, Mike; Mixing Secrets for the Small Studio (2nd Edition), Published by Focal Press, a division of Taylor & Francis, ISBN 978-1-13-855637-9
- Cook, Frank D.; Cubase 101; Music Production with Cubase 10, Hal Leonard, 2019
- Kaye, Deena; Lebrecht, James (1992). Sound and Music For The Theatre. Back Stage Books, an imprint of Watson-Guptill Publications.

B-MMT 203: Audio Production (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 203.1	3	3	3	3	2	3	3	3
B-MMT 203.2	3	3	3	3	2	3	3	3
B-MMT 203.3	3	3	3	3	3	3	3	3
B-MMT 203.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	2.5	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 203.1	3	3	3	3	3
B-MMT 203.2	3	3	3	3	3
B-MMT 203.3	3	3	3	3	3
B-MMT 203.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 203.1	3	3	3	3	2	3	3	3	3	3	3	3	3
B-MMT 203.2	3	3	3	3	2	3	3	3	3	3	3	3	3
B-MMT 203.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 203.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	2.5	3	3	3	3	3	3	3	3

B-MMT-204: Audio Production (Practical)

Time: 3 Hrs. Total Marks: 50
Credits: 2 Practical: 40
Internal Assessment: 10

Course Objectives: This course is designed for practical understanding of audio recording and editing console and its work flow and reproduction formats.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 204.1 Design sound for the production.
B-MMT 204.2: Work on different stages of sound production.
B-MMT 204.3 Edit and amplify sound.
B-MMT 204.4 Add the special effect to the sound.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Dubbing – narration, commentary
Dubbing and multi-track recording
Multi track dubbing
Multi-track FX recording
Re-recording and final mix
FX- pre-mixing, BGM mixing
Multi track FX mixing and multitrack BGM mixing
Final mixing and Mastering Multi track voice levelling with mixing
multi track FX mixing
Multi track BGM mixing, Bouncing and Mastering

B-MMT 204: Audio Production (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 204.1	3	3	3	3	2	3	3	3
B-MMT 204.2	3	3	3	3	2	3	3	3
B-MMT 204.3	3	3	3	3	3	3	3	3
B-MMT 204.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	2.5	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 204.1	3	3	3	3	3
B-MMT 204.2	3	3	3	3	3
B-MMT 204.3	3	3	3	3	3
B-MMT 204.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 204.1	3	3	3	3	2	3	3	3	3	3	3	3	3
B-MMT 204.2	3	3	3	3	2	3	3	3	3	3	3	3	3
B-MMT 204.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 204.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	2.5	3	3	3	3	3	3	3	3

B-MMT 205: Basics of Animation (Theory)

Time: 3 Hrs. Total Marks: 150
Credits: 6 Theory: 120
Internal assessment: 30

Course Objectives: This course is designed to teach the students very fundamentals of Animation. They will get to learn all the principles which will help them to learn and understand how actual animation works

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 205.1: Familiarize with various approaches, methods and techniques of Animation Technology.
B-MMT 205.2: Explore different approaches in computer animation.
B-MMT 205.3: Get knowledge about Flipbook, Storyboarding.
B-MMT 205.4: Get knowledge about production stages of animation.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit I

Principles of Sound- Quality, Intensity, Frequency, Noise, Amplitude, Velocity

Audio Equipments- Microphones, Monitors, MIDI, Audio Sound Card, Headphones, Signal Processing, Mixing Console

Unit II

Sound Interface: Panel, Track & Edit, Channel Setting, Tools, Snap Functioning, VST Fundamentals, Key Editor, Inspector Window, Zones, Strategies in Designing Sound

Unit III

Mix Console Fundamentals: Chords & Scale, Beat Designing, Uses of Automation, MIDI Programming, Layering and Arrangement, Equalization, Compressor, Understanding Frequency Bands

Unit IV

Audio Channel Output - Mono, Stereo, Dolby, Surround, Woofer, Tutor

Creative Uses of Sound - Studio, Live Speech, Music, Live Show, Interview, Audio Editing, Dubbing

Sound Isolation, Room Dimension, Acoustic Treatment, Control Room Design

B-MMT 205: Basics of Animation (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 205.1	3	3	3	3	3	3	3	3
B-MMT 205.2	3	3	3	3	3	3	3	3
B-MMT 205.3	3	3	3	3	3	3	3	3
B-MMT 205.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 205.1	3	3	3	3	3
B-MMT 205.2	3	3	3	3	3
B-MMT 205.3	3	3	3	3	3
B-MMT 205.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 205.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 205.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 205.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 205.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-MMT 206: Web Programming using HTML (Theory)

Time: 3 Hrs.	Total Marks: 100
Credits: 4	Theory: 80
	Internal assessment: 20

Course Objectives: This course is designed for understanding the process of static website making and creating software application tools like lists, tables, hyperlinks etc. using html tags.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 206.1: Become familiar with web design and learn how to implement web theories into practice.
B-MMT 206.2: Learn the language of the web using HTML tags and CSS.
B-MMT 206.3: Use knowledge of HTML and CSS code and HTML editor to create personal and business websites following current professional and/or industry standards.
B-MMT 206.4: Use critical thinking skills to design and create websites.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit I

Process of static web designing
Basic elements of web page
Role of typography
Aesthetics in colour and image selection

Unit II

HTML: introduction and basic elements;
Tags and functions
Head, title and body elements
Block and text level elements

Unit III

Layout designing of a webpage
Links, images, fonts, colour, style sheet and character entities
Text formatting
Interface between HTML and other coding languages

Unit IV

HTML tables and frames
Creating Page Structure with HTML Tables
Diagramming an HTML Table
Web browser support for HTML

References:

"An Introduction to HTML and JavaScript: for Scientists and Engineers" By David R. Brooks, Springer, 2007

"Head First HTML and CSS" By Elisabeth Robson, Eric Freeman, O'Reilly Media Inc.

"Schism's Easy Outline HTML" By David Mercer, Mcgraw Hill Professional

Matthew MacDonald, "HTML 5 - The Missing Manual", 3rd ed, 2015, O'Reilly

David Sawyer McFarland, "CSS 3 - The Missing Manual", 3rd ed, 2013, O'Reilly

W3School HTML/CSS Tutorials, References and Examples, http://www.w3schools.com

B-MMT 206: Web Programming using HTML (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 206.1	3	3	3	3	3	3	3	3
B-MMT 206.2	3	3	3	3	3	3	3	3
B-MMT 206.3	3	3	3	3	3	3	3	3
B-MMT 206.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 206.1	3	3	3	3	3
B-MMT 206.2	3	3	3	3	3
B-MMT 206.3	3	3	3	3	3
B-MMT 206.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 206.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 206.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 206.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 206.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-MMT 207: Web Programming using HTML (Practical)

Time: 3 Hrs. Total Marks: 50
Credits: 2 Practical: 40
Internal Assessment: 10

Course Objectives: This course is designed for practical understanding of static website making and creating software application tools like lists, tables, hyperlinks etc. using html tags.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-MMT 207.1: Insert graphic elements within a webpage.
B-MMT 207.2: Create a link/hyperlink with in a webpage.
B-MMT 207.3: Insert table, headings, ordered list, unordered list with in a web
B-MMT 207.4: Use Cascading style sheet (CSS) with in a web page.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Introduction to HTML. Create a basic HTML file
Create a static web page which defines all text formatting tags of HTML
Create a Time table using table tags of HTML
Create webpage using list tags of HTML(ordered, unordered, definition list)
Create webpage to include image using HTML tag
Create link using HTML tag
Create a layout of webpage using HTML tag
Create employee registration form using HTML tag
Apply style sheet in Web page (inline, embedded and link)
Create a static website using HTML tags according to their own interest

B-MMT 207: Web Programming using HTML (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-MMT 207.1	3	3	3	3	3	3	3	3
B-MMT 207.2	3	3	3	3	3	3	3	3
B-MMT 207.3	3	3	3	3	3	3	3	3
B-MMT 207.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-MMT 207.1	3	3	3	3	3
B-MMT 207.2	3	3	3	3	3
B-MMT 207.3	3	3	3	3	3
B-MMT 207.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-MMT 207.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 207.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 207.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-MMT 207.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

Learning Outcomes-based Curriculum Framework (LOCF)

for

B.Sc. (Graphics & Animation)

A Three Year Bachelor Degree Programme

under

Choice Based Credit System (CBCS)/Learning Outcomes-based Curriculum Framework(LOCF)

w.e.f. Academic Session 2020-21.
Eligibility : 10+2 in any discipline

Institute of Mass Communication & Media Technology
Kurukshetra University, Kurukshetra

Proposed Scheme for Choice Based Credit System in B.Sc. Graphics & Animation Programme

Semester	CORE COURSE (CC) @ 6 Credits	Ability Enhancement Compulsory Course (AECC) @ 2 Credits	Skill Enhancement Course (SEC) @ 2 Credits	Discipline Specific Elective DSE @ 6 Credits
I	CC- 1 CC- 2 CC- 3 CC- 4	(English/MIL Communication)/Environ mental Studies		
II	CC- 5 CC- 6 CC- 7 CC- 8	(English/MIL Communication) / Environmental Studies, Hindi		
III	CC- 9 CC- 10 CC- 11 CC- 12		SEC-1	
IV	CC- 13 CC- 14 CC- 15 CC- 16		SEC -2	
V			SEC -3/MOOC*	DSE-1 (Elective Subject)
				DSE-2 (Elective Subject)
				DSE-3 (Elective Subject)
	Internship/Industry Training **			
VI			SEC-4	DSE-4 (Elective Subject)
				DSE-5 (Elective Subject)
				DSE-6 (Elective Subject)

AECC will be offered according to the time table adjustments in the Institute/Department.

*MOOC Course from Swayam Portal.
** SEC can be offered in 3rd/4th/5th semester according to the time table adjustments in the institute.

****Internship/Industry Training** A candidate must complete industry training of 4 to 6weeks after completion of theory examination of 4th semester. The internship report will be submitted in 5th semester.

General instructions:

- One credit equivalent to 1 hour of teaching/2 hours of Practical work

- Teaching workload will be calculated on the basis of teaching contact hours of the course
- One credit (theory /Practical) equivalent to 25 marks

Total No. of Courses, Credit and Marks

Course	No. of Courses	Credits Teaching/Week	Credits Practical/ Week	Credits Tutorials/Week	Total Credits	Marks
Core Courses	16	2x5=10 14x4=56 Total=66	14x2=28	2x1=2	10+56+28 +2=96	16x150 =2400
AECC	3	3x2=6	--	--	6	3x50 =150
SEC	4	4x2=8	--	--	8	4x50 =200
DSE	6	6x4=24	6x2=12	--	24+12=36	6x150 =900
Industrial Training	--	--	--	--	2	1x50 =50
Total	**29**	**104**	**40**	**2**	**148**	**3700**

Scheme of Examination of B.Sc. Graphics & Animation under CBCS/LOCF for Institute of Mass Communication & Media Technology (IMC&MT, KUK) w.e.f. Academic Session2020-21

Semester-I

Course Code	Course Title	Course Type	Contact Hours per Week				Credits	Total Credits	Marks				Duration of Exam
			L	T	P	Total			T	P	IA	Total	
AECC-100	Communicative English	AECC-1	2	-	-	2	2	2	40	-	10	50	2 Hours
B-GAG 101	Visual Communication	CC-1	5	1	-	6	6	6	120	-	30	150	3 Hours
B-GAG 102	Animation History and Production Process	CC-2	5	1	-	6	6	6	120	-	30	150	3 Hours
B-GAG 103	Digital Art & Sketching (Theory)	CC-3	4	-	-	4	4	6	80	-	20	100	3 Hours
B-GAG 104	Digital Art & Sketching (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-GAG 105	Fundamentals of Computer (Theory)	CC-4	4	-	-	4	4	6	80	-	20	100	3 Hours
B-GAG 106	Fundamentals of Computer (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
							Total Credits	**26**	**Total Marks**			**650**	

Semester-II

Course Code	Course Title	Course Type	Contact Hours per Week				Credits	Total Credits	Marks				Duration of Exam
			L	T	P	Total			T	P	IA	Total	
B-EVS 100	Environmental Studies	AECC-2	2	-	-	2	2	2	40	-	10	50	3 Hours
B-HIN 100	Communicative Hindi	AECC-3	2	-	-	2	2	2	40	-	10	50	2 Hours
B-GAG 201	Script, Storyboard & Animatic(Theory)	CC-5	4	-	-	4	4	6	80	-	20	100	3 Hours
B-GAG 202	Script, Storyboard & Animatic (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-GAG 203	Digital Design & Raster Graphics (Theory)	CC-6	4	-	-	4	4	6	80	-	20	100	3 Hours
B-GAG 204	Digital Design & Raster Graphics (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-GAG 205	Comic Design & Character Anatomy (Theory)	CC-7	4	-	-	4	4	6	80	-	20	100	3 Hours
B-GAG 206	Comic Design & Character Anatomy (Practical)		-	-	2	4	2		-	40	10	50	3 Hours
B-GAG 207	Experimental Animation Techniques (Theory)	CC-8	4	-	-	4	4	6	80	-	20	100	3 Hours
B-GAG 208	Experimental Animation Techniques		-	-	2	4	2		-	40	10	50	3 Hours

	(Practical)												
Total Credits								**28**	**Total Marks**			**700**	

List of Total Subjects in B.Sc. Graphics & Animation:

Sr. No.	Course Type	Number of Subjects
1	CC	16
2	AECC	03
3	SEC	04
4	DSE	06
	Total	**29**

	Course Type	Number of Subjects
Semester I		
	CC	4
	AECC	1
Semester II	CC	4
	AECC	2
Semester III	CC	4
	SEC	1
Semester IV	CC	4
	SEC	1
Semester V	SEC	1
	DSE	3
Semester VI	SEC	1
	DSE	3
Total		**29**

List of Abbreviations

L - Lecture
T- Tutorial
P- Practical
IA – Internal Assessment
CC- Core Course
AECC- Ability Enhancement Compulsory Course
SEC- Skill Enhancement Course
DSE- Discipline Specific Elective

PROGRAMME OUTCOMES

On successful completion of the programme, the student will be able to:-

PO1 Acquire knowledge related to the discipline under study.

PO2 Communicate and reflect effectively and efficiently on the issues related to the discipline.

PO3 Exhibit the professional skills and competencies acquired during the Programme of study.

PO4 Apply the knowledge and skills acquired in planning, organizing, evaluation and decision making.

PO5 Explore, analyze and provide solutions to the problems related to the discipline and life.

PO6 Develop exposure to actual working environment leading to employability and entrepreneurship.

PO7 Exhibit scientific & research capabilities in academic, professional and general life pursuits.

PO8 Recognize, appreciate and follow ethical issues relating to the discipline and society.

Programme Specific Outcomes:

After completion of under graduate programme in Graphics & Animation, the learner will be able to :

PSO1 Acquire knowledge about graphics and animation as visual communication tool.

PSO2 Develop competencies and skills needed for becoming an effective graphic designer and animation artist.

PSO3 Develop competency for employability and entrepreneurship by practicing various designing and animation applications.

PSO4 Understand the significance of good design to build the brand identity.

PSO5 Demonstrate critical & aesthetical skills through design, animation and visual effects projects.

AECC-100: Communicative English

Time: 2 Hrs.	Total Marks: 50
Credits: 2	Practical: 40
	Internal Assessment: 10

Course objectives: The paper is designed to enhance proficiency in English Language. It seeks to develop the basics of English Language through different modules. Each unit will enable and capacitate the learner to have communication competence which is required in the present-day world. The basic knowledge of communication will enable the learners to share and enliven ideas, experience and know-how ubiquitous in the world.

Course Learning Outcomes:
After completing the Course, the student will be able to:
AECC 100.1:Learn the rhetoric of presentation
AECC 100.2: Learn, comment and respond to correspondence.
AECC 100.3: Learn the basics of grammar and composition.
AECC 100.4: Acquaint with verbal and non-verbal communication.

Note : All questions are compulsory.

Q.1. The paper setter will set two questions from unit-II. The student shall attempt one out of the given two. (10)

Q.2. This question shall be based on unit-III. The student shall attempt one out of the given two. (10)

Q.3. There will be 25 grammatical items based on unit-IV. The student shall attempt any 20 items. (10)

Internal Assessment: The students shall be required to make presentation /PPT based on unit-I.

Unit-I

Listening and speaking skills

Listening skills(Active-passive, Accent)

Speaking Skills(Accent, Stress, Intonation, Assertion, Rhetorical questions, Pause, Pitch)

Oral presentation, Debates, Elocution and Extempore

Unit-II

Writing skills

Report writing

Paragraph writing

Letter writing

Unit-III

Technical and Modern communication

Resume writing

E-mail

Blogs and comments on social media

Unit-IV

Grammar

Noun, Pronoun, Verb, Adverb, Adjective, Preposition, Conjunction and their uses

Common errors in the use of English (Noun ,Pronoun, Adjective, Adverb,Conjunctions)

Correct use of verbs and Articles

Vocabulary: Homonyms, Homophones, Pair of words

References:

- Communicative English, Dr. Jimmy Sharma, ArihantParkashan Pvt. Ltd.
- Strengthen Your English, Bhaskaran and Horsburgh, Oxford University Press
- Basic Communication Skills for Technology, and area J Rutherfoord, Pearson Education Asia.
- Murphy's English Grammar with CD, Murphy, Cambridge University Press
- English Skills for Technical Students by Orient Longman
- Everyday Dialogues in English by Robert J. Dixson, Prentice-Hall of India Ltd., 2006.

AECC-100: Communicative English

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
AECC 100.1	2	2	2	2	2	2	2	2
AECC100.2	2	2	2	2	2	2	2	2
AECC 100.3	2	2	2	2	2	2	2	2
AECC 100.4	2	2	2	2	2	2	2	2
Average	2	2	2	2	2	2	2	2

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
AECC 100.1	2	2	2	2	2
AECC100.2	2	2	2	2	2
AECC 100.3	2	2	2	2	2
AECC 100.4	2	2	2	2	2
Average	2	2	2	2	2

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
AECC 100.1	2	2	2	2	2	2	2	2	2	2	2	2	2
AECC100.2	2	2	2	2	2	2	2	2	2	2	2	2	2
AECC 100.3	2	2	2	2	2	2	2	2	2	2	2	2	2
AECC 100.4	2	2	2	2	2	2	2	2	2	2	2	2	2
Average	2	2	2	2	2	2	2	2	2	2	2	2	2

B-GAG 101: Visual Communication

Time:3 Hrs. Total Marks: 150
Credits: 6 Theory: 120
Internal Assessment: 30

Course Objectives: The academic work in the Semester aims at an understanding of the basic elements of compositions that merge to form the language of visual communication.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 101.1: Become aware of the principles and elements of aesthetic including Indian concept.
B-GAG 101.2: Understand the grammar of visual narratives.
B-GAG 101.3: Gain the ability to compose visuals and visual narratives
B-GAG 101.4: Develop creative problem solving skills used in communicating visually as an artist.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit-I

Introduction:

Communication : Concept, Process and significance
Communication Types : Verbal and Non Verbal
Visual Communication: Meaning and Definition
Design Theory: Gestalt Principal, Visual Perception
AIDA Model

Unit II

Basics of Art:

Meaning and Definition of Art
Elements of Art: Point, Line, Form, Shape, Space, Colour, Texture, Value,
Principles of Art: Balance, Rhythm, Harmony, Contrast, Proportion, Dominance, Unity
Process of Designing and A-B Testing

Unit –III

Art Aesthetics:

Aesthetics of Art: Origin of Aesthetics
Meaning and definition of Aesthetics, importance of Aesthetics in arts and animation
Indian concept of Aesthetics and theory of Ras, Bhava, Shadaang, Auchitya, Alankaar, Rasa Nispatti

Unit IV

Compositional Theories:

Golden Rules: Rule of Third, Golden Section, Golden Triangles, Spiral Section, Diagonal, Radial,
Perspective: One Point, Two Point and Three Point
Positive & Negative space

<u>References:</u>

- Golombisky, K., & Hagen, R. (2017). White space is not your enemy: A beginner's guide to communicating visually through graphic, web & multimedia design. CRC Press.
- Smith, K. (2005). Handbook of visual communication: Theory, methods, and media.
- Lester, E (2000) Visual Communications: Images with Messages. Thomson Learning
- Schildgen, T (1998). Pocket Guide to color with digital applications. Thomsom Learning
- Picture this: Media Representation of Visual Arts and artists. University of Luton Press
- Palmer, Frederic: Visual Elements of Art and Design, 1989, Longman
- Porter, Tom and Goodman, Sue: Manual of Graphic Technique 2: For Architects,
- Graphic Designers, and Artists, 1982, Astragal Books. London
- Palmer. F: Visual Awareness (Batsford, 1972)

B-GAG 101: Visual Communication (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG 101.1	3	3	3	3	3	3	3	3
B-GAG 101.2	2	3	3	2	3	3	3	3
B-GAG 101.3	3	3	3	3	3	3	3	3
B-GAG 101.4	3	3	3	3	2	3	3	3
Average	3	3	3	3	2.75	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG 101.1	3	2	3	3	3
B-GAG 101.2	3	2	3	3	3
B-GAG 101.3	3	3	2	3	3
B-GAG 101.4	3	3	3	3	3
Average	3	2.5	2.75	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG 101.1	3	3	3	3	3	3	3	3	3	2	3	3	3
B-GAG 101.2	3	3	3	3	3	3	3	3	3	2	3	3	3
B-GAG 101.3	3	3	3	3	3	2	3	3	3	3	2	3	3
B-GAG 101.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	2.75	3	3	3	2.75	2.75	3	3

B-GAG102: Animation History and Production Process

Time:3 Hrs. Total Marks: 150
Credits: 6 Theory: 120
Internal Assessment: 30

Course Objectives: This course will provide an overview and study of the history of animation and its fundamentals. This subject will shed light on the early magic lantern shows of the late nineteenth century to current and emerging digital animation technologies. This will be accomplished through a series of discussions, lectures, assignments, as well as viewing and evaluating classical Animation films.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 102.1: Know the History of Animation
B-GAG 102.2: Know about the Animation Industry.
B-GAG 102.3: Learn production Stages and Means of Animation
B-GAG 102.4: Get complete knowledge of the different types of Animation

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT-I

Introduction:

- Introduction to Animation
- Definition of Animation
- Types of Animation
- Process of Animation
- Terms Used in Animation: FPS, Thumbnail, Blueprint,

UNIT-II

History:

- Overview of Animation Film History: Earlier Stage and Modern Era
- Working and usage of: Zoetrope, Phenakistoscope and Thaumatrope.
- Walt Disney, Pixar, J-Stuart Blackton, Winsor Mc Cay
- Indian Animation Industry
- Father of Indian Animation

UNIT-III

Pre-Production

- Story Writing
- Script / Dialogue Writing
- Model Sheet
- X-Sheet
- Storyboard
- Sound Recording
- Animatics

UNIT-IV

Production

- Layout and Illustrations
- Key-Frames
- In-betweens – Cleanups
- Rendering

Post-Production

- Video Editing
- Sound Mixing
- Dubbing
- Color Correction
- Rendering Authoring

References:

- 'How to Write for Animation' by Jeffrey Scott's book
- THE TOOLS OF SCREENWRITING: A WRITER'S GUIDE TO THE CRAFT AND ELEMENTS OF A SCREENPLAY by David Howard and Edward Mobley; St. Martins/Griffin; New York; 1993.
- Storyboard Design course by Giuseppe Cristiano--- Barron's
- How to write for animation—Jeffery Scott
- The art of layout and storyboarding- Mark T. Byrne
- Egleiter, Marcie (2011) From Word to Image: Storyboarding and the Filmmaking Process. Michael
- Wiese Productions. Beiman, Nancy. (2012) Prepare to board. Focal Press.
- Animation History and Production by AparnaVats , New Delhi Publisher ,New Delhi.
- Fraioli, James O.(2000) Storyboarding 101: A Crash Course in Professional Storyboarding. Michae
- Wiese Productions. Glebas, Francis.(2008) Directing the Story. Routledge.
- Hart, John. (2007).The Art of the Storyboard: Storyboarding for Film, TV, and Animation. Focal
- Press. Simon, Mark.(2006) Storyboards: Motion In Art. Focal Press.
- Tumminello, Wendy. (2004) Exploring Storyboarding. Course Technology.
- Pardew, Les.(2004) Beginning Illustration And Storyboarding For Games By. Cengage Learning

B-GAG102: Animation History and Production Process

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG102.1	3	3	3	3	3	3	2	3
B-GAG102.2	3	3	3	3	3	3	3	3
B-GAG102.3	3	3	3	3	3	3	3	3
B-GAG102.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG102.1	3	2	3	3	3
B-GAG102.2	3	2	3	3	3
B-GAG102.3	3	3	3	3	3
B-GAG102.4	3	3	3	3	3
Average	3	2.5	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG102.1	3	3	3	3	3	3	2	3	3	2	3	3	3
B-GAG102.2	3	3	3	3	3	3	3	3	3	2	3	3	3
B-GAG102.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG102.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	3	3	2.5	3	3	3

B-GAG103: Digital Art & Sketching (Theory)

Time:3 Hrs.	Total Marks: 100
Credits: 4	Theory: 80
	Internal Assessment: 20

Course Objectives: This course enables the students to learn the different mediums of Drawing and its importance for animation. This course allows student to learn observation, visualization and visually experiencing the content. This course allows the student to learn and practice drawing for use in Animation Design.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 103.1: Know about Art and Indian concept of Art
B-GAG 103.2 Know about the different medium and techniques of drawing and painting
B-GAG 103.3: Understand Light & Shadow, and surface & texture
B-GAG 104.4: Develop knowledge of Digital Drawing In Photoshop

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT-I

Introduction:

- Define Art
- Origin of Art:
  - Study of Prehistoric Indian Art
  - Visual Arts & Its Forms & Creative Pedagogies
- Diversity of Shapes, Form, Lines, Textures
- Traditional Art Materials: Pencils, Brushes, Paper, colors
- Drawing , Sketching and Concept Drawing
- Understanding of Light and Shadow
- Landscapes and Composition

UNIT-II

Color Theory

- Perception of Color and Color Wheel
- Mixing of Primary, Secondary and tertiary Colors
- Tint, Shades, Hues, Tones.
- Warm Colors and Cool Colors.
- Different Color schemes (Complimentary, Split Complimentary, Analogous, Triadic etc.

UNIT-III

Art Work

- Pattern Design and 3D Design
- Perspectives on the Creative Process
- Anatomy & Proportions: Body Types, Poses, Facial Expression
- Painting- Water color, Pencil color
- Calligraphy & Typography

UNIT-IV

Digital Tools

- Overview of Photoshop Interface
- Understanding of Pen tool, Brush Tool and Brush Panel
- Shading and Painting techniques in Photoshop
- Use of Opacity, Flow and Pattern
- Digital Panting Techniques
- Matt Panting Techniques

References:

- Indian painting by Lokesh Chandra Sharma
- Indian cartoon Art by VeenaBansal
- Aesthetic of art, Krishna's publisher, Author Nupur Sharma
- Graphic design by Narender Singh Yadav

B-GAG103: Digital Art & Sketching (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG103.1	3	3	3	2	3	3	3	3
B-GAG103.2	3	3	3	3	3	3	3	3
B-GAG103.3	3	3	3	3	3	3	3	3
B-GAG103.4	3	3	3	3	3	3	2	3
Average	3	3	3	2.75	3	3	2.75	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG103.1	3	2	2	2	3
B-GAG103.2	3	3	3	3	3
B-GAG103.3	3	3	3	3	3
B-GAG103.4	3	3	3	3	3
Average	3	2.75	2.75	2.75	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG103.1	3	3	3	2	3	3	3	3	3	2	2	2	3
B-GAG103.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG103.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG103.4	3	3	3	3	3	3	3	2	3	3	3	3	3
Average	3	3	3	2.75	3	3	3	2.75	3	2.75	2.75	2.75	3

B-GAG104: Digital Art & Sketching (Practical)

Time:3 Hrs. — Total Marks: 50
Credits: 2 — Practical: 40
Internal Assessment: 10

Course Objectives: This course enables the students to learn and practice the different mediums of Drawing and its importance for animation. This course allows student to practice learning through observation. This course allows the student to learn and practice drawing for use in Animation Design.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 104.1: Know about the different medium and techniques of drawing and painting.
B-GAG 104.2: Understand use of Light and Shadow and surface and texture
B-GAG 104.3: Draw landscape with proper perspective sense, study to draw trees, plants, buildings, sky etc. to create the animation backgrounds
B-GAG 104.4: Know Digital Drawing In Photoshop

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Drawing anatomy
Pencil shading techniques
Still Life Drawing & Landscape drawing
Cartoon character sketch
Calligraphy & Typography
Analogous Colors and Color Wheel
Techniques of water color
Patterns and 2D design
Textures and 3d Art
Poster Designing
Digital Illustrations (Digital Painting)

B-GAG104: Digital Art & Sketching (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG104.1	3	3	3	3	3	3	3	3
B-GAG104.2	3	3	3	3	3	3	3	3
B-GAG104.3	3	3	3	3	3	3	3	3
B-GAG104.4	3	3	3	3	3	3	2	3
Average	3	3	3	3	3	3	2.75	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG104.1	3	3	2	3	3
B-GAG104.2	3	3	3	3	3
B-GAG104.3	3	3	3	3	3
B-GAG104.4	3	3	3	2	3
Average	3	3	2.75	2.75	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG104.1	3	3	3	3	3	3	3	3	3	3	2	3	3
B-GAG104.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG104.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG104.4	3	3	3	3	3	3	2	3	3	3	3	2	3
Average	3	3	3	3	3	3	2.75	3	3	3	2.75	2.75	3

B-GAG 105:Fundamentals of Computer (Theory)

Time:3 Hrs. Total Marks: 100
Credits: 4 Theory: 80
Internal Assessment: 20

Course Objectives: This course is designed for theoretical understanding of computer system and its components, functioning and its application software exposure.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 105.1: Understand the basic knowledge of computer system.
B-GAG 105.2: Know about the functioning of different parts of computer.
B-GAG 105.3 Understand the basic concept ofInternet and computer networks .
B-GAG 105.4: Understand the basics of Application Software.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

Unit-I

Computer- Origin, Evolution and Generation of Computer
Types of Computer
Basic Components of a Computer- Input Devices, Output Devices, Storage Devices
Introduction to Software
Types of Software - System software, Application software
Introduction of Windows and its various versions

Unit-II

Introduction to Internet and Its applications
Browser, Search Engine, FTP, URL
Email and Blog
Introduction to Network- LAN,WAN,MAN,
Network Topologies-Ring, Bus, Star, Mesh and Tree topologies
Hardware requirements for Network

Unit-III

Introduction to MS Word and its uses
Various Menus, Toolbars & Buttons
Paragraph and Page Formatting
Creation &Working with Tables, Mail Merge

Unit-IV

Introduction to MS Excel and its uses
Creating Spreadsheet
Creating Tables and Charts
Use of basic arithmetic formulas
Introduction to MS PowerPoint and its uses

Creating a New Presentation
Slide transition and Custom Animation

References:

- Ram, B. 4th ed New Age; ***Computer Fundamentals: Architecture & Organization***
  Sinha, P. K. BPB; ***Computer Fundamentals: Concepts, Systems & Applications***
- Sinha, P. K/ Sinha, P. 3rd ed BPB; ***Computer Fundamentals: Concepts, Systems & Applications***
  Data Communications and Networking by Behrouz A. Forouzan, Sophia Chung Fegan; Published by Huga Media.2011
- **Goel, Anita Pearson;** *Computer Fundamentals*

B-GAG 105: Fundamentals of Computer (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG 105.1	3	3	3	3	3	3	3	3
B-GAG 105.2	3	3	3	3	3	3	3	3
B-GAG 105.3	3	3	3	3	3	3	3	3
B-GAG 105.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG 105.1	3	3	3	3	3
B-GAG 105.2	3	3	3	3	3
B-GAG 105.3	3	3	3	3	3
B-GAG 105.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG 105.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG 105.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG 105.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG 105.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-GAG 106: Fundamentals of Computer (Practical)

Time:3 Hrs. | Total Marks: 50
Credits: 2 | Practical: 40
Internal Assessment: 10

Course Objectives: This course is designed for practical understanding of commonly used application software and its functioning to the students.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 106.1: Use MS-Word
B-GAG 106.2: Use MS-Excel
B-GAG 106.3: Use PowerPoint
B-GAG 106.4: Create Email account, compose & send emails for personal and professional communication.

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
To create a new document, save, open an existing document
Typing and editing texts in a document (*.doc) file.
Apply formats on Texts like Bold, Italics, Underline, font type, colour and size etc.
Apply features like bullet, numbering, breaks, hyphenation
Indentation, leading and kerning using space bar and TAB
Insert images, symbols and mathematical equations
Create and manipulate tables.
Page layout, Page Setup, Paragraph setting
Page Break, Page Numbering, Find & Replace Text, Header & Footer
Designing Resume, timetable of a class, mail merge
Print a document
Create a Spread Sheet, Cell formatting, Basic arithmetic formulas, Freeze Pane and Sort & Filter, Inserting the chart
Basic operations of Power point, Create PPT and inset and delete slides.
Use of Mater Slide in Presentation.
Apply basic formatting features in presentation like font, font size, font colour, text fill, spacing and line spacing Formatting text boxes, word arts, styles bullet and numbering.
Working with drawing tools, Applying shape or picture styles, Applying object borders, object fill, object effects
Adding slide transition, animation effect, adding custom animation
Working with video, Link to video and sound files.
Creating Email- composing and sending a mail, attachment a file, forwarding the email, changing and setting the password

B-GAG 106: Fundamentals of Computer (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG 106.1	3	3	3	3	3	3	3	3
B-GAG 106.2	3	3	3	3	3	3	3	3
B-GAG 106.3	3	3	3	3	3	3	3	3
B-GAG 106.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG 106.1	3	3	3	3	3
B-GAG 106.2	3	3	3	3	3
B-GAG 106.3	3	3	3	3	3
B-GAG 106.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG 106.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG 106.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG 106.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG 106.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-EVS100 : Environment Studies

Time: 3 Hrs. Total Marks: 50
Credits: 2 Theory: 40
Internal Assessment: 10

Scheme of paper: Total number of questions will be nine. Students have to attempt five questions in all. Questions no. 1 is compulsory. All questions carry equal marks. Each question is of 8 marks.

Course objectives: The aim of this course is to aware the students about the environmental problems and current global issues related to environment. It provides knowledge about the topics like ecosystem and biodiversity and develops interest in the students about their role in conservation of environment and reducing pollution and waste generation in their surroundings. By understanding the environmental problems, their causes and solutions, the students can apply it to their daily lives also.

Course Outcomes:

COs	On successful completion of the course, the students will be able to:
1	Understand the definition of environmental studies, its scope and importance in the conservation of environment.
2	Understand the concept of ecosystem and different types of natural and artificial ecosystems in the world, the biogeochemical cycling and energy flow in an ecosystem.
3	Describe the various renewable and non-renewable natural resources and their over-exploitation due to increasing demands of rising population.
4	Become aware about our biodiversity, its importance and the various threats that are a problem for the biodiversity. They will understand the endangered species and their conservation measures that are needed to be adopted at different levels.
5	Have understanding about the types of pollution and how to reduce those pollution levels in air, soil, water, land and from marine bodies as well. They will develop interest in reducing the solid waste generation as well as its

	management at household level.
6	Gain knowledge of various global environmental issues like climate change, global warming and ozone depletion and also about different environmental laws implemented to conserve the environment.
7	Explain the concept of population growth and drug abuse.

Unit 1: Introduction to environmental studies

Multidisciplinary nature of environmental studies;

Scope and importance; Concept of sustainability and sustainable development. (2 lectures)

Unit 2: Ecosystems

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.

Case studies of the following ecosystems :

a) Forestecosystem
b) Grasslandecosystem
c) Desertecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (6 lectures)

Unit 3: Natural Resources: Renewable and Non-renewable Resources

Land resources and landuse change; Land degradation, soil erosion and desertification.

Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 lectures)

Unit 4: Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots

India as a mega-biodiversity nation; Endangered and endemic species of India

Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

(8 lectures)

Unit 5 : Environmental Pollution

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution

Nuclear hazards and human health risks

Solid waste management: Control measures of urban and industrial waste.

Pollution case studies. (8 lectures)

Unit 6 : Environmental Policies & Practices

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

(7 lectures)

Unit 7: Human Communities and the Environment

Human population growth: Impacts on environment, human health and welfare.

Resettlement and rehabilitation of project affected persons; case studies.

Disaster management: floods, earthquake, cyclones and landslides.

Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.

Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi)

Drugs and their effects; Useful and harmful drugs; Use and abuse of drugs; Stimulant and depressant drugs.Concept of drug de-addiction. Legal position on drugs and laws related to drugs.

(6 lectures)

Unit 8: Field work

Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.

Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.

Study of common plants, insects, birds and basic principles of identification.

Study of simple ecosystems-pond, river, Delhi Ridge, etc.

(Equal to 5 lectures)

Suggested Readings:

1) Carson, R. 2002. Silent Spring. Houghton MifflinHarcourt.
2) Gadgil,M.,&Guha,R.1993.ThisFissuredLand:AnEcologicalHistoryofIndia.Univ.ofCaliforniaPress.
3) Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London,Routledge.
4) Gleick,P.H.1993.WaterinCrisis.PacificInstituteforStudiesinDev.,Environment&Security. Stockholm Env. Institute, Oxford Univ.Press.
5) Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates,2006.
6) Grumbine,R.Edward,andPandit,M.K.2013.ThreatsfromIndia's Himalayadams.Science,339:36-37.
7) McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). ZedBooks.
8) McNeill,JohnR.2000.SomethingNewUndertheSun:AnEnvironmentalHistoryoftheTwentieth Century.
9) Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia:Saunders.
10) Pepper, I.L., Gerba, C.P. &Brusseau, M.L. 2011. Environmental and Pollution Science.Academic Press.
11) Rao, M.N. &Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
12) 12.Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
13) Rosencranz,A.,Divan,S.,&Noble,M.L.2001.EnvironmentallawandpolicyinIndia.Tripathi1992.
14) Sengupta, R. 2003. Ecology and economics: An approach to sustainable development.OUP.
15) Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, NewDelhi.
16) Sodhi,N.S.,Gibson,L.&Raven,P.H.(eds).2013.ConservationBiology:VoicesfromtheTropics.John Wiley &Sons.
17) Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
18) Warren, C. E. 1971. Biology and Water Pollution Control. WBSaunders.
19) Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York:Norton.
20) World Commission on Environment and Development. 1987. Our Common Future. OxfordUniversity

B-HIN 100 : Communicative Hindi

Time: 2 Hrs. Total Marks: 50
Credits: 2 Theory: 40
Internal assessment: 10

Course Objectives: The Paper is designed to enhance proficiency in Hindi Language. It seeks to develop the basic of Hindi Language through different modules. Each unit will enable the learner to have the communication in Hindi and to share and express ideas and experiences.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-HIN 100.1: Develop the knowledge of basics of Hindi language.
B-HIN 100.2: Improve vocabulary in Hindi language.
B-HIN 100.3: : Inculcate the knowledge of grammar in Hindi language
B-HIN 100.4: Learn correct uses of Hindi language in media writing

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

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fgUnh Hkk"kk dk bfrgkl ,o vk/kfud Áofr;kA

bdkb ¼2½

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bdkbZ ¼4½

efnr ek/;e vkj fgUnh Hkk"kk] lekpkj y[ku
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foKkiu dh Hkk"kk vkj y[ku
Lkk'ky ehfM;k dh Hkk"kk vkj y[kuA

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- HkkfV;k] M, dyk'kpUn] vuokndyk] fl)kr vkj ç;kx] r{kf'kyk çdk'ku] ub fnYyh
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- >kYV] M,- nxy] ç;ktueyd fgUnh fl)kr vkj ç;kx] ok.kh çdk'ku] ub fnYyh
- xknj] M,- foukn] ç;ktu eyd fgUnh] ok.kh çdk'ku] ub fnYyh
- jk.kk] egUæ flg] ç;ktu eyd fgUnh d vk/kfud vk;ke] g"k çdk'ku] vkxjk
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B-HIN100 : Communicative Hindi

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-HIN100.1	3	3	3	3	2	2	2	3
B-HIN100.2	3	3	3	3	2	2	2	3
B-HIN100.3	3	3	3	3	2	2	2	3
B-HIN100.4	3	3	3	3	2	2	2	3
Average	3	3	3	3	2	2	2	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-HIN100.1	2	2	2	2	2
B-HIN100.2	2	2	2	2	2
B-HIN100.3	2	2	2	2	2
B-HIN100.4	2	2	2	2	2
Average	2	2	2	2	2

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-HIN100.1	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.2	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.3	3	3	3	3	2	2	2	3	2	2	2	2	2
B-HIN100.4	3	3	3	3	2	2	2	3	2	2	2	2	2
Average	3	3	3	3	2	2	2	3	2	2	2	2	2

B-GAG201: Script, Storyboard & Animatic (Theory)

Time:3 Hrs.	Total Marks: 100
Credits: 4	Theory: 80
	Internal Assessment: 20

Course Objectives: This subject will empower students with the soul of a film i.e. the story. They will be able to understand the art of story design and its telling. The subject enhances the storytelling skills required for animation though various novel techniques. It lays the foundation to story visualization ability for Animation and imparts knowledge and skill to design layout compositions for a story

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG201.1: Do ideation and Inception of stories.
B-GAG201.2:Know different kind of stories and Script
B-GAG201.3: Know about the elements and structure of Script
B-GAG201.4: Develop in depth knowledge of all elements of a Storyboard

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT-I

Introduction:
Define Script and Types of Scripts- Proposal script, shooting script, and post-production script
Key terms used in script (Layout of the story, Characters, Situation, Background, Building of the story,
Insurmountable problems, Gradual or sudden crumbling)
Terminology (scene, shot, Fade in and Fade out, Cut to, Scene number, EXT and INT etc.)
Difference in script and screenplay.

UNIT-II

Development of Script :
Story content for a screenplay (High concept, Originality and familiarity, Subplots, Character Growth, Theme, Identification & Motivation, Obstacle & Courage, Familiarity of setting, Film Category & Cost)

Developing a Screenplay (Facets of character, developing a Hero & other characters, creating Sympathy or hatred for the character, putting a character in jeopardy, Make the character likable,
Introduce the character as soon as possible, Placement of the character in a familiar setting, the superhero

UNIT-III

Introduction to Storyboard

- Camera Shots and Compositions
- Different Layouts of Storyboard
- Parts of Storyboard
- Tools of storyboard
- Advantages of storyboarding
- Thumbnails
- Character sheets, BG`s

UNIT-IV

ANIMATICS

- Pencil Test: uses and Advantages
- Sound Recoding
- Animatic Process
- Process of animatic: 2d and 3d animatic

References:

- 'How to Write for Animation' by Jeffrey Scott's book
- THE TOOLS OF SCREENWRITING: A WRITER'S GUIDE TO THE CRAFT AND ELEMENTS OF A SCREENPLAY by David Howard and Edward Mabley; St. Martins/Griffin; New York; 1993.
- Storyboard Design course by Giuseppe Cristiano--- Barron's
- How to write for animation—Jeffery Scott
- The art of layout and storyboarding- Mark T. Byrne
- Egleiter, Marcie.(2011) From Word to Image: Storyboarding and the Filmmaking Process. Michael
- Wiese Productions. Beiman, Nancy. (2012)Prepare to board. Focal Press.
- Animation History and Production by AparnaVats , New Delhi Publisher ,New Delhi.
- Fraioli, James O.(2000) Storyboarding 101: A Crash Course in Professional Storyboarding. Michae
- Wiese Productions. Glebas, Francis.(2008) Directing the Story. Routledge.
- Hart, John. (2007).The Art of the Storyboard: Storyboarding for Film, TV, and Animation. Focal
- Press. Simon, Mark.(2006) Storyboards: Motion In Art. Focal Press.
- Tumminello, Wendy. (2004) Exploring Storyboarding. Course Technology.
- Pardew, Les.(2004) Beginning Illustration And Storyboarding For Games By. Cengage Learning

B-GAG201: Script, Storyboard & Animatic (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG201.1	3	3	3	3	3	3	3	3
B-GAG202.2	3	3	3	3	3	3	3	3
B-GAG201.3	3	3	3	3	3	3	3	3
B-GAG201.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG201.1	3	2	3	3	3
B-GAG202.2	3	3	3	3	3
B-GAG201.3	3	3	3	3	3
B-GAG201.4	3	3	3	3	3
Average	3	2.75	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG201.1	3	3	3	3	3	3	3	3	3	2	3	3	3
B-GAG202.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG201.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG201.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	2.75	3	3	3

B-GAG202: Script, Storyboard & Animatic (Practical)

Time:3 Hrs.	Total Marks: 50
Credits: 2	Practical: 40
	Internal Assessment: 10

Course Objectives: This subject will empower students to practice the art of story design and its telling. The subject enhances the storytelling skills required for animation though various novel techniques. It lays the foundation to story visualization ability for Animation and imparts knowledge and skill to design layout compositions for a story

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 202.1: Write Script in format
B-GAG 202.2: Know different kind of stories and Script
B-GAG 202.3: Know about the elements and structure of Script
B-GAG 202.4: Produce storyboard and Animatic for production

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Study single short film and prepare review assignment
Write a story any single genre
Develop a story according to character
Understand and create screen play script
Prepare script for five minute video
Record sound and audio
Use pencil testing technique to create smooth animation
Able to produce animatic according to script

B-GAG202: Script, Storyboard & Animatic (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG202.1	3	3	3	3	3	3	2	3
B-GAG202.2	3	3	3	3	3	3	3	3
B-GAG202.3	3	3	3	3	3	3	3	3
B-GAG202.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG202.1	3	3	3	3	3
B-GAG202.2	3	2	3	3	3
B-GAG202.3	3	3	3	3	3
B-GAG202.4	3	3	3	3	3
Average	3	2.75	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG202.1	3	3	3	3	3	3	2	3	3	3	3	3	3
B-GAG202.2	3	3	3	3	3	3	3	3	3	2	3	3	3
B-GAG202.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG202.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	3	3	2.75	3	3	3

B-GAG203: Digital Design & Raster Graphics (Theory)

Time:3 Hrs.
Credits: 4

Total Marks: 100
Theory: 80
Internal Assessment: 20

Course Objectives: The course is designed to impart the knowledge about Print, Advertising, Graphic Design and its applications.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 203.1: Develop knowledge of software to design raster graphical images
B-GAG 203.2 Understand the difference between different graphics and image file formats
B-GAG 203.3: Develop knowledge of using Photoshop's various tools and techniques.
B-GAG 203.4: Understand Image Retouching and Image Manipulation for Advertising

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT-I

Introduction to graphics:

Define graphics & types of graphics
Elements and principles of graphic design
Study of Raster images - its advantage and application areas,
Difference between vector and raster images.
Fonts: Serif, San-Serif, Slab-Serif and Decorative
Overview of Designing Industry and Designing Trends

UNIT-II

Raster Graphics

Introduction to Photoshop: Tools and Menus
Layers & Layer styles, Opacity, Masking, Adjustment layers, Blending modes,
Image Editing: Retouching, Color Correction, Smoothing skin & wrinkles.
Image Manipulation, Filter Gallery
Portrait enhancements
Working with typography: Threading text, changing font size and Color, using styles, wrapping text, text on a path, creating Outlines, wrapping text around an object, sampling text.

UNIT-III

Techniques

Gradient tool and Gradient Map
Cloning / Stamping, Patch Tool
Noise Reduce and edges sharpness
Dodge & Burn Tool
Page setup
Action and Batch Render
Effects: Orton Effect, Retro, Bokeh
Filters: Liquify, Vanishing Point, Pattern Maker, Artistic

UNIT-IV

Designing process

Photo Collage, Black & White images to Color, Web Banner
Social Media and Magazine cover design
Digital Flyer Designs
Cartoon character design
Promotional designs
Layout process: (create press and magazine layouts)
Poster design: productive & social
Newsletter design

References:

- Golombisky, K., & Hagen, R. (2017). White space is not your enemy: A beginner's guide to communicating visually through graphic, web & multimedia design. CRC Press.
- Harrington, R. (2012). Understanding Adobe Photoshop CS6: The essential techniques for imaging professionals. Peachpit Press.
- Gulbins, J. (2013). Mastering Photoshop layers: A photographer's guide. Rocky Nook.

B-GAG203: Digital Design & Raster Graphics (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG203.1	3	3	3	3	3	3	2	2
B-GAG203.2	3	3	3	3	3	3	3	3
B-GAG203.3	3	3	3	3	3	3	3	3
B-GAG203.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	2.75

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG203.1	3	3	2	3	3
B-GAG203.2	3	3	3	2	3
B-GAG203.3	3	3	3	2	3
B-GAG203.4	3	3	3	3	3
Average	3	3	2.75	2.5	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG203.1	3	3	3	3	3	3	2	2	3	3	2	3	3
B-GAG203.2	3	3	3	3	3	3	3	3	3	3	3	2	3
B-GAG203.3	3	3	3	3	3	3	3	3	3	3	3	2	3
B-GAG203.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	2.75	3	3	2.75	2.5	3

B-GAG204: Digital Design & Raster Graphics (Practical)

Time:3 Hrs.	Total Marks: 50
Credits: 2	Practical: 40
	Internal Assessment: 10

Course Objectives: The aim of the course is to impart the practical knowledge about Print, Advertising, Graphic Design and its applications.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 204.1: Able to use Raster Graphics Software
B-GAG 204.2: Understand the difference between different graphics and image file formats
B-GAG 204.3: Become familiar with layer panel and tools
B-GAG 204.4: Get practical knowledge of Image Retouching techniques

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Black & White to color conversion of image
Portrait Enhancement & Photo Retouching
Image Manipulation
Day to night conversion of Image
Effects passed exercise
Typography Designs
Social Media Designs
Web Banners
Magazine Cover page and layouts
Newsletter Design
Cartoon Character Designs

B-GAG204: Digital Design & Raster Graphics (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG204.1	3	3	3	3	3	3	3	3
B-GAG204.2	3	3	3	3	3	3	3	3
B-GAG204.3	3	3	3	3	3	3	2	3
B-GAG204.4	3	3	3	3	3	3	2	3
Average	3	3	3	3	3	3	2.5	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG204.1	3	3	2	2	3
B-GAG204.2	3	3	3	3	3
B-GAG204.3	3	3	3	3	3
B-GAG204.4	3	3	3	3	3
Average	3	3	2.75	2.75	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG204.1	3	3	3	3	3	3	3	3	3	3	2	2	3
B-GAG204.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG204.3	3	3	3	3	3	3	2	3	3	3	3	3	3
B-GAG204.4	3	3	3	3	3	3	2	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.5	3	3	3	2.75	2.75	3

B-GAG205: Comic Design & Character Anatomy (Theory)

Time:3 Hrs. Total Marks: 100
Credits: 4 Theory: 80
Internal Assessment: 20

Course Objectives: The Course is designed to impart the knowledge of character design and its significance. It will help the students to know about history and production process of comic book.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 205.1: Get knowledge about different types of characters design
B-GAG 205.2: Get knowledge of comic history
B-GAG 205.3: Understand the anatomy of organic and non-organic characters.
B-GAG 205.4: Understand the different comic styles along with presentation styles

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT-I

Introduction:

- Understand Character Design, Types and Design Pattern
- History of Character Designing
- Process of Character Designing
- Understand Caricature
- Concept of Model Sheet / Expression Sheet

UNIT-II

Shape Language and Design

- Cartoon Character Anatomy & Proportions
- Body Types and Poses, (Fingers, Hands, Arms, Foot and Legs)
- Facial Expression: Eyes, Nose, Lips, Hairs
- Development of Character Design
- Design Character with Shapes and Forms

UNIT-III

Comic Design

- Comic Book: Types & Sizes
- Study Comic Characters
- Principals of Comic Book
- Understand composition in comic
- Designing Process of Comic Book
- Elements of Comic Book

UNIT-IV

Production

- Vector Drawing and Coloring Techniques (Digitally)
- Splash, Explosion, Cracking, Fire
- Concept Character
- Techniques and use Perspective Angles

References:

- Blair, P. (1994). Cartoon animation. Walter Foster Publishing.
- Indian painting by Lokesh Chandra sharma
- Indian cartoon Art by VeenaBansal
- Aesthetic of art, Krishna’s publisher, Author Nupur Sharma
- Graphic design by Narender Singh Yadav

B-GAG205: Digital Design & Raster Graphics (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG205.1	3	3	3	3	3	3	3	3
B-GAG205.2	3	3	2	3	3	3	3	3
B-GAG205.3	3	3	3	3	3	3	3	3
B-GAG205.4	3	3	3	3	3	3	3	3
Average	3	3	2.75	3	3	3	3	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG205.1	3	3	3	3	3
B-GAG205.2	3	3	3	2	3
B-GAG205.3	3	3	3	3	3
B-GAG205.4	3	3	3	2	3
Average	3	3	3	2.5	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG205.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG205.2	3	3	3	3	3	3	3	3	3	3	3	2	3
B-GAG205.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG205.4	3	3	3	3	3	3	3	3	3	3	3	2	3
Average	3	3	3	3	3	3	3	3	3	3	3	2.5	3

B-GAG206: Comic Design & Character Anatomy (Practical)

Time:3 Hrs. | Total Marks: 50
Credits: 2 | Practical: 40
Internal Assessment: 10

Course Objectives: The aim of the course is to impart the knowledge of character design and to teach practical use of digital tools to produce illustrations and landscapes.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 206.1: Learn and Practice the anatomy of organic and non-organic characters
B-GAG 206.2: Develop and produce story based comic
B-GAG 206.3:Able to draw different types of characterfor comics as well as animation
B-GAG 206.4: Learn pre-production for animation

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Human & Cartoon Character Anatomy
Design Pattern and Layout
Reviews of any Comic Book
Model Sheet & Expression Sheet
Composition in Comic
Cartoon character sketch and Digital Conversation
Comic Book Strip
Action Sheet of Cartoon Character
Perspective Angles
Study of Comic Characters and make Slam Book
Final Output (Comic Book)

B-GAG206: Comic Design & Character Anatomy (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG206.1	3	3	3	3	3	3	3	3
B-GAG206.2	3	3	3	3	3	3	3	3
B-GAG206.3	3	3	3	3	3	3	2	3
B-GAG206.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG206.1	3	3	3	3	3
B-GAG206.2	3	3	3	3	3
B-GAG206.3	3	3	3	3	3
B-GAG206.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG206.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG206.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG206.3	3	3	3	3	3	3	2	3	3	3	3	3	3
B-GAG206.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.75	3	3	3	3	3	3

B-GAG207: Experimental Animation Techniques (Theory)

Time:3 Hrs. Total Marks: 100
Credits:4 Theory: 80
Internal Assessment: 20

Course Objectives: The course is designed to introduce various techniques and styles of Animation, to provide the students hands on experience of simple idea for animation using the materials available in the immediate surroundings, to provide knowledge of ideation and imagination of animation and to introduce procedures and steps for Material Animation as an Example.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 207.1: Understand and apply Principals of Animation
B-GAG 207.2 : Learn various techniques and styles of Animation.
B-GAG 207.3: Do ideation and imagination of animation
B-GAG 207.4: Recognize and identify the power of animation which is not restricted to any medium.

Note:- The question paper will be divided into five Units containing nine questions. Students are required to attempt five questions in all. There will be two questions in each unit from I to IV and students are required to attempt one question from each unit. Unit V will have only one Compulsory question containing six short notes covering the entire syllabus and students are required to attempt any four. All questions will carry equal marks.

UNIT-I

Classical & Traditional Animation:

- Define Animation
- Persistence of Vision
- Animation & Motion
- Animation Principals
- Working of Light-Box
- Flip Book / Flick Book
- Ball Bounce

UNIT-II

Timing & Spacing (On Flipbook)

- Pendulum Animation
- Vehicle Animation
- Walk Cycle (Adolescent & Adult)
- Jump and Run
- Leaf Animation
- Water Drop & Water Splash

UNIT-III

Stop Motion Animation

- Define Stop Motion
- Process of Stop Motion
- Key-Framing and Timing
- Stop Motion Animation Different Techniques
- Basic Lighting Techniques & Camera Setup

UNIT-IV

Developing a Short Experimental Animation Film:

- Clay Animation
- Cut-Out Animation
- Mix Media Animation
- Add Sound and Audio
- Export and Authoring
- Stop Motion Animation in Animation & VFX Industry
- Student will choose a specific technique and implement his idea as a short film or gag.

References::

- Williams, R. (2012). The animator's survival kit: A manual of methods, principles and formulas for classical, computer, games, stop motion and internet animators. Macmillan.
- Thomas, F., & Johnston, O. (1995). The illusion of life: Disney animation. Hyperion.
- Laura Moreno (2014) THE CREATION PROCESS OF 2D ANIMATED MOVIES
- Wells, P. Understanding animation. Routledge.
- Blair, P. (1994). Cartoon animation.Walter Foster Publishing.
- Gasek, T. (2017). Frame-by-frame stop motion: The guide to non-puppet photographic animation techniques (2nd ed.). CRC Press.
- Priebe, K. A. (2011). The advanced art of stop-motion animation.Cengage Learning.

B-GAG207: Experimental Animation Techniques (Theory)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG207.1	3	3	3	3	3	3	3	3
B-GAG207.2	3	3	3	3	3	3	2	3
B-GAG207.3	3	3	3	3	3	3	3	3
B-GAG207.4	3	3	3	3	3	3	2	3
Average	3	3	3	3	3	3	2.5	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG207.1	3	2	3	3	3
B-GAG207.2	3	3	3	3	3
B-GAG207.3	3	3	3	3	3
B-GAG207.4	3	2	3	3	3
Average	3	2.5	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG207.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG207.2	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG207.3	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG207.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3

B-GAG208: Experimental Animation Techniques (Practical)

Time:3 Hrs.	Total Marks: 50
Credits: 2	Practical: 40
	Internal Assessment: 10

Course Objectives: The course is designed to practice various techniques and styles of Animation, to provide the students hands on experience of simple idea for animation using the materials available in the immediate surroundings and to do ideation and imagination of animation.

Course Learning Outcomes:
After completing the Course, the student will be able to:
B-GAG 208.1: Understand the working of flip book animation technique
B-GAG 208.2: Able to create little animation movements by using flip book
B-GAG 208.3: Know the process of stop motion animation by different material
B-GAG 208.4: Develop skills to handle problem during traditional and stop motion animation production

Note:- The students will do practical assignments assigned by the concerned teacher throughout the whole semester and will submit them in the form of hardcopy/softcopy to the teacher. External Examiner will evaluate the work done by the student, will conduct the practical and viva voce.

List of Practical Exercises:
Animate Time on flip book
Water drop morphing and animation
Understand Time and Spacing principal by Pendulum animation
Squash and Stretch exercise with the use of ball animation
Object Weight Impact on animation
Leaf animation to understand staging rules
Normal walk cycle of cartoon character
Slow walk cycle of old age character
Animate Humans /Objects with Stop Motion Animation Techniques
Cut-out / Clay, used to produce story based animation clip

B-GAG208: Comic Design & Character Anatomy (Practical)

CO-PO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
B-GAG208.1	3	3	3	3	3	3	3	3
B-GAG208.2	3	3	3	3	3	3	2	3
B-GAG208.3	3	3	3	3	3	3	2	3
B-GAG208.4	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.5	3

CO-PSO Mapping Matrix

CO	PSO1	PSO2	PSO3	PSO4	PSO5
B-GAG208.1	3	3	3	3	3
B-GAG208.2	3	3	3	3	3
B-GAG208.3	3	3	3	3	3
B-GAG208.4	3	3	3	3	3
Average	3	3	3	3	3

CO-PO-PSO Mapping Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
B-GAG208.1	3	3	3	3	3	3	3	3	3	3	3	3	3
B-GAG208.2	3	3	3	3	3	3	2	3	3	3	3	3	3
B-GAG208.3	3	3	3	3	3	3	2	3	3	3	3	3	3
B-GAG208.4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	2.5	3	3	3	3	3	3

Kurukshetra University Kurukshetra

Syllabus and Scheme of Examination for M.Sc. (Integrated) Biotechnology
Under
Choice Based Credit System (CBCS) w.e.f. 2020-21(in phased manner)

Subject: Biotechnology

Semester	Course	Paper	Nomenclature of paper	Credits	Workload/ week (hr)	Internal marks	External Marks	Total	Exam Time (hrs)
1	CC-1	IN-BTY-101	Biomolecules	4	4	20	80	100	3
		IN-BTY-102	Biomolecules - Practicals	2	4	10	40	50	3
	CC-2	IN-BTY-103	General Microbiology	4	4	20	80	100	3
		IN-BTY-104	General Microbiology-Practicals	2	4	10	40	50	3
	GE-1	IN-ZOO-101	Cell Biology	4	4	20	80	100	3
		IN-ZOO-102	Cell Biology-Practicals	2	4	10	40	50	3
	AECC-1		(English/ MIL) communication/Environmental Studies	2	2	10	40	50	3
2	CC-3	IN-BTY-201	Enzymology	4	4	20	80	100	3
		IN-BTY-202	Enzymology-Practicals	2	4	10	40	50	3
	CC-4	IN-BTY-203	Genetics	4	4	20	80	100	3
		IN-BTY-204	Genetics-Practicals	2	4	10	40	50	3
	GE-2	IN-ZOO-201	Mammalian -Physiology	4	4	20	80	100	3
		IN-ZOO-202	Mammalian -Physiology-Practicals	2	4	10	40	50	3
	AECC-2		(English/ MIL) communication/Environmental Studies	2	2	10	40	50	3
3	CC- 5	IN-BTY-301	Metabolism	4	4	20	80	100	3
		IN-BTY-302	Metabolism- Practicals	2	4	10	40	50	3
	CC-6	IN-BTY-303	PlantAnatomy and Physiology	4	4	20	80	100	3
		IN-BTY-304	Plant Anatomy and Physiology-Practicals	2	4	10	40	50	3
	CC-7	IN-BTY-305	Inorganic Chemistry-1	2	2	10	40	50	3
		IN-BTY-306	Physical Chemistry-1	2	2	10	40	50	3
		IN-BTY-307	Organic Chemistry-1	2	2	10	40	50	3
		IN-BTY-308	Chemistry-I Practicals	2	4	10	40	50	3
	SEC-1		Computer Science-level-1	2	2	10	40	50	3
	GE-3	IN-ZOO-301	Developmental Biology	4	4	20	80	100	3
		IN-ZOO-302	Developmental Biology-Practicals	2	4	10	40	50	3
	AECC-3		Hindi/Sanskrit	2	2	10	40	50	3
4	CC-8	IN-BTY-401	Molecular Biology	4	4	20	80	100	3
		IN-BTY-402	Molecular Biology-Practicals	2	4	10	40	50	3
	CC-9	IN-BTY-403	Animal Biotechnology	4	4	20	80	100	3
		IN-BTY-404	Animal Biotechnology-Practicals	2	4	10	40	50	3
	CC-10	IN-BTY-405	Inorganic Chemistry-II	2	2	10	40	50	3
		IN-BTY-406	Physical Chemistry-II	2	2	10	40	50	3
		IN-BTY-407	Organic Chemistry-II	2	2	10	40	50	3
		IN-BTY-408	Chemistry-II Practicals	2	4	10	40	50	3

	SEC-2	IN-BTY-S1	Bioanalytical Tools	2	2	10	40	50	3
		OR							
		IN-BTY-S2	MOOC* (From Swayam Portal)						
	GE-4	IN-ZOO-401	Animal Diversity	4	4	20	80	100	3
		IN-ZOO-402	Animal Diversity- Practicals	2	4	10	40	50	3
5	CC-11	IN-BTY-501	Recombinant DNA Technology	4	4	20	80	100	3
		IN-BTY-502	Recombinant DNA Technology-Practicals	2	4	10	40	50	3
	CC-12	IN-BTY-503	Plant Biotechnology	4	4	20	80	100	3
		IN-BTY-504	Plant Biotechnology- Practicals	2	4	10	40	50	3
	DSE-1	IN-BTY-505	Food Technology	4	4	20	80	100	3
		IN-BTY-506	Food Technology-Practicals	2	4	10	40	50	3
		OR							
		IN-BTY-507	Biomathematics	4	4	20	80	100	3
		IN-BTY-508	Biomathematics-Practicals	2	4	10	40	50	3
		OR							
		IN-BTY-509	MOOC*						
	DSE-2	IN-BTY-510	MOOC*						
		OR							
		IN-BTY-511	Medical Biotechnology	4	4	20	80	100	3
		IN-BTY-512	Medical Biotechnology-Practicals	2	4	10	40	50	3
		OR							
		IN-BTY-513	Inorganic Chemistry-III	2	2	10	40	50	3
		IN-BTY-514	Physical Chemistry-III	2	2	10	40	50	3
		IN-BTY-515	Organic Chemistry-III	2	2	10	40	50	3
		IN-BTY-516	Chemistry-III Practicals	2	4	10	40	50	3
	GE-5	IN-ZOO-501	Evolutionary Biology	4	4	20	80	100	3
		IN-ZOO-502	Evolutionary Biology-Practicals	2	4	10	40	50	3
6	CC-13	IN-BTY-601	Genomics & Proteomics	4	4	20	80	100	3
		IN-BTY-602	Genomics & Proteomics-Practicals	2	4	10	40	50	3
	CC-14	IN-BTY-603	IPR, Bioethics and Biosafety	4	4	20	80	100	3
		IN-BTY-604	IPR, Bioethics and Biosafety – Practicals	2	4	10	40	50	3
	DSE-3	IN-BTY-605	Immunology	4	4	20	80	100	3
		IN-BTY-606	Immunology-Practicals	2	4	10	40	50	3
		OR							
		IN-BTY-607	Bioinformatics	4	4	20	80	100	3
		IN-BTY -608	Bioinformatics-Practicals	2	4	10	40	50	3
	DSE-4	IN-BTY-609	Molecular diagnostics	4	4	20	80	100	3
		IN-BTY-610	Molecular diagnostics -Practicals	2	4	10	40	50	3
		OR							
		IN-BTY-611	Inorganic Chemistry-IV	2	2	10	40	50	3
		IN-BTY-612	Physical Chemistry-IV	2	2	10	40	50	3
		IN-BTY-613	Organic Chemistry-IV	2	2	10	40	50	3
		IN-BTY-614	Chemistry-IV Practicals	2	4	10	40	50	3
	GE-6	IN-ZOO-601	Ecology and Environment management	4	4	20	80	100	3
		IN-ZOO-602	Ecology and Environment management-Practicals	2	4	10	40	50	3
7	CC-15	IN-BTY -701	Advanced Molecular Biology	4	4	20	80	100	3

		IN-BTY -702	Advanced Molecular Biology-Practicals	2	4	10	40	50	3
	CC-16	IN-BTY -703	Bioprocess and fermentation Technology	4	4	20	80	100	3
		IN-BTY -704	Bioprocess and fermentation – Practicals	2	4	10	40	50	3
	CC-17	IN-BTY -705	Biostatistics	4	4	20	80	100	3
		IN-BTY -706	Biostatistics-Practicals	2	4	10	40	50	3
	DSE-5	IN-BTY -707	Nanotechnology	4	4	20	80	100	3
		IN-BTY -708	Nanotechnology-Practicals	2	4	10	40	50	3
			OR						
		IN-BTY -709	Medicinal Microbiology	4	4	20	80	100	3
		IN-BTY -710	Medicinal Microbiology – Practicals	2	4	10	40	50	3
			OR						
		IN-BTY -711	MOOC*						
8	CC-18	IN-BTY -801	Advanced Recombinant DNA Technology	4	4	20	80	100	3
		IN-BTY -802	Advanced Recombinant DNA Technology-Practicals	2	4	10	40	50	3
	CC-19	IN-BTY -803	Animal Cell Culture	4	4	20	80	100	3
		IN-BTY -804	Animal Cell Culture Practicals	2	4	10	40	50	3
	CC-20	IN-BTY -805	Bioentrepreneurship Development	4	4	20	80	100	3
		IN-BTY -806	Bioentrepreneurship Development - Practicals	2	4	10	40	50	3
	Open Elective	IN-BTY -807	Biotechnology and Human Welfare-I	2	2	10	40	50	3
			OR						
		IN-BTY -808	One month summer/Industrial Training						
			OR						
		IN-BTY-809	MOOC from Swayam portal						
9	CC-21	IN-BTY -901	Bioinstrumentation	4	4	20	80	100	3
		IN-BTY -902	Bioinstrumentation -Practicals	2	4	10	40	50	3
	CC-22	IN-BTY -903	Research Methodology	4	4	20	80	100	3
		IN-BTY -904	Research Methodology-Practicals	2	4	10	40	50	3
	CC-23	IN-BTY -905	Enviornmental Biotechnology	4	4	20	80	100	3
		IN-BTY -906	Enviornmental Biotechnology-Practicals	2	4	10	40	50	3
	DSE-6	IN-BTY -907	Immunology	4	4	20	80	100	3
		IN-BTY -908	Immunology-Practicals	2	4	10	40	50	3
			OR						
		IN-BTY -909	Bioinformatics	4	4	20	80	100	3
		IN-BTY -910	Bioinformatics-Practicals	2	4	10	40	50	3
	Open Elective	IN-BTY-911	Biotechnology and Human Welfare-II	2	2	10	40	50	3
			OR						

		IN-BTY-912	One month summer/Industrial Training						
			OR						
		IN-BTY-913	MOOC from Swayam portal						
10	CC-24	IN-BTY-1000	Project	20					500

Programme Outcomes (POs) for UG courses of Faculty of Life Sciences

1. To develop skills in graduate students to be able to acquire theoretical and practical knowledge in fundamentals of biology in respective disciplines of plants, animals, microbes and environment.
2. To inculcate ability to critically evaluate problems and apply lateral thinking and analytical skills for professional development.
3. To create awareness on ethical issues, good laboratory practices and biosafety.
4. To develop ability in youth for understanding basic scientific learning and effective communication skills.
5. To prepare youth for career in teaching, industry, government organizations and self reliant entrepreneurship.
6. To make students aware of natural resources and environment and its sustainable utilization.
7. To provide learning experience in students that instills deep interest in biological science for the benefit of society.

Programme Specific Outcomes (PSOs) for UG courses in Biotechnology

After the successful completion of the programme the student will be able to

PSO1 : demonstrate the knowledge and understanding of biological sciences i.e. structure and function of biological molecules, biological mechanisms, such as the processes and control of bioenergetics and metabolism, as chemical reactions with engineering technologies to manipulate living organisms and biological systems to produce products that advance healthcare, medicine, agriculture, food, pharmaceuticals and environment control

PSO2 :critically think and correlate the biological knowledge of distribution, morphology and physiology of organisms (animals, plants and microorganisms) to techniques in aseptic procedures, isolation, identification, characterization and modifications to improve quality of life in person as well as community.

PSO3 : demonstrate an understanding of the principles of bio- techniques, and exhibit basic professional skills pertaining to biotechnology, carry out laboratory-orientated numerical calculations and analyse biological data (e.g. in enzyme kinetics, molecular structure analysis, microbiological techniques, immunological inferences)

PSO4 :scientific writing and authentic reporting, effective presentation skills and ability to work in a group with cooperation

Semester – I
CC-BIOTECHNOLOGY-1
Paper: IN-BTY-101
BIOMOLECULES-I

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

101.1 Classify, define and explain various properties of carbohydrates and correlate them to their functions.
101.2 Classify, define, draw structures and explain functions of various types of lipids: Illustrate various parameters of characterization of lipids.
101.3 Classify, draw structures of standard amino acids, explain chemical and physical properties of amino acids; Describe different classes of proteins and explain different levels of structural organization in protein architecture
101.4 Explain the characteristics and draw structures of various types of nucleic acids and illustrate the chemical and physical properties of nucleic acids

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Biomolecules: Introduction, important features, covalent and non-covalent interactions.

Carbohydrates: Introduction and Biological Significance. Definition and classification: Monosaccharides; families of monosaccharides; simple aldoses and ketoses, Configuration and Conformation, Stereoisomerism/ Asymmetric centres, Fischer and Haworth projection formula, pyranose and furanose ring forms, reducing and non-reducing sugars, sugar derivatives viz. sugar alcohols, amino sugars, deoxy sugars, acidic sugars, Glycosidic bond Disaccharides and Oligosaccharides: Definition, structure and function of important di and oligosaccharides viz. lactose, sucrose, maltose, raffinose, stachyose, verbascose etc. Polysaccharides: Homo and Hetero polysaccharides, storage polysaccharides: Starch and Glycogen. Structural polysaccharides: Cellulose and Chitin. A brief account of structure and function of mucopolysaccharides/Glycosaminoglycans (Hyaluronic acid, Chondroitin sulphate), Glycoproteins and Proteoglycans.

Lipids: Introduction and Classification – simple and complex lipids, Fatty acids - structure and nomenclature, soap value, acid value, iodine number, rancidity. Essential fatty acids. A general account of structure and function of triacylglycerols, phospholipids, glycolipids, sphingolipids, steroids, bile acids, bile salts and terpenes

Unit II

Amino acids and Peptides: Classification and structure of amino acids, essential amino acids, rare and non-protein amino acids, optical and chemical properties of amino acids; acid-base behavior/zwitterions; pKa value and titration curve. Peptide bond – nature and characteristics.Definition; structure and function of some biologically important peptides.

Proteins: Classification based on structure and function. Structural organization of proteins: Primary structure; Secondary structure-α-Helix, β- pleats and β - turn Tertiary structure – myoglobin and lysozyme etc. Quaternary structure-hemoglobin.Forces stabilizing different structural levels. Amino acid analysis/N-terminal amino acid analysis- Sanger's method, Edmann's degradation, Dansyl chloride and Dabsyl chloride

Nucleotides and Nucleic acids: Building blocks: bases, sugars and phosphates. Structure and nomenclature of nucleosides and nucleotides; polynucleotides, DNA (A, B, Z-DNA) and RNA (rRNA, mRNA, tRNA).Properties of DNA - absorption, denaturation, renaturation, hybridization, Tm/Cot values.Biologically important nucleotides and their functions - ATP, GTP, Coenzyme A, NAD^+, FAD and cAMP.

Suggested readings:

1. Principles of Biochemistry - Albert L. Lehninger, CBS Publishers & Distributors
2. Biochemistry - Methews and Methews
3. Biochemistry - Voet and Voet
4. Biochemistry - KeshavTrehan Wiley Eastern Publications
5. Fundamentals of Biochemistry - J.L. Jain, S. Chand and Company

Semester – I
CC- BIOTECHNOLOGY-1
Paper: IN-BTY- 102
BIOMOLECULES- PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

102.1 Prepare various types of solutions used in qualitative and quantitative biochemical estimations; verify and apply the basic principles of spectroscopy
102.2 Analyse the unknown samples qualitatively for the presence of various biomolecules

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practical's, records and viva voce.

Practicals:

1. Preparation of normal, molar, percent solutions, buffer solutions and determination of their pH.
2. Qualitative tests for Carbohydrates
3. Qualitative tests for lipids
4. Qualitative tests for amino acids and Proteins
5. Estimation of acid value and saponification value of fat sample
6. Verification of Beer- Lambert's Law.

Suggested reading

1. Introductory Practical Biochemistry by S.K.Sawhney& R. Singh (2000). Narosa Publishers
2. Practical Biochemistry by David Plummer (1990). Tata Mc-Graw Hill
3. Biochemical Methods by Sadasivam&Manickam (1996) New Age International (P) Ltd.
4. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.
5. A Lab. Manual in Biochemistry by J. Jayaraman (1996) New Age International (P) Ltd.

Semester – I
CC-BIOTECHNOLOGY-2
Paper: IN-BTY-103
GENERAL MICROBIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

103.1 Illustrate the knowledge of history, scope, classification, various approaches of study and microbial diversity
103.2 Compare and characterize prokaryotic and eukaryotic cells based on morphology; different groups of microorganisms based on their structures.
103.3 Give an account of microbial growth, reproduction and metabolism
103.4 Identify the microorganisms in water and food along with methods to control them

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT I

Microbial Taxonomy and classification: Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity:

Distribution and characterization: Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT II

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Food and Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms.Sewage composition and its disposal. Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods.Fermented Foods.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996).Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology.7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology.2nd edition.Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms.12th edition.Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.

Semester – I
CC- BIOTECHNOLOGY-2
Paper: IN-BTY- 104
GENERAL MICROBIOLOGY- PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

104.1 Exhibit skills in preparation of media and staining

104.2 Isolate bacteria from different sources and determine their count and cell size

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods
4. Methods of Isolation of bacteria from different sources.
5. Determination of bacterial cell size by micrometry.
6. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996).Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology.7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology.2nd edition.Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms.12th edition.Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ.(2008). Prescott, Harley and Klein's Microbiology.7th edition.McGraw Hill Higher Education.

AECC-1 -(English/ MIL) communication / Environmental Studies will be same as AECC approved by UGBOS, Department of English/ UGBOS, Department of Environment Sciences, KUK

Semester – I

GE-ZOOLOGY-1
Paper: IN-ZOO-101
CELL BIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

101.1 Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
101.2 Understand how these cellular components are synthesized and degraded in cells
101.3 Explain the structure and function of prokaryotic cell & its components
101.4 Describe the various models and solute transporter systems belonging to cell membrane and will explain cell cycle and apoptosis

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit-I
Basics of Cell Biology – Discovery of cell and Cell Theory; Comparison between plant and animal cells;

Cell Structure-Protoplasm ;Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome and microbodies; Ribosome; Centriole; Nucleus;Chromosomes, Chemical components of a cell; Catalysis and use of energy by cells.

Biogenesis of Cellular organelles – Biogenesis of mitochondria, chloroplast, ER,
Golgi complex; Biosynthetic process in ER and golgi apparatus; Protein synthesis andfolding in the cytoplasm; Degradation of cellular components.

Unit-II

Structure and function of Prokaryotic cell & its components - The Slime and the cell wall of bacteria containing peptidoglycan and related molecules; the outer membrane of Gram-negative bacteria, the cytoplasmic membrane. Water and ion transport, mesosomes, flagella, Pilus, fimbriae, ribosomes,carboxysomes, sulfur granules, glycogen, polyphosphate bodies, fat bodies, gas vesicles; endospores,exospores, cysts. Mycelia of fungi and Actinomycetes, Cytoskeleton filament, heterocysts and akinets of Cyanobacteria, Gliding and motility.

Membrane structure & transport – Models of membrane structure, Membrane lipids, proteins and carbohydrates; Solute transport by Simple diffusion, Facilitated diffusion and Active transport

Cell cycle - An overview of cell cycle; Components of cell cycle control system;
Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis).

REFERENCES

1. Molecular Biology of cell – Bruce Alberts et al, Garland publications
2. Animal Cytology & Evolution – MJD, White Cambridge University Publicatins
3. Molecular Cell Biology – Daniel ,Sceintific American Books.
4. Cell Biology – Jack D.Bruke, The William Twilkins Company.
5. Cell Biology – Ambrose &DorouthyMEasty, ELBS Publications.
6. Fundamentals of Cytology – Sharp, Mc Graw Hill Company
7. Cytology – Wilson &Marrision, Reinform Publications
8. Molecular Biology – Smith Faber & Faber Publications
9. Cell Biology & Molecular Biology – EDP Roberties& EMF Roberties, Sauder College.

Semester – I
GE-ZOOLOGY-1
Paper: IN-ZOO-102
CELL BIOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

102.1 Prepare slides of animal and plant cells and cell division
102.2 Conduct the morphomatric analysis of chromosomes

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:
1. Cell division: Permanent slides of animal and plant cells and cell division;
2. Mitotic studies in onion root tip
3. meiotic studies in grasshopper testes/flower buds
4. Chromosomes: Mounting of polytene chromosomes
5. Effect of different osmotic concentration solutions on animal and plant cells
6. Buccal smear – Barr bodies

Semester – 2
CC- BIOTECHNOLOGY-3
Paper: IN-BTY- 201
ENZYMOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After successful completion students will be able to

201.1 Define various characteristics of enzymes, classify them and elaborate the role of cofactors in enzyme catalysis

201.2 Correlate the structure of enzymes to their functions, mechanism of enzyme catalysis and describe various approaches for purification of enzymes

201.3 Exhibit the knowledge of enzyme kinetics of unisubstrate reactions, various kinetics parameters (Km, Vmax etc.) and describe different types of enzyme inhibitions.

201.4 Correlate different ways of enzyme regulation to cellular metabolism: discuss and analysethe industrial importance of enzymes and the techniques to use them.

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit- I

Enzymes: Historical perspectives, general characteristics, nomenclature & classification, significance of numbering system, holoenzyme, apoenzyme, coenzymes, cofactors, activators, inhibitors, active site, metallo-enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes, multifunctional enzyme and multi-enzyme complexes. Enzyme specificity. Measurement and expression of enzyme activity: Enzyme assay, enzyme units, enzyme turn over number and specific activity. Role of cofactors in enzyme catalysis: NAD/NADP, FMN/FAD, coenzyme A, biocytin, Vitamin B12 Coenzyme, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions

Enzyme catalysis: Reaction co-ordinate diagram, transition state, Acid-base catalysis, covalent catalysis, proximity and orientation effects, strain and distortion theory. Mechanism of action of chymotrypsin, carboxypeptidase, andribonuclease.

Enzyme Purification: Methods of isolation of enzymes, purification of enzymes - ammonium sulfate precipitation, molecular-sieving, ion-exchange chromatography, affinity chromatography, criteria of homogeneity and determination of molecular weight of enzyme.

Unit- II

Enzyme Kinetics: Factors affecting enzyme activity- enzyme concentration, substrate concentration, pH and temperature. Derivation of Michaelis - Menten equation for uni-substrate reactions. Km and its significance.Lineweaver-Burk plot.Importance of Kcat/Km. Bi-substrate reactions- brief introduction of sequential and ping-pong mechanisms with examples.Reversible (competitive, non-competitive and uncompetitive inhibitions) and irreversible inhibition.Determination of Km &Vmax in the presence and absence of inhibitor.

Enzyme regulation: Feedback inhibition, Allosteric enzymes. Covalently modulated enzymes.Zymogen activation.

Immobilized enzymes: Advantages, methods of immobilization - Adsorption, ionic binding, covalent coupling, cross-linking, entrapment, microencapsulation etc. Applications of immobilized enzymes (A brief account).Industrial applications of enzymes (Production of glucose from starch, cellulose and dextran; use of lactase in dairy industry; production of glucose-fructose syrup from sucrose; use of protease in food, detergent and leather industry).

Suggested readings:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer (2001) Horwood Publishing.
2. Fundamentals of Enzymology, 3rd edition, by Nicholas C. Price and Lewis Stevens (1999) Oxford U.
3. The Chemical Kinetics of Enzyme action by K.J. Laidler and P.S. Bunting, Oxford University Press London.
4. Structure and mechanism in Protein Science, 2nd edition, by Alan Fersht (1999). W.H. Freeman and Co., NY

Semester – 2
CC- BIOTECHNOLOGY-3
Paper: IN-BTY- 202
ENZYMOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to
202.1 Extract and quantitatively estimate the enzyme activity and protein content of the samples
202.2 Exhibit skills in studying various characteristics of enzymes like pH optima, temperature optima, Km, Vmax

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Estimation of protein by Biuret / Lowry method
2. Assay of acid phosphatase activity from germinating mungbean seeds and calculation of specific activity of acid phosphatase.
3. Effect of enzyme concentration on enzyme activity.
4. Effect of substrate concentration on acid phosphatase activity and determination of its Km value.
5. Effect of pH on enzyme activity and determination of optimum pH.
6. Effect of Temperature on Enzyme activity.

Suggested reading:

1. Introductory Practical Biochemistry by S.K.Sawhney& R. Singh (2000). Narosa Publishers
2. Practical Biochemistry by David Plummer (1990). Tata Mc-Graw Hill
3. Biochemical Methods by Sadasivam&Manickam (1996) New Age International (P) Ltd.
4. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.
5. A Lab. Manual in Biochemistry by J. Jayaraman (1996) New Age International (P) Ltd.

Semester – 2
CC- BIOTECHNOLOGY-4
Paper: IN-BTY- 203
GENETICS

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After successful completion students will be able to

203.1 Exhibit conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
203.2 Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders.
203.3 Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
203.4 Analyze the effect of mutations on gene functions and dosage

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit- I

Genetics - Definition, history and scope

Mendelism & Chromosome Theory: Mendel's principles, applications of Mendel's principles,Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal, Mitochondrial, Unifactorial , Multi-factorial). Deviation from Mendel's Dihybrid phenotype, Linkage, Sutton's view on linkage, Morgan's view on linkage, Bateson & Punnet's Coupling & Repulsion hypothesis.

Linkage & Crossing over: Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, kinds of Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.

Allelic Variation & Gene function – Multiple allele, Genetic interaction, Epiststic interactions, Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes.

Non-Mendelian inheritance – Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast)

Unit- II

Chromosomal variation in Number & Structure – Euploidy, Non-disjunction &Aneuploidy,Aneuploid segregation in plants, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Giant chromosome, Deletion, Duplication, Inversion, Translocation, Position Effect, Centromeric& Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being, Chromosomal aberrations & evolution. Gene Mutation

Chromosome Mapping - Haploid mapping (2 point & 3 point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping.

Human Cyto-Genetics – Human karyotype, Banding techniques, classification, use of Human Cyto-genetics in Medical science, Chromosomal abnormalities in spontaneous abortions, viable monosomies&trisomies, chromosomal deletions & duplications, genetics of chromosomal inversions & translocations, human traits, Genomic position effects on Gene expression, Inborn diseases

Pedigree analysis – Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial, Incomplete dominance & Penetrance.

Suggested readings:

1. Principles of Gene Manipulations – Old & Primrose, Black Well Scientific Publications.
2. Principles of Genetics – E.J.Gardener, M.J.Simmons and D.P.Snustad, John Wiley & Sons Publications
3. Elements of Genetics – PK Gupta, Rastogi Publications
4. Molecular Biology and Genetic Engineering – PK Gupta
5. Cytogentics, Evolution and Plant Breeding – PK Gupta

Semester – 2
CC BIOTECHNOLOGY-4
Paper: IN-BTY- 204
GENETICS-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to
204.1 Identify various stages of mitotic and meiotic cell cycles
204.2 Analyze the effect of mutations on gene functions

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals

1. Cell division: Permanent slides of animal and plant cells and cell division;
2. Mitotic and meiotic studies in grasshopper testes, onion root tips and flower buds
3. Chromosomes: Mounting of polytene chromosomes
4. Buccal smear – Barr bodies
5. Karyotype analysis – Man and Onion
6. Man – Normal and Abnormal – Down and Turner's syndromes (with the help of slides)
7. Simple genetic problems (Problems and Interaction of genes)
8. Chromosome mapping using three point test cross; tetrad analysis,
9. Induction and detection of mutations through genetic tests
10. Pedigree analysis in humans,

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006).
2. Principles of Genetics. VIII Edition John Wiley & Sons. 2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

AECC-2 -(English/ MIL) communication / Environmental Studies will be same as AECC approved by UGBOS, Department of English/ UGBOS, Department of Environment Sciences, KUK

Semester – II
GE-ZOOLOGY-2
Paper: IN-ZOO-201
MAMMALIAN PHYSIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

201.1 Gain in-depth understanding and appropriate functioning of digestive and cardiovascular system in animals
201.2 Describe the Physiology of humanrespiration&excretion
201.3 Understand the functioning of nerve impulse&reflex action and will explain about different types ofmuscles and their physiology in human
201.4 Explain the mechanism of action of hormones and related molecules involved in various physiological processes and will describe about human reproductive system

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit-1
Digestive system: Types of nutrition, ingestion, digestion, absorption, and assimilation, BMR.
Cardiovascular System: Types of circulatory systems, Composition of Blood, blood coagulation, Haemopoiesis, blood volume, blood pressure, control of blood pressure, cardiac cycle, origin and conduction of heart beat, control of heart beat, ECG – its principle and significance
Respiratory system: transport of gases, exchange of gases, neural and chemical regulation of respiration.
Excretory system: excretory products, kidney, structure of nephron, urine formation, urine concentration, micturition, osmoregulation

Unit-II
Nervous system: Neurons, generation and transmission of nerve impulse neurotransmitors
Muscle physiology: Types of muscular tissue, ultrastructure of myofibrillar filaments, neuro muscular junctions, physical and chemical changes in muscle contraction, energy for muscle contraction, Cori's cycle
Endocrinology: Endocrine glands and their functions, basic mechanism of Peptide and steroid hormones,
Reproduction: Menstrual and oestrual cycle, implantation, gestation, parturition

Suggested reading:

1. Guyton Medical Physiology Textbook By Guyton and Hall
2. C. C.Chatterji**,** Human Physiology
3. Human physiology: the basis of medicine V HigginsEdited by Gillian Pocock, Christopher D Richards. Published by Oxford University Press, 2004, ISBN 0198585276
4. Ross & Wilson, Anatomy & Physiology in Health & Illness, Churchill Livingstone.Tortora GJ, &Anagnodokos NP, Principles of Anatomy & Physiology, Harper & Rave Publishers, New Delhi.
5. Keele, C.A., Niel, E and Joels N, Samson Wright's Applied Physiology, Oxford University Press

Semester – II

GE-ZOOLOGY-2
Paper: IN-ZOO-202
MAMMALIAN PHYSIOLOGY- PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

202.1 analyse blood sample for total blood cell count, TLC, DLC
202.2 analyze urine sample and identify various tissues

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Use of Kymograph unit
2. Urine analysis
3. Total RBC count
4. Enumeration of white blood cells using haemocytometer
5. Erythrocyte sedimentation rate
6. Study of permanent slides of mammalian organs such as oesophagus, stomach, ileum, rectum, liver, trachea, lung, kidney etc

Semester – 3
CC-BIOTECHNOLOGY -5
Paper: IN-BTY- 301
METABOLISM

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After successful completion students will be able to

301.1 Apply the knowledge of biological redox reactions, coupled reactions, energy rich compounds and the energy transactions in studying metabolism; describe the metabolic pathways *i.e.* glycolysis (catabolism), gluconeogensis (anabolism), and TCA cycle and their regulations

301.2 Discuss the reactions, regulation and importance of pentose phosphate pathway, glycogen metabolism, glyoxylate, ETC and apply the concept of oxidative phosphorylation to calculate energy production by oxidation of carbohydrates

301.3 Describe the reactions and regulation of lipid biosynthesis and catabolism by beta, alpha and omega oxidative pathways: ketone bodies metabolism and integration to the metabolism of other biomolecules

301.4 Analyse how amino acid catabolism leads to formation of diverse type molecules including ketone bodies, glucose, urea: discuss the catabolism and anabolismof nucleic acids and porphyrins

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Bioenergetics: Concept of free energy, standard free energy, relation between equilibrium constant and standard free energy change and coupled reactions. Biological oxidation-reduction: redox potentials, relation between standard reduction potentials and free energy change (numericals included). High-energy compounds: phosphate group transfer potential, free energy of hydrolysis of ATP, PEP and glucose-6 phosphate along with reasons for high ΔG.

Carbohydrate Metabolism: Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentations.Feeder pathways, Entry of fructose into glycolysis.Reactions and energetics of TCA cycle.Regulation of glycolysis and TCA cycle.Gluconeogenesis.Glycogenesis and glycogenolysis.Reactions and physiological significance of pentose phosphate pathway.

Electron Transport Chain and Oxidative Phosphorylation: Structure of mitochondria, organization and sequence of electron carriers, sites of ATP production, inhibitors of electron transport chain. Oxidative phosphorylation: chemiosmotic theory, structure of ATP synthase, Inhibitors and uncouplers of oxidative phosphorylation. Transport of reducing equivalents from cytosol into mitochondria.

UNIT-II

Lipid Metabolism: Introduction, hydrolysis of triacylglycerols, activation of fatty acids, transport of fatty acyl CoA into mitochondria, beta-oxidation of saturated, and odd chain fatty acidss. ATP yield from fatty acid oxidation. Biosynthesis of saturated fatty acids.triglycerides.Metabolism of ketone bodies.

Amino acid Metabolism: General reactions of amino acid metabolism: transamination, oxidative and non-oxidative deamination and decarboxylation. Urea cycle.Glycogenic and ketogenic amino acids.Biosynthesis of aromatic amino acids.Glucose-Alanine cycle.

Nucleotide Metabolism: Sources of the atoms in the purine and pyrimidine molecules, denovo biosynthesis and degradation of purine and pyrimidine nucleotides, Regulation of purine and pyrimidine biosynthesis. Salvage pathways of purines and pyrimidines.

Suggested readings:

1. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999). John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999). Saunders College Publishing, NY.
4. Outlines of Biochemistry by E.E.Conn, P.K.Stumpf, G. Bruenimg and Ray H.Doi (1987). John Wiley & Sons, NY
5. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice Hall.

Semester – 3
CC- BIOTECHNOLOGY-5
Paper: IN-BTY- 302
METABOLISM-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to-
302.1 Determine biomolecules in the samples quantitatively.
302.2 Isolate and characterize carbohydrates, lipids and proteins from the natural sources

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals

1. Estimation of nitrogen by micro-Kjeldahl method.
2. Estimation of blood glucose by colorimetrically.
3. Estimation of ascorbic acid by titrimetric method.
4. Preparation of starch from potato and determination of achromatic point by salivary amylase
5. Isolation of total lipids by Folch method and determine acid value.
6. Isolation of casein from milk and determination of isoelectric pH.

Suggested reading:

1. Introductory Practical Biochemistry by S.K.Sawhney& R. Singh (2000). Narosa Publishers
2. Practical Biochemistry by David Plummer (1990). Tata Mc-Graw Hill
3. Biochemical Methods by Sadasivam&Manickam (1996) New Age International (P) Ltd.
4. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.

Semester – 3
CC- BIOTECHNOLOGY-6
Paper: IN-BTY- 303
PLANT ANATOMY AND PHYSIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning outcomes: : After successful completion students will be able to-

303.1 Exhibit the knowledge of fundamentals of plant anatomy and examine the internal anatomy of plant organs
303.2 Correlate the concept of water relation of plants to various physiological processes and nutrition of plants
303.3 Explain the process and significance of Photosynthesis and nitrogen metabolism
303.4 Illustrate various phases of plant growth and factors affecting them

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT I

Anatomy: The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

Plant water relations and micro & macro nutrients: Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT II

Carbon and nitrogen metabolism : Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Growth and development ; Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.

2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4 th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4 th edition, Sinauer Associates Inc .MA, USA

Semester – 3
CC-BIOTECHNOLOGY -6
Paper: IN-BTY- 304
PLANT ANATOMY AND PHYSIOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to-

304.1 Prepare stained mounts of anatomy and demonstrate physiological processes: plasmolysis, stomata opening, guttation of leaf tips,aerobic respiration

304.2 Separate photosynthetic pigments and prepare mounts of root nodules

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

PRACTICALS

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by Tradescantia leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4 th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4 th edition, Sinauer Associates Inc .MA, USA

CC- BIOTECHNOLOGY-7 Paper IN-BTY-305, IN-BTY-306, IN-BTY-307 and IN-BTY-308 will be same as Core Course CC-1 Chemistry Paper B-CHEM-101,B-CHEM-102, B-CHEM-103 and B-CHEM-104 approved by UG-BOS-Chemistry, Department of Chemistry, Kurukshetra University, Kurukshetra

SEC-1 Computer Science-level-1will be same as approved by UGBOS , Department of Computer Science, Kurukshetra University, Kurukshetra

Semester – III
GE-ZOOLOGY-3
Paper: IN-ZOO-301
DEVELOPMENTAL BIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

301.1 Gain detail understanding ofvarious developmental processes includinggametogenesis, fertilization and different pattern and mechanism of fertilized cell cleavage,
301.2 Understand the concept of germ layers, their formation and differentiation and will describe about early phase of embryonic development
301.3 Explain about the concept of differentiation and embryonic induction
301.4 Describe the development of organ including eye and fate of primary germ layers and will explain the process of aging & senescence in vertebrates

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Development Biology: Scope & historical perspective
Gametogenesis-Spermatogenesis, Metamorphosis of spermatid, Oogenesis
Fertilization-Definition, mechanism, types of fertilization
Cleavage-definition, types, patterns, Mechanism
Gastrulation- Morphogenetic movements-epiboly, emboly, extension, invagination, Convergence, de-lamination.
Formation and differentiation of primary germ layers
Fate maps in early embryos

Unit II

Differentiation: Cell commitment and determination-epigenetic landscape: a model of determination and differentiation at the level of genome, transcription and post transcriptional
Concept of embryonic induction: Primary, secondary and tertiary embryonic induction. Neuronal induction and induction of vertebrate lens
Pathway selection, target and address selection
Extra embryonic membranes, placenta in mammals
Neurulation, notogenersis, Development of vertebrate eye
Fate of primary germ layers
Development of behaviour: constancy and plasticity
Aging & Senescence

Suggested Reading:
Developmental Biology by Scott Gilbert

Semester – II
GE-ZOOLOGY-3
Paper: IN-ZOO-302
DEVELOPMENTAL BIOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to
302.1 Differentiate various life stages of mosquito/frog and will identify chick embryo stages
302.2 Able to prepare permanent histological slides

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Preparation of permanent/temporary slides of developmental stages of frog/mosquito.
2. Study of permanent slides of WM of chick embryo (13-18h, 24-36h, 36-48h, 48-72h).
3. Window preparation and identification of stages of development in chick egg.
4. Histology: Preparation of permanent histological slides of mammalian testes, ovary, kidney, intestine, liver of rat (H & E staining).

AECC-3 Hindi/Sanskrit will be same as AECC approved by UGBOS, Department of Hindi/ UGBOS, Department of Sanskrit, Kurukshetra University, Kurukshetra.

Semester – 4
CC-BIOTECHNOLOGY-8
Paper: IN-BTY- 401
MOLECULAR BIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After successful completion students will be able to

401.1 Elaborate the central dogma of life at molecular level and the general principles of gene organization, DNA supercoiling; nucleases and various approaches of sequencing of DNA

401.2 Describe the structure and functions of proteins involved in replication and mechanism of DNA replication and correlate molecular basis of different types of DNA mutations with the repair systems of the mutations

401.3 Give an insight of the process of gene expression, mechanism of transcription, post-transcriptional processing of RNA in prokaryotes; Describe and correlate the concept of genetic code and mechanism of translation in prokaryotes

401.4 Describe the process of regulation of gene expression in prokaryotes and exhibit the knowledge of basics of recombinant technology for the manipulation of genetic information stored in the cells with the help of diverse cloning vectors

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Basic Concepts of Genetic Information: Structure of DNA, various forces responsible for stability of DNA, various forms of DNA, DNA topology, topological and geometric properties, DNA supercoiling, Topoisomerases in prokaryotes and eukaryotes, DNA organization in prokaryotes and eukaryotes, C-value paradox, denaturation: different ways for carrying out denaturation, renaturation: requirements, kinetics, significance, various classes of DNA: highly repetitive, moderately repetitive and unique sequence, RNA: structure and types.

DNA replication, mutations and DNA repair: Possible modes of DNA replication, Meselson-Stahl experiment, DNA polymerases and other enzymes involved in DNA replication, Okazaki fragments, Mechanism of replication in prokaryotes and eukaryotes, inhibitors of DNA replication, molecular basis of mutations, DNA repair mechanisms like direct, base-excision, nucleotide-excision, mismatch, SOS and recombinational repair.

Unit II

Transcription and post-transcriptional modifications: RNA polymerase/s in prokaryotes and eukaryotes, DNA footprinting technique, initiation, elongation and termination of transcription in prokaryotes and eukaryotes, inhibitors of transcription, RNA replicase, reverse transcriptase, post-transcriptional modifications: different types of introns and their splicing mechanisms, processing of mRNA, rRNA and tRNA precursors, overlapping genes and split genes.

Protein synthesis, targeting and degradation: Characteristics of the genetic code, biological significance of degeneracy, decoding the code, Wobble hypothesis, ribosomes structure and function in prokaryotes and eukaryotes, Aminoacyl-tRNA-synthetases various factors and steps involved in protein synthesis in prokaryotes and eukaryotes, polyribosomes, post-translational processing, signal hypothesis and protein targeting to lysosomes, Plasma membrane, extracellular matrix and different compartment of mitochondria and chloroplast, protein degradation.

Suggested readings:

1. Molecular Cell Biology, 5th edition H Lodish et al. (2004) W H Freeman and Company.
2. Genes VIII, B Lewin (2004) Pearson Education International.
3. Freifelder's Essentials of Molecular Biology, 4rd edition, D Freifelder. (2005) Narosa publishing house
4. Biochemistry, 2nd edition, Moran. Neil Patterson Publishing.
5. Fundamentals of Biochemistry, 2nd edition, D Voet& G J Voet. John-Wiley & sons.
6. Biochemistry, 5th edition, JM Berg et al. W H Freeman & Co. N York.
7. Lehninger's Principles of Biochemistry, 4nd edition, D L Nelson and M M Cox. (2005) W H Freeman & Co. N York.
8. The Biochemistry of Nucleic acid, 11th edition, R L Adams et al, Chapman and Hall.
9. Molecular Biology of the Gene, 5th Edition, Watson et al (2004) Pearson Education International.

Semester –4
CC-BIOTECHNOLOGY-8
Paper: IN-BTY- 402
MOLECULAR BIOLOGY–PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to

402.1 Isolate and quantify genetic material from plant/animal sources by colorimetric methods

402.2 Exhibit the skill in separating the fragments of DNA by electrophoresis and characterizing by absorption spectrum.

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Isolation of DNA from plant/Animal source
2. Estimation of DNA by diphenylamine method.
3. Separation of DNA fragments by Agarose gel electrophoresis
4. Isolation of RNA from spinach leaves/bacteria/yeast
5. Estimation of RNA by orcinol method.
6. Determination of absorption maxima of nucleic acids

Suggested readings:

1. Molecular Cell Biology, 5th edition H Lodish et al. (2004) W H Freeman and Company.
2. Genes VIII, B Lewin (2004) Pearson Education International.
3. Freifelder's Essentials of Molecular Biology, 4rd edition, D Freifelder. (2005) Narosa publishing house
4. Biochemistry, 2nd edition, Moran. Neil Patterson Publishing.
5. Fundamentals of Biochemistry, 2nd edition, D Voet& G J Voet. John-Wiley & sons.
6. Biochemistry, 5th edition, JM Berg et al. W H Freeman & Co. N York.
7. Lehninger's Principles of Biochemistry, 4nd edition, D L Nelson and M M Cox. (2005) W H Freeman & Co. N York.
8. The Biochemistry of Nucleic acid, 11th edition, R L Adams et al, Chapman and Hall.
9. Molecular Biology of the Gene, 5th Edition, Watson et al (2004) Pearson Education International.

Semester-4
CC-BIOTECHNOLOGY-9
Paper: IN-BTY- 403
ANIMAL BIOTECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

403.1 Describe the scope, application of animal biotechnology and elaborate the techniques of gene transfer in mammalian cells
403.2 Explain the concept of animal transgenesis and their applications in pathogenesis
403.3 Describe about cloning, artificial insemination, their role in animal propagation and will understand the role of biotechnology including IVF and stem cells in conservations of livestock diversity
403.4 Elaborate the gene therapy, its type and their role in bioengineering

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Animal Biotechnology: Scope, global perspective and new horizons, Historical perspective, and economically important livestock breeds, Model animals in animal biotechnology and genetic engineering.
Gene transfer methods in Animals: DNA transfer techniques into mammalian cells: calcium phosphate precipitation, DEAE-dextran procedure, Microinjection, Electroporation, Selectable markers, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

Introduction to transgenesis: Transgenic Animals – Mice, Sheep, Cow, Pig, Goat, Bird, Insect. Animal diseases need help of Biotechnology–Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis

Unit II

Animal propagation: Artificial insemination, Animal Clones (Concepts of animal cloning, Principles and techniques of cloning).

Conservation Biology: Biotechnology in conservation of livestock diversity, Superovulation, Embryo biotechnology-Embryo collection, evaluation, and transfer, *In vitro* fertilization (IVF) and *In vitro* embryo production, Cryobanking of germplasm, oocytes and sperm, Somatic and Stem cells; Somatic nuclear transfer (SCNT), Stem technology in livestock

Genetic modification in Medicine - Gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Suggested Readings:

1. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
2. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.
3. Text Book of Animal Biotechnology- (2020) published by The Energy and Resources Institute Press, New Delhi.
4. Advances in Animal Biotechnology (2020) published by Springer Nature Switzerland AG.
5. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
6. Culturing of animal cells by Ian Freshney, 6th edition

Semester – 4
CC-BIOTECHNOLOGY-9
Paper: IN-BTY - 404
ANIMAL BIOTECHNOLOGY -PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to
404.1 Prepare different media, culture and cryopreserve the animal cells.
404.2 Perform gene transfer technique and demonstrate about animal cloning and IVF

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Preparation of media for animal cells
2. Preparation of cryopreservation media
3. Isolation and cryopreservation of lymphocytes
4. Freezing/cryopreservation of animal cells and post thaw damages in animal cells after cryopreservation
5. Perform one gene transfer method
6. Demonstrate about animal cloning
7. Demonstrate about *In vitro* fertilization (IVF) including collection of ovaries, maturation of oocytes, recovery of oocytes etc

Suggested Readings:

1. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
2. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
3. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.
4. Biotechnology, Vol. 7b 1993 Rehm. H.J. and Reed, G.(eds) VCH Publications.
5. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd. Oxford.
6. Cell Growth and Division: a Practical Approach. Ed. R. Basega, IRL Press.
7. Culture of Animal Cells, (3rdedition), R. Ian Freshney. Wiley-Liss.

CC- BIOTECHNOLOGY-10 Paper IN-BTY-405, IN-BTY-406, IN-BTY-407 and IN-BTY-408 will be same as Core Course CC-2 Chemistry Paper B-CHEM-201,B-CHEM-202, B-CHEM-203 and B-CHEM-204 approved by UG- BOS-Chemistry, Department of Chemistry, Kurukshetra University, Kurukshetra

SEC-BIOTECHNOLOGY
Paper: IN-BTY- S1
BIOANALYTICAL TOOLS

Credits: 2
Max. Marks: 50
Internal assessment: 10
Time: 3 hrs

Learning Outcomes: Students who successfully complete this course will be able to

S1.1 Demonstrate the knowledge of the general principles, components and applications of pH meter and centrifuges;
S1.2 Exhibit the insights of principles and applications of chromatographic techniques in isolation, quantification and characterization of biomolecules
S1.3 Demonstrate the knowledge of the general principles, components and applications of spectrophotometer;
S1.4 Describe the principles and applications of electrophoresis and radioisotopes in biochemical studies.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit- I

Measurement of pH: Principles of glass and reference electrodes.

Hydrodynamic Methods: Sedimentation: sedimentation velocity including factors affecting it, preparative and analytical centrifugation techniques, ultracentrifugation, determination of molecular weight by hydrodynamic methods (derivations excluded and numericals included).

Chromatographic techniques- General principles and applications of adsorption, ion-exchange, molecular-sieve, thin layer, hydrophobic, affinity & paper chromatography.

Unit- II

Electrophoresis- Basic principles of electrophoresis; Native & SDS-PAGE; Agarose gel electrophoresis and Isoelectricfocussing.

Radioisotopic Techniques: Types of radiations, radioactive decay, units of radioactivity, detection and measurement of radioactivity (methods based on gas ionization and liquid scintillation counting) and Quenching. Autoradiography: overview, nuclear emulsions used in biological studies, isotopes commonly used in biochemical studies (^{32}P, ^{35}S, ^{14}C and

^{3}H), track length of emitted particles and physical arrangements between emitting source and emulsion. Biological hazards of radiations and safety measures in handling radioisotopes.Biological applications of radioisotopes.

Spectroscopic Techniques: Beer-Lambert law, light absorption and its transmittance, extinction coefficient, a brief account of instrumentation and applications of visible and UV spectroscopic techniques (structure elucidation excluded).

Suggested readings:

1. Physical Biochemistry, 2nd edition, by D Friefelder (1983). W.H. Freeman & Co., U.S.A.
2. Biophysical Chemistry: Principles and Techniques, 2nd edition, by A. Upadhyay, K. Upadhyay and N.Nath. (1998). Himalaya Publishing House, Delhi.
3. Principles & Techniques of Practical Biochemistry, 5th edition, by Keith Wilson and John Walker (2000). Cambridge University Press.
4. Introductory Practical Biochemistry by S.K. Sawhney and Randhir Singh (2000). Narosa Publishing House, New Delhi.

Semester – IV

GE-ZOOLOGY-4
Paper: IN-ZOO-401
ANIMAL DIVERSITY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

401.1 Describe unique characters, diversity and ecological role of phylum Protozoa, Porifera, Coelenterate & Helminthes
401.2 Explain in detail about the characters, diversity and ecological role of phylum Arthropoda, Mollusca&Echinodermata
401.3 Identify different Urochordates, Cephalochordates, about their adaptations and associations in relation to their environment.
401.4 Identify (based on morphological characters) and understand adaptations in vertebrate class including amphibians, reptiles, birds, and mammals.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit-1

General classification of animal kingdom

Non-chordates –Study of phylum Protozoa, Porifera, Ceolenterata,Platyhelmenthes, Nemathelmenthes, Arthropoda, Mollusca&
Echinodermata – General characters, biodiversity with economic importance

Unit-2

Chordates:-
Study of Urochordates ,Cephalochordates and Vertebrates-Generalcharacters ,biodiversity with economic importance

REFERENCES

- Invertebrate by Jordan and Verma
- Invertebrate by Kotpal
- Non Chordate by Dhami and Dhami
- Chordate Zoology by Verma
- Chordate Zoology by Kotpal
- Chordate Zoology by Jordan
- Chordate Zoology by Dhami and Dhami

Semester – IV
GE-ZOOLOGY-4
Paper: IN-ZOO-402
ANIMAL DIVERSITY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion of this course students will be able to
402.1 Identify invertebrates and vertebrate specimeas well as classify them
402.2 Prepare slides of different parts as was whole mounts of vertebrate and Invertebrate

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. To study permanent slides of protozoans available
2. To study specimens from various Invertebrate groups
3. Preparation of temporary whole mounts of insect mouthparts
4. Prepare slides of piscean scales,feathers,amphioxus,herdmania spicules
5. To study specimens of vertebrate groups

Semester – V
CC-BIOTECHNOLOGY-11
Paper: IN-BTY - 501
RECOMBINANT DNA TECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

501.1 Understand the concept and scopes of Genetic Engineering and central role of recombinant DNA technology in all fields of Biotechnology

501.2 Learn about enzymes, vectors, and their types to be used in the recombinant DNA technology

501.3 Describe about different methodologies to be used for the isolation and analysis of genomic and nuclear DNA

501.4 Illustrate about the PCR, their types along with strategies required for gene cloning purpose including preparation of competent cell, introduction of foreign DNAs into competent cells and selection of recombinants.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Genetic Engineering: Introduction, scope and applications of Genetic Engineering, Miles stones in Genetic engineering, Central role of E.coli.

Gene Modifying Enzymes: DNA polymerase, Polynucleotide kinase, Terminal deoxynucleotidy1 transferase, Reverse transcriptase, Restriction endonucleases (R.E.) - Host controlled restriction and modification, Nomenclature, types, Recognition sequence, blunt and sticky ends, applications, online tools & Database (like REBASE) for studyingrecognition site and about R.E. enzymes, Nucleases, Methylases, Alkaline phosphatase, Ligases- E. coli and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing, Nick translation system

Gene Cloning Vectors: Types, classes and uses of cloning vectors *viz.* Plasmids, Cosmids, Phagemid

Plasmid Biology: Structural and Functional Organization of Plasmids, Plasmid Replication, Stringent and Relaxed Plasmids, Incompatibility of Plasmid Maintenance, Ti plasmids,

Biology of Bacteriophage Lambda: Lambda Phage as a natural *in vivo* vector, *in vitro* construction of lambda vector, Bacteriophage (ssDNA Phages), Cauliflower Mosaic Virus, Artificial chromosomes (YAC, BAC, PAC).

Unit II

Isolation & Analysis of Genomic and Nuclear DNA: Purification of total cell DNA, plasmid DNA, phage DNA, DNA digestion and restriction fragment analysis and sequencing by chemical, enzymatic and BigDye terminator methods.

Polymerase Chain Reaction: Concept, Basic PCR reaction, Factors affecting the PCR, Types of PCR (RT- PCR, Real time PCR, Allele specific PCR, Multiplex PCR), Applications of PCR, Preparation of Primers by using online tools

Cloning and Subcloning Strategy: Construction of recombinant DNA: Preparation of competent cell - Transformation, Transfection – Selection and Screening of Recombinants (bacteria and phages); Cloning strategies in yeast, *E. coli* and *B. subtilis*

Suggested Readings:

1. "Principles of Gene Manipulation" by R.W.Old and S.B.Primrose Third Edition Blackwell Scientific Publication
2. "Genes VI" by B. Lewin
3. "From Genes to Clones" by E. L. Winnecker.
4. "Gene Cloning " by T. A. Brown

Semester – 5
CC-BIOTECHNOLOGY-11
Paper: IN-BTY - 502
RECOMBINANT DNA TECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

502.1 Isolate nucleic acids, quantify and analyze by gel electrophoresis

502.2 Exhibit the skill in designing primers and exploring restriction enzymes by using online database and will also carry out restriction digestion and perform PCR based analysis to study recombinant genes

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. To perform plasmid isolation from *E.Coli* and its quality determination by agarose gel electrophoresis.
2. Designing primers in Gene Runner for PCR.
3. To perform PCR with given template and primers.
4. Demonstrate about RT-PCR
5. To perform Restriction digestion of given DNA sample.
6. Exploration of Restriction Enzyme Database REBASE
7. Drawing vector DNA map with specified features.

Suggested readings:

1. “Principles of Gene Manipulation” by R.W.Old and S.B.Primrose Third Edition Blackwell Scientific Publication
2. “Genes VI” by B. Lewin
3. “From Genes to Clones” by E. L. Winnecker.
4. “Gene Cloning “ by T. A. Brown

Semester – 5
CC-BIOTECHNOLOGY-12
Paper: IN-BTY- 503
PLANT BIOTECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

503.1 Elaborate the concept of plant tissue culture, totipotency, differentiation and somaclonal variation.
503.2 Describe different techniques of micropropagation in plants, their applications and limitations.
503.3 Give an insight of vector mediated and vectorless methods of plant cell transformation, along with merits and demerits.
503.4 Correlate the plant genome organization with different types of transformations

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT I

Introduction: Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation

In vitro haploid production: Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT – II

Protoplast Isolation and fusion: Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

Organization of plant genome: Nuclear, Chloroplast and Mitochondrial genome. Chloroplast Transformation- vector designing, methods and advantages. Plant Nuclear Transformation- Agrobacterium mediated transformation, Ti and Ri plasmids, role of virulence genes, mechanism of T-DNA transfer, vectors based on Ti and Ri plasmids, cointegrate and binary vectors, techniques and factors effecting Agrobacterium mediated transformation of plants.Direct gene transfer methods- particle bombardment, PEG-mediated, electroporation, microinjection and other alternative methods.

Suggested Reading

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB.,Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture.Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook&Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

Semester – 5
CC-BIOTECHNOLOGY-12
Paper: IN-BTY - 504
PLANT BIOTECHNOLOGY - PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to
504.1 Prepare and sterilize different media required for plant tissue culture
504.2 Perform micro-propagation with different explants

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture
4. Haploid culture: Andogenesis and Gynogenesis.
5. Protoplast isolation using enzymatic method.
6. Analysis of various plant extracts for their antibiotic activity.
7. Performance of node culture.
8. Suspension culture with different explants.
9. Embryo culture.
10. Transferring the grown plants to hardening medium.

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Suggested Reading

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture.Narosa Publishing House.
3. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
4. Sambrook &Russel. Molecular Cloning: A laboratory manual. (3rd edition)

Semester – V
DSE1-BIOTECHNOLOGY
Paper: IN-BTY-505
FOOD TECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

- **505.1** Gain the knowledge about different food and dietary supplements such as food from fungi, algae and bacteria and their large scale production and genetically modified (GM) foods.
- **505.2** Learn about food additives & its classification and functions alongwith diverse methods of food preservation.
- **505.3** Understand about various packing materials, their properties and functioning in food industries
- **505.4** Learn the concept of safety, quality assurance and food adulteration along with the role of national and international food regulatory bodies their standards for maintaining food quality and safety.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit – 1

Foods and supplements: Introduction to food technology- history, background, food compositions; Dietary supplements; Production of food from fungi, algae and bacteria: Single cell proteins (SCP), mushrooms (edible fungus) etc; fermented foods and beverages-Bread, coffee, cheese, butter, yoghurt, meat, fish, beer, wine etc; transgenic plant foods-carbohydrates, proteins, vitamins nutritional quality improvement of the food crops by genetic engineering; Food borne disease (brief)

Food additives & preservation techniques: Food additives- definitions, need for food additives, classification and functions of different additives: thickeners, antioxidants, coloring agents, flavoring agents, sweeteners, emulsifiers, flour improvers; Preservation techniques: techniques like refrigeration & freezing, dehydration, heating etc., antimicrobial agents used in food preservation.

Unit –II

Food Packaging: Introduction to Food Packaging: definition, factors involved in the evolution and selection of a food package, functions of food packaging. Types of packaging materials and their functioning properties; Aseptic packaging of foods: sterilization techniques of food and packaging material; Advantages and disadvantages associated with packaging of foods.

Food Safety and Quality Control: Introduction to concepts of food safety including safety of GM food crops and food quality assurance; Food adulteration, nature of adulterants, methods of evaluation of food adulterants and toxic constituents. Role of national and international regulatory agencies, Bureau of Indian Standards (BIS), AGMARK, Food Safety and Standards Authority of India (FSSAI), USFDA, International organization for standards (ISO) and its standards for food quality and safety (ISO 9000 series, ISO 22000, ISO 15161, ISO 14000).

Suggested Readings:

- Food Sciences and Food Biotechnology, Lopez GFP, Canas G, Nathan EV, CRC Publications
- Genetically Modified Foods; Ruse M, Castle D, Prometheus Book publication.
- Biotechnology and Food Process Engineering; Schwartzberg HG, Rao MA, Marcel Dekker.
- Modern Food Biotechnology; Jay JM, Lossner MJ, Golden DA.
- Food Science; Potter NN, Hotchkiss JH.
- Sivasankar,B (2002): Food Processing and Preservation, Prentice Hall of India Pvt.Ltd., New Delhi.
- Khetarpaul N. (2005).Food Processing and Preservation, Dya Publishing House, New Delhi.
- Robertson, G.L. (2006). Food Packaging: Principles and Practice (2^{nd} ed.), Taylor and Francis
- Ahvenainen, R. (Ed.) Novel Food Packaging Techniques, CRC Press, (2003).
- Han, J.H.(Ed.) Innovations in Food Packaging, Elsevier Academic Press, (2005).
- Food and Agricultural Organization (1980): Manuals of Food Quality Control. 2 Additives Contaminants Techniques, Rome.
- Gould,W.A. and Gould, R.W. (1998). Total Quality Assurance for the Food Industries, CTI Publications Inc.Baltimore.
- Dietrich Knorr, Steven R. Tannebaum and Pieter Walstra.Food Biotechnology. Biotechnology group, Department of food and sciences, University of Delaware, New York Delaware.Marcel Dekker Inc. New Yorl and Baset.
- V.K. Josh (2009).Biotechnology; Food fermentation in Microbiology, Biochemistry and Technology, Vol. 1 and 2.

Semester – V
DSE1-BIOTECHNOLOGY
Paper: IN-BTY-506
FOOD TECHNOLOGY- PRACTICALS

Credits: 2
Total Marks: 50
External Marks: 40
Internal Assessment: 10
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

506.1 check the quality of packed and unpacked foods and role of preservation techniques
506.2 characterize food samples for nutrients and adulterants

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. To study the various sterilization and food preservation techniques.
2. Determination of water vapour transmission rate for given packaging materials.
3. Determination of Acidity & pH in food sample/beverages.
4. Determination of total, non-reducing and reducing sugars in the given food sample.
5. To test the quality of milk (branded, non-branded and local) by Methylene Blue Reduction Test (MBRT) and other tests
6. Determination of adulterants in the given oil/milk/food samples

Suggested Readings:

- Sivasankar,B (2002): Food Processing and Preservation, Prentice Hall of India Pvt.Ltd., New Delhi.
- Khetarpaul N. (2005).Food Processing and Preservation, Dya Publishing House, New Delhi.
- Robertson, G.L. (2006). Food Packaging: Principles and Practice (2nd ed.), Taylor and Francis
- Ahvenainen, R. (Ed.) Novel Food Packaging Techniques, CRC Press, (2003).
- Han, J.H.(Ed.) Innovations in Food Packaging, Elsevier Academic Press, (2005).

Semester – V
DSE1-BIOTECHNOLOGY
Paper: IN-BTY-507
BIOMATHEMATICS

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

- **507.1** Understand the basics of mathematics and its use in biological sciences.
- **507.2** Learn about complex numbers and matrices which can help them to understand various biological models involving variables i.e. frequencies of multiple alleles, population dyanamics, image processing and bioinformatics etc.
- **507.3** Learn about differential equation and its application which can be used in modeling.
- **507.4** Gain knowledge related to partial differential equations which help them to understand regulatory feedbacks and transport processes in multicellular biological systems

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Complex Numbers: Introduction, Operations on complex numbers, Complex conjugate, Modules and argument of complex number and simple examples on it.,.4 DE MOIVRE'S Theorem., Simple examples on above theorem ,th n roots of a complex number and simple examples on it.

Matrices: Definition and types of Matrices, Algebra of Matrices (addition, subtraction, scalar multiplication and multiplication of matrices), Examples on operation of Matrices, Inverse of a matrix by a ad joint method, Rank of a Matrix (Definition) and examples, System of Linear equation, Non homogenean, Homogenean with examples, Eigen values and eigen vectors with simple examples

Unit II

Differential equation: Definition of ordinary differential equation and degree, order of differential equation Exact differential equation with simple examples, Linear differential equation dy/dx+py =Q method of solution with simple examples. Bernoulli's differential equation with examples, Application of differential equation i) Growth and decay problems ii) Newton's law of cooling with examples.

Partial differentiation: Introduction, Simple examples on evaluation of partial derivatives, Composite function with examples, Homogenous function (Definition), Euler's theorem for first and second order., Simple examples on above theorems., Extreme values with examples., Lagrange's method of undetermined multipliers (with proof), Examples on above method.

Suggested reading:

1. Partial Differential Equation by IN Sneiden
2. Matrices by Shanti Narayan
3. Complex Variables by Shanti Narayan
4. Ordinary Differential Equation by Saplay & Ross

Semester – V
DSE1-BIOTECHNOLOGY
Paper: IN-BTY-508
BIOMATHEMATICS-PRACTICALS

Credits: 2
Total Marks: 50
External Marks: 40
Internal Assessment: 10
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

508.1 Apply operation on complex number and matrices
508.2 Apply composite functions and differential equation

Approaches to teaching
Instructions, Chalk and board teaching, practical and practice
Requirements
Regular attendance and active participation during the course; reference material
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1) Exercises on Operations on complex numbers and theorems,
2) Exercises on operation of Matrices, Inverse of a matrix and ad joint method
3) Exercises on Rank of a Matrix: System of Linear equation, Non homogenean, Homogenean, Eigen values and Eigen vectors
4) Exercises based on ordinary differential equation and Linear differential equation
5) Examples on evaluation of partial derivatives, Composite function, Homogenous function
6) Application of differential equation i) Growth and decay problems ii) Newton's law of cooling, Extreme value, Lagrange's method of undetermined multipliers

Semester – V
DSE2-BIOTECHNOLOGY
Paper: IN-BTY-511
MEDICAL BIOTECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

511.1 Understand chromosomal, gene and mitochondrial disorders and will describe about various biotechnology tools to detect these disorders.
511.2 Learn about various invasive and non-invasive techniques to diagnose human disorders during prenatal period.
511.3 Understand metabolic disorders and their management by using diverse therapeutic approaches.
511.4 Describe and appraise broad knowledge of the use of gene products as vaccines

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Classification of genetic diseases:
Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies; Structural disorders - deletions, duplications, translocations & inversions; Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders and Multifactorial conditions. Identification of disease genes, Functional cloning –haemophilia gene. Positional cloning - DMD and CGD genes. Candidate gene approach –Marfan's syndrome, Alzheimer's disease.

Molecular basis of human diseases - Pathogenic mutations. Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor Genes, PAX- 3 gene; Gene Dosage Effect - PMP22 , Collagen gene; Genomic Imprinting -Mechanisms, Praderwilli / Angelman syndrome, WAGR syndrome, Beckwith Weidemann Syndrome; Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy; Mitochondrial diseases: MELAS, LHON
Autoimmune Disorders-SLE, RA

Diagnostics

Prenatal diagnosis - Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Non-invasive techniques - Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood; Diagnosis using protein and enzyme markers, monoclonal antibodies. DNA/RNA based diagnosis Microarray technology- genomic and c DNA arrays, application to diseases

Unit II

Therapeutics

Clinical management and Metabolic manipulation - PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism; Gene therapy: Ex-vivo, Invivo, Insitu gene therapy, Strategies of gene therapy: gene augmentation – ADA defeiciency, CFTR Prodrug therapy/ suicide gene – glioma, evoking immune response – melanoma TFO, Antisense therapy, Ribozymes, Protein Aptamers, Intrabodies

Vectors used in gene therapy: Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer; Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumours. Cell and tissue engineering: Encapsulation technology and therapeutics - Diabetes, Hypothyroidism, Haemophilia Bioartificial organs, Artificial Cells- For Haemophilia, Phenylkeptonuria

Gene products in medicine: Functional cloning – anti-haemophilic factor; Positional cloning- Dystrophin; Gene products in medicine - Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon; DNA based vaccines; Vector vaccines – Cholera and Salmonella; Attenuated Vaccines– Cholera

Semester – V
DSE2-BIOTECHNOLOGY
Paper: IN-BTY-512
MEDICAL BIOTECHNOLOGY-PRACTICALS

Credits: 2
Total Marks: 50
External Marks: 40
Internal Assessment: 10
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

512.1 analyse DNA damage and modifications
512.2 give an insight of development of disease causing agents and diagnostic tools

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Single Cell Gel Electrophoresis to detect DNA damage
2. Perform immunoelectrophoresis
3. Perform DNA fingerprinting analysis
4. Determine TLC and DLC in human blood smear.
5. Determine mutation by AIMS test
6. Illustrate about artificial cells and organs.
7. Illustrate the formation of Adenoviruses/Retroviruses.
8. Illustrate about the invasive and non-invasive diagnostic tools

DSE2-BIOTECHNOLOGY Paper IN-BTY-513,IN-BTY-514, IN-BTY-515 and IN-BTY-516 will be same as B-CHEM-301**,** B-CHEM-302, B-CHEM-303 and B-CHEM-304 approved by UG-BOS, Department of Chemistry, KUK

Semester – V

GE-ZOOLOGY-5
Paper: IN-ZOO-501
EVOLUTIONARY BIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

501.1 Understand the conditions conducive for origin of life on earth and also about various theories related to origin of life and evolutionary biology.
501.2 Differentiate between micro, macro and mega evolution and will understand interrelation amongst various species and can develop the phylogeny trees accordingly
501.3 Explain the concept of variations in the species and will describe about the population genetics and role of migration and mutation in the evolution
501.4 Understand the concept of selection, types and their impact on evolution

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit-1

- Origin of life.
- Concept and evidences of organic evolution.
- Theories of organic evolution.
- Concept of micro, macro-and mega-evolution.
- Phylogeny of horse.
- Phylogeny of man.

Unit-2

- Variations
- Population genetics: Gene pool, gene frequency, Hardy-Weinberg Law, Genetic Drift, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in evolution
- Natural selection, sexual selection
- Isolation
- Speciation

- Concept of species

Suggested readings:

- Cell Biology, Genetics, Molecular Biology, Evolution & Ecology by Verma and Aggarwal
- Organic evolution by Veer BalaRastogi

Semester – V
GE-ZOOLOGY-5
Paper: IN-ZOO-502
EVOLUTIONARY BIOLOGY: PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion of this course students will be able to
502.1 Understand the process of adaptations and variations
502.2 Identify fossils

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:
1. To study beaks and feet of birds
2. To study fossils from photographs
3. To study living fossil from specimens
4. To monitor human height, weight and BMI
5. To monitor discrete characteristics i.e. tough rolling, air lobe etc.

Semester – 6
CC-BIOTECHNOLOGY-13
Paper: IN-BTY- 601
GENOMICS & PROTEOMICS

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: Students who successfully complete this course will be able to

601.1 Determine the function of genes and elements that regulate genes throughout the genome and apply sequence for analysis of organism genome.
601.2 Perform on various web based softwares for genome analysis
601.3 Correlate the findings of protein techniques to the structures of proteins
601.4 Analyse proteomes using various tools and techniques

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT I

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods,

Computer tools for sequencing projects: Genome sequence assembly software.

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT II

Introduction to protein structure, Chemical properties of proteins.Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions.

Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

Introduction to Proteomics, Analysis of proteomes.2D-PAGE.Sample preparation, solubilization, reduction, resolution.Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

SUGGESTED READING:

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics.IX Edition. Benjamin Cummings. 4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
7. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
8. Pevsner, J. (2009). Bioinformatics and Functional Genomics.IIEdition.John Wiley & Sons.

Semester – VI
CC-BIOTECHNOLOGY-13
Paper: IN-BTY- 602
GENOMICS & PROTEOMICS - PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: Students who successfully complete this course will be able to

602.1 Perform on various databases of genome analysis.
602.2 Perform on various tools of proteome analysis.

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; computers, Internet facility; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

PRACTICALS:
1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

SUGGESTED READINGS:

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. 6.Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics.IX Edition. Benjamin Cummings. 4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
7. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
8. Pevsner, J. (2009). Bioinformatics and Functional Genomics.IIEdition.John Wiley & Sons.

Semester – 6
CC-BIOTECHNOLOGY-14

Paper: IN-BTY- 603
IPR, BIOETHICS AND BIOSAFETY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h
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Learning Outcomes: Students who successfully complete this course will be able to

603.1 Learn the concept of Intellectual property rights, national institutes belonging to the IPRs, patent laws, IPR's regulatory affairs and their applications in modern world and also will understand about commercialization of inventions in the biotechnology sector

603.2 Understand about start-ups and business strategies by taking account of IPRs and will gain the importance of innovative research.

603.3 Understand the concepts, its laws and the importance of regulatory bodies in bioethics and will describe about ethical practices appropriate to the scientific disciplines at all times.

603.4 Gain the concept about the biosafety, its levels and government guidelines while working with microorganisms, animal blood/tissue/cells, other hazardous & non-hazardous samples and will understand about other safe working practices relevant to the fields of research & different biotechnology industries.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Intellectual property rights: General Introduction to intellectual property rights and its different forms. Farmers Rights, Animal and Plant breeders rights. Development of patent system in India. WTO agreement and TRIPS Patent Cooperation treaty, Basic requirements of patentability, patentable subject matter, novelty and the Public Domain; Non obviousness Compulsory licensing, Patent infringements and revocation. Special issues in Biotechnology Patents: Disclosure Requirements, Collaborative research, competitive research, Patent Litigation: Recent Development in Patent System; Patentability of Biotechnology invention and its commercialization, Budapest treaty.

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.Innovation & Start-ups.

UNIT-II

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies

Biosafety: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary
Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication. Brief account of bioethics in Biotechnology

Suggested Readings:

1. Elements of Biotechnology; Gupta PK, Rastogi Publications, Meerut.
2. Intellectual Property rights in the WTO and Developing countries; Watal J, Oxford
3. Entrepreneurship: New Venture Creation : David H. Holt
4. Patterns of Entrepreneurship : Jack M. Kaplan
5. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
6. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd. 5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Semester – 6
CC-BIOTECHNOLOGY-14
Paper: IN-BTY- 604
IPR, BIOETHICS AND BIOSAFETY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: Students who successfully complete this course will be able to

604.1 Demonstrate the knowledge of the intellectual property rights and its utility in the securing inventor's rights against new innovation and in initiating start-ups
604.2 Exhibits skill when and how to handle biological and non-biological; hazardous and non-hazardous samples

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; computers, Internet Facility
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals
1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence
7. Case study on handling and disposal of radioactive waste

Suggested Readings:

1. Elements of Biotechnology; Gupta PK, Rastogi Publications, Meerut.
2. Intellectual Property rights in the WTO and Developing countries; Watal J, Oxford
3. University Press.
4. Intellectual Property Bulletin, New Delhi

Semester – VI
DSE3-BIOTECHNOLOGY
Paper: IN-BTY-605
IMMUNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

605.1 Exhibit the knowledge of basic components, organs, cells of immune system, components of immunity and will understand the coordination between humoral, cell-mediated and innate immune responses in combating pathogens.
605.2 Illustrate the attributes of antigens, immunogens, factors affecting immunogenicity; the structure and functions of different types of immunoglobulins.
605.3 Explain the mechanisms generating diversity and specificity in immune system alongwith principles and applications of several immunotools (RIA, ELISA, FACS etc) which can be used to quantify the interaction between antigen and antibody of the immune system.
605.4 Describe about the immunonization, role of vaccines against complex disorders and will also understand the concept of immune tolerance, immunosupression and immune responses to infectious diseases.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Introduction to immune system: Memory, specificity, diversity, innate and acquired immunity, self vs non-self-discrimination, structure and functions of primary and secondary lymphoid organs
Cells involved in immune responses: Phagocytic cells and their killing mechanisms; T and B lymphocytes, differentiation of stem cells and idiotypic variations
Nature of antigen and antibody: Antigens vsimmunogen, haptens, structure and functions of immunoglobulins; isotypic, allotypic and idiotypic variations

Humoral and cell mediated immune responses: kinetics of primary and secondary immune responses, complement activation and its biological consequences, antigen processing and presentation, cytokines and costimulatory molecules-role in immune responses, T and B cell interactions.

Major Histocompatibility Complex (MHC) genes and products: polymorphism of MHC genes, role of MHC antigens in immune responses, MHC antigens in transplantation

Unit II

Generation of diversity in immune system: Clonal selection theory- concept of antigen specific receptor, organization and expression of immunoglobulin genes- generation of antibody diversity, T-cell receptor diversity.

Measurement of antigen –antibody interaction: Production of polyclonal and monoclonal antibodies- principles, techniques and applications; Agglutination and precipitation techniques; Radio immunoassay; ELISA; Immunofluorescence assays- Fluorescence activated cell sorter (FACS) technique.

Immunization: Active & passive immunization, vaccines and their types, role of vaccines in the prevention of diseases

Tolerance vs activation of immune system: Immune tolerance, immunosuppression, hypersensitivity (Types I, II, III and IV).

Immune responses in diseases: Immune responses to infectious diseases- viral, bacterial and protozonal; cancer and immune system, immunodeficiency disorders and autoimmunity

Suggested Reading:

1. Immunology, 4th ed. by Roitt et al., Mosby Publications
2. Cellular and Molecular Immunology, 5th ed. by Abbas and Litchman (2003), Saunders Publication.
3. Kuby Immunology, 4rd ed. by R.A. Goldsby et al, W.H. Freeman & Co.
4. Immunology: an introduction, 4th Edition by Ian R Tizard, (1995), Saunders College Publishing

Semester – VI
DSE3-BIOTECHNOLOGY
Paper: IN-BTY-606
IMMUNOLOGY-PRACTICALS

Credits: 2
Total Marks: 50
External Marks: 40
Internal Assessment: 10
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

606.1 perform various immunoassays such as Radial immunoassay FACS
606.2 separate and quantify proteins from blood/serum/ plasma samples

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. To identify blood group
2. To estimate Hb by cyan-meth hemoglobin method
3. To isolate γ-globulins by ammonium sulfate fractionation
4. To separate globulins and estimate albumin globulin ratio in blood
5. Separation of serum and plasma from the blood sample
6. Perform gel electrophoresis (PAGE) by using serum and plasma samples
7. Radial immunoassay
8. Demonstration of FACS

Semester – VI
DSE3-BIOTECHNOLOGY
Paper: IN-BTY-607
BIOINFORMATICS

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

607.1 Understand the fundamentals, importance and limitation of bioinformatics and biological databases.
607.2 Describe the concept of sequence alignment, its types and importance of scoring matrices and will understand about bioinformatics tools such as BLAST, FASTA, clustal-w etc. that will help in generating accurate prediction about gene and its product.
607.3 Learn about molecular phylogenetic tools which will help to depict the probable evolution of various organisms by building a "relationship tree".
607.4 Learn about biological macromolecular structures and structure prediction methods.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit I

Bioinformatics and biological databases: Introduction, application and limitation to bioinformatics; introduction, classification and pitfalls of biological databases, Biological data formats, Introduction to single letter code of aminoacids, symbols used in nucleotides, data retrieval- Entrez and SRS.

Sequence alignment: Substitution matrices, Scoring matrices – PAM and BLOSUM. Local and Global alignment concepts, Dot plot. Dynamic programming methodology: Needleman and Wunsch algorithm. Smith–Waterman algorithm. Statistics of alignment score.

Multiple sequence alignment.Progressive alignment.Database search for similar sequences using FASTA and BLAST Programs. Evolutionary analysis: distances, Cladistic and Phenetic methods. Clustering Methods. Rooted and unrooted tree representation. Bootstrapping strategies, Use of Clustal and PHYLIP.

Unit II

Molecular Phylogenetics: Molecular Evolution, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation, Phylogenetic Tree Evaluation, Phylogenetic Programs

Distance-Based Methods, Character-Based Methods,

Gene finding methods. Gene prediction: Analysis and prediction of regulatory regions. Fragment assembly. Genome sequence assembly, Restriction Mapping, Repeat Sequence finder.

Structural Bioinformatics:Concepts of secondary structure prediction of RNA and Protein. Probabilistic models: Markov chain, Hidden Markov Models-other applications.

Suggested reading:

- Bioinformatics – Concepts, Skills, Applications”. S.C. Rastogi, NamitaMendiratta, ParagRastogi.
- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andréa’s D. Baxevanis, B.F. Francis Ouellette.
- Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Richard Durbin et al.
- Computer Methods for Macromolecular Sequence Analysis. Doolittle R.F. (Ed.) (Methods in Enzymology, Vol. 266).
- Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.
- DNA and Protein Sequence Analysis. A Practical approach. Bishop M.J.Rawlings C.J. (Eds.).
- Introduction to Bioinformatics. Teresa. K. Atwood and David J. Parry-Smith.
- (http://www.imtech.res.in/raghava/gpsr/).

Semester – VI
DSE3-BIOTECHNOLOGY
Paper: IN-BTY-608
BIOINFORMATICS-PRACTICALS

Credits: 2
Total Marks: 50
External Marks: 40
Internal Assessment: 10
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

608.1 search, use and download various biological database
608.2 perform prokaryotic, eukaryotic gene analysis: prosite, motif and rna structure prediction

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:
1. Types & Examples of Biological Databases (Primary and Secondary), their URLs and Major functions.
2. NCBI (PubMed, Nucleotide): Literature search and Data retrieval. (How to do literature search using NCBI's PubMed & Data retrieval of a gene using NCBI's Nucleotide database).
3. Download Human Haemoglobin gene from NCBI database in GenBank and FASTA format.
4. Using NCBI Nucleotide database, search and download FASTA file of a Human gene (e.g. BRCA1), run BLAST at NCBI website.
5. Global alignment: Make scoring matrix of these two sequences, ACGGCTC & ATGGCCTC using values as match= +1, mismatch= -3, gap penality= -4.
6. How to run BLAST software (Nucleotide BLAST, blastx, tblastn, Protein BLAST) and their uses.
7. Run ClustalW for Multiple sequence alignment of three human proteins.
8. Phylogenetic tree construction using PHYLIP program.
9. Prokaryotic gene finding using GLIMMER, Eukaryotic by GENSCAN program.
10. Major steps of Eukaryotic Genome Assembly (Whole Genome Assembly).
11. Protein structure prediction by HMM profile (sequence) based method.
12. To perform prosite for domain perdiction
13. To perform Pfam for motif prediction
14. To perform RNA FOLD for rna structure prediction
15. To perform jpred
16. To perform GENSCAN

Semester – VI
DSE4-BIOTECHNOLOGY
Paper: IN-BTY-609
MOLECULAR DIAGNOSTICS

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

609.1 Know about uses of enzymes and antibodies (monoclonal & polyclonal) for diverse immunooassays and their applications in medical diagnostic purpose
609.2 Gain the knowledge of various molecular approaches (PCR, RFLP etc) and chemotherapy tests which can be used in clinical testing.
609.3 Explain about automation in microbial diagnosis and other rapid diagnostic approaches based on the concept of idiotypes.
609.4 Describe and appraise various diagnostic tools which can help to study in details about cell biology such as RIA, immunoflorescence, chromatrography, microscopy etc and associated with medical science.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT I

Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays.Enzyme immunoassays after immuno blotting.

Enzyme immuno histochemical techniques: Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology; Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT II

Automation and rapid diagnostic approach: Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies.

Idiotypes and immunodiagnostic: Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors.Epitope design and applications.Immunodiagnostic tests- Immuno florescence.Radioimmunoassay.

Diagnostic tools: GLC, HPLC, Electron microscopy, flow cytometry and cell sorting.

SUGGESTED READING

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology.7th edition (edited by Paniker CKJ).University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA.(2007). Jawetz, Melnick and Adelberg's Medical Microbiology.24th edition.McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition.Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology.19th edition.AppletonCentuary-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ.(2008). Prescott, Harley and Klein's Microbiology.7th edition.McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

Semester – VI
DSE4-BIOTECHNOLOGY
Paper: IN-BTY-610
MOLECULAR DIAGNOSTICS-PRACTICALS

Credits: 2
Total Marks: 50
External Marks: 40
Internal Assessment: 10
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

610.1 use different diagnostic tools like Immunobloting, PCR, PAGE etc.
610.2 quantify cells by cytometry, nucleic acid by southern hybridization and determine MIC

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Perform Immunoblotting by using housekeeping gene product
2. Perform Nucleic acid based PAGE
3. Perform Column Chromatography (any) and demonstrate about GLC/HPLC.
4. Perform PCR based diagnosis of human/plant pathogen
5. Perform Rapid Diagnostic Assay (as per availability)
6. Determination of MIC of streptomycin against *E.coli* by broth method
7. Demonstrate Nucleic acid labeling and Southern Hybridization
8. Demonstrate flow cytometery

DSE4-BIOTECHNOLOGY Paper IN-BTY-611,IN-BTY-612, IN-BTY-613 and IN-BTY-614 will be same as B-CHEM-401**,** B-CHEM-402, B-CHEM-403 and B-CHEM-404 approved by UG-BOS, Department of Chemistry, KUK

Semester – VI

GE-ZOOLOGY-6

Paper: IN-ZOO-601

ECOLOGY AND ENVIRONMENT MANAGEMENT

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

601.1 Understand the basic concepts of ecology and will describe about various factors including abiotic and biotic which affect environment.
601.2 Describe about ecosystem, ecological energetic, energy flow and biogeochemical cycles.
601.3 Explain about the biodiversity conservation of natural resources and population ecology
601.4 Understanddifferent types of pollution, impact on environment and their management strategies.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit-I

Basic concepts of ecology: Definition, signification. Concepts of habitat and ecological Niche.
Factors affecting environment: Abiotic factors (light-intensity, quality and duration), temperature, humidity, topography; edaphic factors; Biotic factors.
Introduction to major ecosystemt of the world.
Ecosystem: Concept, components, properties and functions; Ecological energetics and energy flow-food chain, food web, trophic structure; ecological pyramids concept of productivity.
Biogeochemical cycles: Concept, reservoir pool, gaseous cycles and sedimentary cycles.

Unit-II

Concept of biodiversity and conservation of natural resources.
Population: Growth and regulation.
Population interactions: Competition, predation, parasitism, commensalisms and mutualism.
Environmental pollution: Soil, Water, Air, radiation, landscape, noise
Detection of Environmental pollutant. Hazardous wastes Environmental cleanup Bioremediation, Waste disposal.

Semester – VI
GE-ZOOLOGY-6
Paper: IN-ZOO-602
ECOLOGY AND ENVIRONMENT MANAGEMENT: PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion of this course students will be able to

602.1 Measure various physio-chemical parameters of water samples
602.2 Document biodiversity

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:
1. Chemical analysis of pond and soil ecosystem for pH,
2. Chemical analysis of pond and soil ecosystem for dissolved oxygen, BOD
3. Chemical analysis of pond and soil ecosystem for free CO_2
4. Chemical analysis of pond and soil ecosystem for Nitrates, phosphates and chlorides
5. To study the diversity of vertebrates/ invertebrates in the campus

Programme Outcomes for PG courses of Faculty of Life Sciences

PO1: To acquaint students with recent knowledge and techniques in basic and applied biological sciences.

PO2: To develop understanding of organismal, cellular, biochemical and environmental basis of life

PO3: To provide insight into ethical implications of biological research for environmental protection and good laboratory practices and biosafety.

PO4:To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological ,environmental and nutritional sciences.

PO5: To understand application of biotic material in health , medicine, food security for human well being and sustainable development.

PO6:To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self reliance.

Programme specific Outcomes for PG courses in Biotechnology

After the successful completion of the programme the student will be able to

PSO1: acquaint with theoretical and practical knowledge in different areas of Biotechnology. They will be able to understand various biological aspects and will develop into Biotech savvy integrated personalities with scientific thinking.

PSO2: analyse , solve problems related to Biotechnology fields. They will be able to launch startups, become entrepreneurs for novel biotechnology products and processes in various industries

PSO3: understand biosafety measures, ethical issues and regulatory compliances in Biotechnolgy

PSO4: communicate effectively, work independently, imbibe the values of team spirit, write execute and manage their research project.

Semester-7
CC-BIOTECHNOLOGY-15
Paper: IN-BTY- 701
ADVANCED MOLECULAR BIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: Students who successfully complete this course will be able to

701.1 Understand the concepts of gene regulation in prokaryotes, the importance of E. coli lac & trp operon models along with gene expression regulation in lamda phages

701.2 Learn about diverse regulatory sequences, transcriptional, post-transcriptional, translational and post-translation regulations in eukaryotes

701.3 Describe the concept of transposable elements and their role in living systems including in viruses and will understand about RNAs world which includes siRNAs & miRNAs and their potential as a gene silencing and therapeutic agent

701.4 Explain types of cancer, cancer causing agents, proto-oncogenes and mechanism for the activation of proto-oncogenes into oncogenes.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Gene regulation in prokaryotes: Inducer, repressor, co-repressor and activator concept,
+vely and –vely regulated genes, description of various levels of control of gene expression in prokaryotes, operon concept, lac operon: regulation by +ve and –ve mechanisms, trp operon: regulation by -ve and attenuation mechanisms, regulon, regulation of gene expression in lambda phages.

Gene regulation in eukaryotes: Regulatory sequences in eukaryotes like promoter,
enhancers, response elements, insulators and silencers, short-term and long term regulation of gene expression, molecular aspects of regulation of gene expression at transcription level like transcription repression by nucleosomes, histone modification by ubiquitination, acetylation, and phosphorylation, at post-transcriptional level like regulation of RNA splicing, RNA transport, RNA stability, at translational, post-translational and protein degradation level in eukaryotes.

UNIT-II

Transposable genetic elements: Discovery, mechanism of nonreplicative and replicative transposition, bacterial transposable genetic elements: simple transposons, complex transposons- the composite family and Tn3 transposon family and mechanisms of transposition, bacteriophage Mu elements. Eukaryotic transposable genetic elements – Ty elements of yeast, various autonomous and non autonomous elements of maize and mechanism of transposition.

RNA world: RNA world hypothesis, messenger RNA (mRNA), transfer RNA (tRNA), ribosomal RNA (rRNA), antisense RNA, RNA as an Enzyme, as a regulator. MicroRNA (miRNA)- History of microRNA, definition, composition, Dicer, RNA induced silencing complex (RISC), modern concepts on their roles in translation inhibition. Small interfering RNA or silencing RNA (siRNA) - History of siRNA, composition and
structure, roles in post-transcriptional gene silencing and potential as therapeutics

Molecular Biology of Cancer: Benign and malignant tumors, types of cancers, cancer causing agents- radiations, chemical compounds, DNA and RNA viruses, mechanism of carcinogenesis, important characteristics of cancerous cells, proto-oncogenes and oncogenes, promoter insertion, enhancer insertion, chromosomal translocation, gene amplification and point mutation as mechanism for activation of proto-oncogenes.

Suggested Readings:

1. he Biochemistry of the Nucleic Acids; Adams RLP, Knowler JT and Leader DP,
2. Chapman and Hall Publication.
3. Genetics; Peter JR and Benjamin S, Cummings Publication.
4. Recombinant DNA; Watson JD, Tooze T, Kurtz DT, Scientific American Books.
5. Principles of Gene Manipulation; Old RW and Primose SB. Blackwell Scientific
6. Publication.
7. Molecular Biotechnology; Glick and Pasternack, ASM press.

Semester – VII
CC-BIOTECHNOLOGY-15
Paper: IN-BTY- 702
ADVANCED MOLECULAR BIOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to

702.1 Isolate, quantify and analyze plant histone proteins using various techniques including microscopy & electrophoresis

702.2 Use diverse online tools to explore promoter sequences in given prokaryotic/ eukaryotic genes

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals

1. Isolation and quantification of Histone proteins from dark-grown wheat coleoptiles.
2. Separation of various Histone proteins using denaturing PAGE.
3. Finding promoter sequence of given animal gene and determining its sequence elements using tools like CISTER.
4. Finding promoter sequence of given plant gene and determining its sequence elements using PlantCare

Suggested Readings:

1. The Biochemistry of the Nucleic Acids; Adams RLP, Knowler JT and Leader DP,Chapman and Hall Publication.
2. Genetics; Peter JR and Benjamin S, Cummings Publication.
3. Recombinant DNA; Watson JD, Tooze T, Kurtz DT, Scientific American Books.
4. Principles of Gene Manipulation; Old RW and Primose SB. Blackwell Scientific
5. Publication.
6. Molecular Biotechnology; Glick and Pasternack, ASM press.

Semester -7
CC-BIOTECHNOLOGY-16
Paper: IN-BTY- 703
BIOPROCESS AND FERMENTATION TECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After successful completion students will be able to

703.1 Describe the techniques of isolation, screening and improvement of industrially important microbial strains.
703.2 Describe the designing of a bioreactor with different modifications
703.3 Give an insight of upstream and downstream processing
703.4 Explore applications and achievements of fermentation technology in the field of medicine.

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Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Introduction to bioprocess technology.Range of bioprocess technology and its chronological development.Basic principle components of fermentation technology.Types of microbial culture, Isolation and screening of microbes of industrial importance, Strain improvement: mutation and genetic manipulations

Culture preservation techniques and its growth kinetics– Primary and Secondary metabolites, Feedback inhibition & repression, Batch, Fedbatch and Continuous culture.

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes.Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT-II

Introduction to oxygen requirement in bioprocess Energetics of microbial growth in fermenters: Reaction rates, heat and mass transfer, transport phenomenon in reactors, macrscopic balances of energy and energy flow etc

Introduction to Upstream and downstream processing of industrial fermentations, Cell disruptions, Flocculation, Filterations, Ultrafilteration, ultracentrifugation, gel filtration, chromatographic methods, two phase aqueous separations. Cells andenzyme immobilizations Fermentation of :Antibiotics (Penicillin, Streptomycin), Organic acids (Citric acid, Lactic acid), Enzymes (Penicillin G Acylase, Streptokinase), ethanol, Recombinant Proteins (Insulin).Hygiene and safety in fermentation laboratory

SUGGESTED READINGS:

1. Casida LE. (1991). Industrial Microbiology.1st edition.Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition.Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology.1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ.(2006). Principles of Fermentation Technology.2nd edition, Elsevier Science Ltd.
5. Biotransformations and Bioprocesses (Biotechnology and Bioprocessing Series); Doble M, Kruthiventi AK and Gaikar VG, CRC Publisher.
6. Bioprocess Engineering Basic Concepts; Prentice Hall Publisher
7. Principles of Fermentation Technology; Stanbury PF, Whitaker, A Hall S.
8. Bioprocess Engineering: Basic Concepts; Shuler ML and Kargi F, Prentice Hall PTR Publisher.
9. Solid-State Fermentation Bioreactors: Fundamentals of Design and Operation; Mitchell DA, Krieger N, and Berovic M, Springer Publisher

Semester -7
CC-BIOTECHNOLOGY-16
Paper: IN-BTY- 704
BIOPROCESS AND FERMENTATION TECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to

704.1 Isolate economically important microbes from environment and perform biomass and metabolite production in microbial cultures.

704.2 Demonstrate analysis of produced metabolites

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Production of red wine.
2. Estimation of acids formed during wine production.
3. Estimation of alcohol produced in wine by dichromate titration method.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

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SUGGESTED READINGS:

1. Biotransformations and Bioprocesses (Biotechnology and Bioprocessing Series); Doble M, Kruthiventi AK and Gaikar VG, CRC Publisher.
2. Bioprocess Engineering Basic Concepts; Prentice Hall Publisher
3. Principles of Fermentation Technology; Stanbury PF, Whitaker, A Hall S.
4. Bioprocess Engineering: Basic Concepts; Shuler ML and Kargi F, Prentice Hall PTR Publisher.
5. Solid-State Fermentation Bioreactors: Fundamentals of Design and Operation; Mitchell
6. DA, Krieger N, and Berovic M, Springer Publisher.

Semester -7
CC-BIOTECHNOLOGY-17
Paper: IN-BTY- 705
BIOSTATISTICS

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h
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Learning Outcomes: After successful completion students will be able to

705.1 Comprehend the fundamental concepts related to descriptive and inferential biostatistics.
705.2 Develop skills in data tabulation, its treatment, analysis, interpretation and graphical representation of data.
705.3 Analyze the implications of inferential statistics in biology.
705.4 Develop their competence in hypothesis testing and interpretation.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

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UNIT-I

Biostatistics: History of the field, objectives and connection with population genetics, levels of measurements, types of variables, precision vs accuracy

Data Summarization and Visualization: Types of variables, frequency tabulations (EFD, ERFD, ECD), various types of charts, error bars, scatterplots, Concepts of moments, Skewness and kurtosis, Intuitive definition of random variables, probability mass function and probability density function, expectation and variance .Standard distribution; binomial, Poisson and normal distribution with their important properties and significance.

UNIT-II

Descriptive Statistics : measures of central tendency (mean, mode, median) and their dispersion, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

Correlation, Regression and Statistical inference: Fitting of main distributions and testing of goodness –of – the –fit with special reference to $\chi 2$- test, t –test, Z-test. Fitting of trends; linear and quadratic with least square method.Lines of regression, coefficient of correlation, coefficient of variation and their significance.Analysis of variance; one way and two way classification. Learn applications of statistics in the field of biology

Suggested Readings:

1. Biostatistics; Arora PN, Malhotra PK, Himalaya Publishing House.
2. Introduction to Biostatistics; Sokal S &Rohit S, Toppan Publication.
3. Le CT (2003) introductory biostatistics. 1st edition, John Wiley, USA
4. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
5. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
6. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc

Semester- 7
CC-BIOTECHNOLOGY-17
Paper: IN-BTY- 706
BIOSTATISTICS - PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to

706.1 Solve the problems based on graphical Representation and measures of Central Tendency & Dispersion.

706.2 Solve the problems based on Distributions Binomial Poisson Normal, t, f, z and Chi-square

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; computers, internet facility; softwares

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. For the given ungrouped data, construct the exclusive and inclusive type frequency distribution.
2. Draw the multiple and subdivided bar diagram for the given data.
3. To find the various measures of central tendency for the given frequency distribution.
4. To find the quartiles, deciles and percentiles for the given frequency distribution.
5. Calculate the mean deviation, variance, standard deviation and coefficient of variation for the given data.
6. Fit a binomial distribution for the given data.
7. Fit a Poisson distribution for the given data.
8. Fit a normal distribution for the given data.
9. To test a given null hypothesis using Chi-square test of goodness of fit.
10. To test the single mean using t-test.
11. To test if there is any significance difference between means from two different samples.
12. To test the single proportion using t-test.
13. To fit a straight line using principle of least squares.
14. To fit a parabola for the given bivariate data using principle of least squares.

Suggested Readings:

1. Biostatistics; Arora PN, Malhotra PK, Himalaya Publishing House.
2. Introduction to Biostatistics; Sokal S &Rohit S, Toppan Publication.
3. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
4. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
5. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
6. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc

Semester – VII
DSE5-BIOTECHNOLOGY
Paper: IN-BTY-707
NANOTECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

707.1 Describethe basic fundamentals of nanobiotechnology with detail understanding of different nanomaterials, their types and properties.
707.2 Acquire the knowledge on different nano-fabarication methods and will be skilled in various visualization and characterization techniques requires for nanomaterials.
707.3 Understand about the principles of interaction of biomolecules to the surfaces of different nanomaterials and their relevance in the biomedical sciences.
707.4 Explain use of nanoparticals in medical care and will understand the possible impact of nanotechnology on society, industry and environment.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

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Unit-I

Introduction to Bio-Nanotechnology: The world of small dimensions (Nanoworld), history, scientific revolutions and current practice; dimensionality and size dependent phenomena, properties at nanoscale, Nanomaterials synthesis techniques.

Nanoparticles: classification & types: classification based on dimensionality, (synthesis, properties and applications of Fullerens, Carbon nanotube, Metal nanoparticles, Quantum dots, Dendrimers, Multilayer Thin Film: Polyelectrolyte multilayers, coated colloids, smart capsules Biological nanomaterials, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles)

Visualization & Characterization techniques for nanoparticles: Electron microscopy: FESEM, HRTEM, Scanning probe microscopy: AFM, STM, Diffraction techniques (XRD), UV-Vis & FTIR, light scattering

Unit-II

Biomolecules and nanotechnology: Biomolecular Structure and Stability, Protein Folding, Self assembly, self-organization, molecular recognition, Flexibility, Information-Driven Nano-assembly, Energetics, Chemical Transformation, Biomolecular Motors, Traffic Across Membranes, Machine-Phase Bio-nanotechnology

Nanobiotechnology applications: Nanoparticles for drug delivery (including biopolymeric), Tissue engineering, Nanoengineered biosensors, Nanoengineered biosensors, Fiber Optic, Nano-sensors in medical care, Semiconductor and Metal Nanoparticles, bio-imaging, cancer nanotechnology,

Nanobiotechnology Challenges: Nanotoxicology challenges, Impact of nanotechnology on society and industry

Suggested Reading

- Multilayer Thin Films; Decher G, Schlenoff JB, Wiley-VCH Verlag GmbH & Co.
- Bionanotechnology : Lessons from Nature; Goodsell DS, Wiley-Liss.
- Nanotechnology - A Gentle Introduction to the Next Big Idea; Ratner and Ratner, Prentice Hall PTR.
- Niemeyer and Mirkin ed. Nanobiotechnology: concepts, applications & perspectives,
- David S Goodsell, “Bionanotechnology”, John Wiley & Sons, 2004
- Jain, KK. Nanobiotechnology in molecular diagnostics: current techniques and applications
- T. Pradeep, “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw Hill Education Pvt. Ltd., 2012 2.

Semester – VII
DSE5-BIOTECHNOLOGY
Paper: IN-BTY-708
NANOTECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to
708.1 Synthesize nanoparticals by diverse methods
708.2 characterize nanoparticals byUV-Vis, FTIR, XRD and prepare samples for electron microscopy

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; computers, internet facility; softwares
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:
1. Synthesis of nanoparticles by using biological process including E.coli – (2-3 methods).
2. Synthesis of Al_2O_3 nanoparticles using sol-gel/chemical method.
3. Detection of nanoparticles in colloidal solutions using UV-Vis absorption Technique.
4. Characterize nanoparticles by UV-Vis & FTIR, XRD methods
5. Biological sample preparation for SEM/TEM
6. Demonstrate about Nano-sensors in medical care and analyze blood/urine samples by using sensor-based tools
7. Synthesis of semiconductor (ZnS, CdS etc.) nanoparticles by chemical method.

Semester – VII
DSE5-BIOTECHNOLOGY
Paper: IN-BTY-709
MEDICAL MICROBIOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

- **709.1** Describebasic principles of medical microbiology, infectious diseases and mechanisms of disease transmission and the role of microflora of the human body.
- **709.2** Understand the morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive and gram negative bacteria.
- **709.3** Explain about viral pandemic, epidemic and endemic diseases.
- **709.4** Understand the importance of pathogenic microorganisms (fungal and protozoan) in human disease with respect to systemic, subcutaneous, gastrointestinal tract infections and infections to immunocompromized host.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae.

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.

UNIT II

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses, SARS (Severe Acute Respiratory Syndrome), MERS (Middle East respiratory syndrome)

Fungal and Protozoan infections. Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis),

Blood-borne infections (Leishmaniasis, Malaria)

SUGGESTED READINGS

- Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
- Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
- Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Semester – VII
DSE5-BIOTECHNOLOGY
Paper: IN-BTY-710
MEDICAL MICROBIOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: After successful completion students will be able to
710.1 Isolate and characterize pathogens from clinical samples
710.2 determine antibacterial activity by different methods

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; computers, internet facility; softwares
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Isolation of following pathogens from clinical samples (wherever possible) and identification of the same by morphological, cultural and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
    a. Pseudomonas aeruginosa
    b. Staphylococcus aureus
    c. Candida albicans
2. Study of microbial flora of skin/sliva/buccal cavity/nose by swab method
3. Determination of sensitivity of common pathogens to antibiotics by paper disc method.
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Serological tests:
    a. Widal test -Quantitative
    b. Rapid Diagnostic Test for Malaria

Books recommended for Practical :

1. Medical Lab Technology - Ramnikand Sood, Jaypee brothers(Medical pub, New Delhi)
2. Practical Biochemistry -Plummer
3. APHA(American Public Health Association)Handbook
4. Soil, Plant and Water Analysis- P.C. Jaiswal
5. Biochemical methods-S. Sadasivam, A. Manickam
6. Practical Biochemistry-J. Jayraman 7. Practical Microbiology – R.C. Dubey , D. K. Maheshwari , S. Chand & Co. Ltd.

Semester – 8
CC-BIOTECHNOLOGY-18
Paper: IN-BTY- 801
ADVANCED RECOMBINANT DNA TECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

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Learning Outcomes: On successful completion of the course the student will be able to:-

801.1 Learn in-depth understanding about gene library and their types along with diverse procedures required for selection of rDNA clones and their expression products including In-situ hybridization and Protein-protein interactions
801.2 Understand the concept of mutagenesis, types and their impact on gene modification
801.3 Learn about different approaches to be used for studying gene expression, its regulation and manipulation of recombinant gene expression in Prokaryotes
801.4 Describe about heterologous protein production in diverse eukaryotic cell systems and will elucidate wide applications of rDNA technology including in medical care and food industry

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Genomic and cDNA library: Gene library, types and Applications, Making genomic and cDNA libraries in plasmids and phages. PCR product cloning (TA cloning), cDNA synthesis strategies – Linkers – Adapters – Homopolymer tailing; Properties of cDNA, mRNA enrichment

Selection of rDNA clones and their expression products: Direct and indirect methods. Drug resistance, gene inactivation, DNA hybridization, Colony and Plaque hybridization; Abundancy probing, Heterologus probing, In-situ hybridization (Southern, Northern and Dot blots and immunological techniques Western blotting), Subtractive hybridization; Protein-Protein interactions **-** Phage display, Yeast two hybrid system, Yeast three hybrid system.

Site Directed Mutagenesis: Oligonucleotide directed mutagenesis, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primers / nucleotide analogs. Deletion mutagenesis, Applications

UNIT-II

Gene expression and Regulation studies: Primer extension, S1 mapping, RNase protection assay, Gel retardation assay, Deletion analysis, Reporter genes, DNA foot printing, Modification interference assays, HRT, HART

Manipulation of recombinant gene expression in Prokaryotes: Problems with production of recombinant proteins in *E coli*, Optimizing expression of foreign genes in *E.coli*- Strong and regulatory promoters, Codon usage, Fusion proteins, Increasing protein stability and secretion, Translation expression vectors, Protease deficient host strains.

Heterologous protein production in Eukaryotes: *Saccharomyces cerevisiae* and *Pistia pastoris* expression systems, Baculovirus Insect cell expression systems, Mammalian cell expression system, CRE LOX system and CRISPR/Cas9

Applications of rDNA technology: Diagnostics; Pathogensis; Genetic diversity; Therapeutic proteins-Vaccines. Molecular probes (Production, labelling and uses)

Suggested Readings:

1. Gene cloning and DNA analysis – An Introduction (2006) 5th edition, T.ABrown, Blackwell publisher.
2. Essential genes (2006), BenzaminLewin, Pearson education international.
3. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.
4. Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primoseand R.M Twyman, Blackwell publishing.

Semester-8
CC-BIOTECHNOLOGY-18
Paper: IN-BTY- 802
ADVANCED RECOMBINANT DNA TECHNOLOGY - PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

802.1 Exhibit the skill to study any damage and mutations in the isolated DNA

802.2 Demonstrate analysis of Cre-Lox and CRISPR/Cas9 systems used for production of recombinant gene products

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals

1. To study *in vitro* DNA damage and analysis by agarose gel electrophoresis by using either purified DNA or plasmid.
2. Designing primers for PCR using online tools.
3. To study mutagenesis concept by using cancer-causing agents
4. Perform any method to be used for the selection of recombinant DNA clone
5. Gene expression in *E. coli* and analysis of gene product
6. Demonstration about Mammalian cell expression system with uses of CRE-LOX system
7. Demonstration about Mammalian cell expression system with uses of CRISPR/Cas9 system

Suggested Readings:

1. Biotechnology-Applying the genetic Revolution (2009), Clark and Pazdernik, Academic Press
2. Molecular Cloning : A Laboratory Manual (2000), J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York
3. DNA Cloning : A Practical Approach (1995) , D.M. Glover and B.D. Hames, IRL Press, Oxford,
4. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998), S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.

Semester – 8
CC-BIOTECHNOLOGY-19
Paper: IN-BTY- 803
ANIMAL CELL CULTURE

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Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h
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Learning Outcomes: On successful completion of the course the student will be able to:-

803.1 Describe the biology of cultured cells and basic requirements of animal cell culture

803.2 Elaborate the diverse media require for animal cell culture with their merits & demerits and will extend the diverse applications of animal cell culture

803.3 Illustrate about the primary cell culture, sub-culture along with various parameters of cell line characterizations

803.4 Understand the concept of cell cloning, techniques to scale up production of cell, organ culture and will explain diverse types of stem cells including satellite cells, iPS and their impact in future therapy against incurable diseases

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

Unit-I

Biology of the Cultured Animal Cells, Tissue & Organ: Historical, Advantages and limitations - medical/pharmaceutical products of animal cell culture and their applications. Risks in a tissue culture laboratory and safety - biohazards.

Facilities for animal cell culture: Infrastructure, Equipments including Biosafety Cabinets and Laminar Air Flow, Culture vessels – types (treated, Non-treated surfaces), the substrate, Nitrogen Container, CO_2 incubator, Filters-sizes, types (for aqueous solution, for DMSO soluble solution). Biology and characterization of cultured cells-cell adhesion, proliferation, differentiation, morphology of cells and identification. Evolution of cell lines, development of continuous cell lines, dedifferentiation

Culture Media: Balanced salt solutions, Complete media including proliferation, differentiation, Freezing and wash media. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium.

Role of CO_2, Serum and Supplements. Serum free media and their application: advantages and disadvantages of serum and serum free media, replacement of serum and development of serum free media.

Applications of Animal Cell Culture: Production of high value therapeutics (enzymes, hormones, monoclonal antibody, cytokines etc), virology, cancer research, gene therapy, drug development and cytotoxicity, animal cloning, genetic counseling, cryopreservation of cells.

Unit-II

Primary Cell Cultures and Sub-cultures: types of primary cell culture, isolation of the tissue and preparation of primary cell culture, characteristics of limited life-span cultures, Techniques (mechanical disaggregation, enzymatic treatment, separation of viable and non-viable cells); Subculture and propagation, Criteria for subculture, Subculture of monolayer cells, growth cycle and split ratio, propagation and subculture in suspension ;

Cell Lines and Characterization: Establishment and properties of continuous cell lines; Need for characterization, authentication (lineage or tissue markers), cell morphology, chromosome content, DNA content, RNA and protein expression, enzyme activity, antigen markers.

Cell Cloning: Development of cloning techniques, dilution and suspension cloning, scaling up in suspension and monolayer, large scale production of cells using bioreactors, special requirement of cells growing at very low densities, uses of cloning; Organ culture - whole embryo culture

Stem Cell Culture

Embryonic and adult stem cells and their applications. Satellite Cells. Totipotent, Pluripotent and Multipotent stem cells. Induced Pluripotent Stem Cells (iPS) – Concept, Discovery, its impact on research in stem cell biology and in future therapy

Suggested Readings:

1. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
2. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
3. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.
4. Biotechnology, Vol. 7b 1993 Rehm. H.J. and Reed, G.(eds) VCH Publications.
5. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd. Oxford.
6. Cell Growth and Division: a Practical Approach. Ed. R. Basega, IRL Press.
7. Culture of Animal Cells, (3rdedition), R. Ian Freshney. Wiley-Liss.

Semester – 8
CC-BIOTECHNOLOGY-19
Paper: IN-BTY- 804
ANIMAL CELL CULTURE-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to learn:

804.1 Prepare and sterilize media used in animal cell culture
804.2 Culture, check viability, iPS and animal cell culture process

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Preparation and sterilization of different types of cell culture media i.e. RPMI 1640, Balanced Salt solutions, MS basal media, NAM.
2. To isolate lymphocytes from whole blood by gradient centrifugation
3. To culture lymphocytes using RPMI1640 media.
4. To check cell viability by cell counting
5. To check cell viability by MTT staining
6. Demonstrate the culture of iPS
7. Demonstrate the complete process of animal cell culture including freezing, thawing, proliferations etc by taking suitable example of cell line

Suggested Readings:

1. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
2. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
3. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.

Semester-8
CC-BIOTECHNOLOGY-20
Paper: IN-BTY- 805
BIOENTERPRENEURSHIP DEVELOPMENT

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to:

805.1 Exhibit the knowledge of structure, management and role of innovations in an organization
805.2 Discuss the government schemes for commercialization of biotechnology
805.3 Describe various elements of operational research and management
805.4 Compare and analyse the characteristics of biotech enterprises, various parameters of quality control and government regulations.

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Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology
Organizational structure & Management; Capital Management; Product innovation and management; Government schemes for commercialization of technology (Eg. Biotech Consortium); Basics of production management:
Methods of manufacturing-Project/Jobbing, Batch Production, Flow/Continuous production, process production-Characteristics of each method. Plant location-Importance-Factors affecting location-factory Building-Plant layout-Installation of Facilities.

UNIT-II

Operational Research: Linear Programming, PERT and CPM;
Production Planning & Control-Scheduling-Gantt Charts-Documentation-Production Work Order. Kaizen (Continuous improvement in product & management);
Biotech enterprises: Small, Medium & Large; Quality control in Biotech industries; Govt. regulations for biotech products; Public policy, regulatory and ethical challenges facing the biotechnology
Entrepreneurship; Business development for medical products

Suggested Reading

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand &Sons.Innovation and Entrepreneurship in Biotechnology: Concepts, Theories &Cases;
4. Hyne D and KapelerisJ.Entrepreneurship in Biotechnology: Managing for growth from start-up; Martin Gross Mann.
5. Best Practices in Biotechnology Education; Friedman Y, Logos Press.

Semester-8
CC-BIOTECHNOLOGY-20
Paper: IN-BTY- 806
BIOENTERPRENEURSHIP DEVELOPMENT-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to:

806.1 Analyse his personality and ability as an entrepreneur
806.2 Plan and analyse the requirement and status of Biotech industry

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements
Regular attendance and active participation during the course; reference material; computers, Internet facility

Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals

1. To analyze your entrepreneurial personality and creativity
2. To analyze your entrepreneurial potential by performing online Bill Wager's self assessment test.
3. To analyze your personality type by performing online Jung & Myer Brigg's assessment test.
4. To analyze personality type by performing online DISC self assessment test.
5. To make a business plan.
6. To study Biotech Enterprises

Suggested Reading:

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons. Innovation and Entrepreneurship in Biotechnology: Concepts, Theories & Cases;
4. Hyne D and KapelerisJ.Entrepreneurship in Biotechnology: Managing for growth from start-up; Martin Gross Mann.
5. Best Practices in Biotechnology Education; Friedman Y, Logos Press.

Open Elective, IN-BTY-807 will be the same as Open Elective-Biotechnology and Human Welfare-I, approved by PGBOS, Department of Biotechnology, Kurukshetra University Kurukshetra

Semester-9
CC-BIOTECHNOLOGY-21
Paper: IN-BTY- 901
BIOINSTRUMENTATION

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to:

901.1 Describe the principles and types of various techniques like spectroscopy, centrifugation and chromatography
901.2 Elaborate the applications of advanced techniques in isolation and purification of biomolecules
901.3 Describe the principles and applications of various techniques of multiplication and characterization of nucleic acids
901.4 Give an insight of applications of immunotechniques and biosensors

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Spectroscopy: Raman, Fluorescence and NMR spectroscopy; ORD & CD; Mass spectrometry, MALDI-TOF, LC-MS; X-ray diffraction; Atomic absorption spectroscopy; Applications of these spectroscopic techniques in the study of Biomolecules

Centrifugation: Basic principles of sedimentation; types of centrifuge (Bench top, high speed& ultracentrifuges); types of rotor; Preparative & analytical centrifugation. Separation methods-Differential centrifugation, Density gradient centrifugation; Subcellular fractionation- Disruption of cells, isolation of subcellular organelles from liver & plant cells and marker enzymes

Advanced purification techniques: FPLC, HPLC

UNIT-II

Nucleic acid based techniques – Northern, Southern, Sequencing of proteins and nucleic acids, PCR, RT-PCR, QRT-PCR, DNA microarray, DNA fingerprinting (RFLP, RAPD, AFLP, SSR)

Immunotechniques- Flow cytometry, Immuno-cytochemistry, immune-fluorescence and Western & Dot blots, Florescence activated cell sorter (FACS) technique, Cytotoxicity assay

Biosensors - Principle and application

Suggested Readings:

1. Bioinstrumentation, Student; John GW, John Wiley & Sons Ltd.
2. Practical Biochemistry Principles and Techniques; Wilson K and Walker J, Cambridge University Press.
3. Essentials of Molecular Biology; Malacinski GM, Freifelder D, Jones & Bartlett Publishers.
4. Proteins-Structure and Molecular Properties; Creighton TE, Freeman and Company.
5. Genes IX; Benjamin L, Jones and Bartlett Publishers.

Semester-9
CC-BIOTECHNOLOGY-21
Paper: IN-BTY- 902
BIOINSTRUMENTATION-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: Students who successfully complete this course will be able to

902.1 Isolate subcellular organelles from animal and plant tissues.
902.2 Perform electrophoresis, zymography and analyse the results

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. To prepare absorption spectrum of plant pigments by UV- Vis spectroscopy
2. Isolation of subcellular organells from animal tissue and identification by marker enzymes
3. Isolation of subcellular organells from plant tissue and identification by marker enzyme.
4. Determination of cytotoxic concentration (IC50)
5. Perform SDS PAGE, Zymography and demonstrate about Western blotting
6. Demonstrate about the FACS
7. Demonstrate about chromatography specifically HPLC

REFERENCES:

- Bioinstrumentation, Student; John GW, John Wiley & Sons Ltd.
- Practical Biochemistry Principles and Techniques; Wilson K and Walker J, Cambridge University Press.
- Essentials of Molecular Biology; Malacinski GM, Freifelder D, Jones & Bartlett Publishers.
- Proteins-Structure and Molecular Properties; Creighton TE, Freeman and Company.
- Genes IX; Benjamin L, Jones and Bartlett Publishers.

Semester – IX
CC-BIOTECHNOLOGY-22
Paper: IN-BTY- 903
RESEARCH METHODOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h
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Learning Outcomes: On successful completion of the course the student will be able to:

903.1 Elaborate the concept of research and different types of research in the context of biology
903.2 Develop laboratory experiment related skills.
903.3 Develop competence on data collection and process of scientific documentation
903.4 Analyze the ethical aspects of research and evaluate the different methods of scientific writing, reporting and focuses on plagiarism

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Basic Concepts of Research: Meaning –Purpose, Types and significance of research in basic/applied sciences. Steps in Research: Identification, selection and formulation of research problem- Research questions-Research design-Formulation of hypothesis- Literature collection, Review of literature.
Journals: standard of research journals, impact factor - citation index. Information retrieval - access to archives and databases, search engines - google, pubmed - national informatics center network services. Online data base library.Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness.
Measures of dispersion: Sampling theory-Types of sampling-Steps in sampling- Sampling and Non-sampling error-Sample size – Advantages and limitations of sampling. Scaling method – mean, standard deviation, standard error - coefficient of variation; Comparisons of means- Students t-test and ANOVA

UNIT-II

Data for Research: Primary data-Meaning-Collection methods-Observation–Interview- Questionnaire-Schedule-Pretest-Pilot study –Experimental and case studies- Secondary data- Meaning – Relevance, limitations and cautions. Processing Data: Checking- Editing-Coding- transcriptions and Tabulation-Data analysis- Meaning and methods- Quantitative and Qualitative analysis

Structuring the Report: Chapter format- Pagination- Identification- Using quotations- Presenting footnotes – abbreviations- Presentation of tables and figures- Referencing- Documentation-Use and format of appendices- Indexing

Preparation of Research report & Proposal- Thesis - dissertation -Manuscript/research article –monograph/review, Research Proposal; Check Plagiarism; Oral and poster presentation of research papers in conferences/symposia/workshop.

Suggested Readings:

1. Dawson, C. (2002). Practical research methods.UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. MS office; Sexena S, Vikas Publishing House.
4. Statistical methods; Snedecor GW and Cohran WG, Oxford and IBH publishing CO Pvt. Ltd.
5. Biometry; Sokal RR and Rohlf FJ, Freeman WH publishing House.
6. Biostatistical analysis; Zar JH, Prentice Hall Publishing House.

Semester – IX
CC-BIOTECHNOLOGY-22
Paper: IN-BTY- 904
RESEARCH METHODOLOGY - PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

904.1 Design, plan and write up the research proposals
904.2 Demonstrate skill in critically analyzing the observations to draw inference

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; computers, internet facility
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practical

1. Demonstrate about methods involved (including survey/questionnaires/interviews/ case studies/observations etc) in writing a research paper/manuscript/article
2. Demonstrate about methods involved (including survey/questionnaires/interviews etc) in writing a review paper/manuscript/article
3. Formulate a statistic problem and answer with the help of Scaling method (SD/SEM) by taking suitable examples related to biotechnology
4. Formulate a statistic problem and answer with the help of Comparisons of means (T-test/Anova) by taking suitable examples related to biotechnology
5. Oral Presentation of a research paper
6. Poster presentation of a research paper
7. Demonstration about plagiarism using available softwares
8. Demonstrate about curation of relevant scientific literature/journals, impact factor and its purpose by using online tools/webpage including Google Scholar, PubMed, Science Direct etc at the time of preparation and submission of a new manuscript

Suggested Readings:

1. Dawson, C. (2002). Practical research methods.UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. MS office; Sexena S, Vikas Publishing House.
4. Statistical methods; Snedecor GW and Cohran WG, Oxford and IBH publishing CO Pvt. Ltd.
5. Biometry; Sokal RR and Rohlf FJ, Freeman WH publishing House.
6. Biostatistical analysis; Zar JH, Prentice Hall Publishing House.

Semester -9
CC-BIOTECHNOLOGY-23
Paper: IN-BTY- 905
ENVIORNMENTAL BIOTECHNOLOGY

Credits: 4
Total Marks: 100
External Marks: 80
Internal Assessment: 20
Examination Time: 3 h
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Learning Outcomes: On successful completion of the course the student will be able to

905.1 Describe various dimensions of ecology, biodiversity and their importance.
905.2 Analyse the causes of air pollution and their control mechanisms
905.3 Analyse the causes of water pollution and their control mechanisms using biotechnological processes
905.4 Give an insight of application of biosources as the solution to various environmental concerns

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each unit. All questions carry equal marks.

UNIT-I

Ecology & Biodiversity
Introductory concepts, The biological world and Ecology: Ecological balance and consequences of change, Biological word and eco-systems; Biochemical Diversity in ecosystem development; Diversity indices; Cellular diversity and the classification of living system – Prokaryotic & Eukaryotic organisms, General physical properties and Tolerance to environmental conditions; Microbial Biodiversity – strategies – bio-prospecting and recovery.

Air Pollution Control Methods and Equipment
Primary and secondary air pollutants, standards, sampling, basic ideas of air pollution control equipments, Bag Filter, Electrostatic Precipitators, cyclone separators, Wet-scrubbers, Bioscrubbers, Electrostatic precipitators, High volume sampler, RSPM Sampler, Control of specific gaseous pollutants.

UNIT-II

Wastewater Treatment by Biotechnological Processes

Water pollution; sources and classification of pollutants, B.O.D, C.O.D, D.O, T.D.S, Oil and grease, Metals etc.Standards, sampling and method of analysis, Bacteriological measurements. Overview of treatment principles and theory of aeration, Municipal Sewer and Industrial Wastewater Treatment –Principles, operation and design aspects of: Activated Sludge process, Extended Aeration, Nitrification-denitrification, Trickling Filter, Mechanically aerated lagoons, Concepts of Waste stabilization ponds, Aquatic plant systems, Ranking of waste water treatment processes, common effluent treatment plant.

Environmental Biotechnology: Specialized aspects

Oil pollution – treatment with micro-organisms, Bioremediation- recovery of metals from waste water and sludge, xenobiotics, degradative capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons, Anaerobic and aerobic composting, Vermiculture, Wetland Management, Membrane based waste water treatment processes – case studies.

Suggested Readings:

1. Fundamentals of Ecology; Odum EP.
2. Wastewater Engineering – Treatment, Disposal and Reuse; Metcalf & Eddy, Tata McGrawhill
3. Environmental Pollution Control Engineering, Rao CS, New Age International Publication.
4. Wastewater treatment for pollution control; Arceiwala SJ, TMH Publication.

Semester -9
CC-BIOTECHNOLOGY-23
Paper: IN-BTY- 906
ENVIORNMENTAL BIOTECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to:

906.1 Qualitatively analyse the soil samples and isolate microbes from soil

906.2 Analyse the water samples for TDS, DO and COD

Approaches to teaching

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

Requirements

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

Evaluation

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

PRACTICALS

1. To study pH and moisture content of soil
2. To study carbonate and nitrate content of soil
3. Calculation of Total Dissolved Solids (TDS) of water sample
4. To determine dissolved oxygen (DO) of given water sample.
5. Determination of COD of given water sample.
6. DNA isolation from soil microbial community
7. Isolation of azotobacter species from soil

Suggested Readings:

1. Fundamentals of Ecology; Odum EP.
2. Wastewater Engineering – Treatment, Disposal and Reuse; Metcalf & Eddy, Tata McGrawhill
3. Environmental Pollution Control Engineering, Rao CS, New Age International Publication.
4. Wastewater treatment for pollution control; Arceiwala SJ, TMH Publication.

DSE-6, IN-BTY-907 & IN-BTY-908 will be the same as DSE-3, IN-BTY-605 & IN-BTY-606 in the present scheme

DSE-6, IN-BTY-909 & IN-BTY-910 will be the same as DSE-3, IN-BTY-607 & IN-BTY-608 in the present scheme

Open Elective, IN-BTY-911 will be the same as Open Elective-Biotechnology and Human Welfare-II, approved by PGBOS, Department of Biochemistry, KUK

Semester -10
CC-BIOTECHNOLOGY-24
PROJECT

Credits: 20
Max. Marks: 500
Time allowed: 3 h (one session)

Programme Outcomes (POs) for UG Courses of Faculty of Life Sciences

1. To develop skills in graduate students to be able to acquire theoretical and practical knowledge in fundamentals of biology in respective disciplines of plants, animals, microbes and environment.
2. To inculcate ability to critically evaluate problems and apply lateral thinking and analytical skills for professional development.
3. To create awareness on ethical issues, good laboratory practices and biosafety.
4. To develop ability in youth for understanding basic scientific learning and effective communication skills.
5. To prepare youth for career in teaching, industry, government organizations and self-reliant entrepreneurship.
6. To make students aware of natural resources and environment and its sustainable utilization.
7. To provide learning experience in students that instills deep interest in biological science for the benefit of society.

Programme Specific Outcomes for UG Course in Biotechnology

After the successful completion of the programme the student will be able to

PSO1: demonstrate the knowledge and understanding of biological sciences i.e., structure and function of biological molecules, biological mechanisms, such as the processes and control of bioenergetics and metabolism, as chemical reactions with engineering technologies to manipulate living organisms and biological systems to produce products that advance healthcare, medicine, agriculture, food, pharmaceuticals and environment control

PSO2: Critically think and correlate the biological knowledge of distribution, morphology and physiology of organisms (animals, plants and microorganisms) to techniques in aseptic procedures, isolation, identification, characterization and modifications to improve quality of life in person as well as community.

PSO3: Demonstrate an understanding of the principles of bio- techniques, and exhibit basic professional skills pertaining to biotechnology, carry out laboratory-orientated numerical calculations and analyse biological data (e.g. in enzyme kinetics, molecular structure analysis, microbiological techniques, immunological inferences)

PSO4: Scientific writing and authentic reporting, effective presentation skills and ability to work in a group with cooperation

CORE COURSE - BIOTECHNOLOGY-1 BIOMOLECULES	
CO#	After the successful completion of the course the student will be able to
101.1	Classify, define and explain various properties of carbohydrates and correlate them to their functions
101.2	Classify, define, draw structures and explain functions of various types of lipids: Illustrate various parameters of characterization of lipids.
101.3	Classify, draw structures of standard amino acids, explain chemical and physical properties of amino acids; Describe different classes of proteins and explain different levels of structural organization in protein architecture.
101.4	Explain the characteristics and draw structures of various types of nucleic acids;Illustrate chemical and physical properties of nucleic acids.
102.1	Prepare various types of solutions used in qualitative and quantitative biochemical estimations; verify and apply the basic principles of spectroscopy
102.2	Analyse the unknown samples qualitatively for the presence of various biomolecules

CORE COURSE- **BIOMOLECULES**

CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
101.1	3	3	1	3	3	3	3	3	3	2	3
101.2	3	3	2	3	3	3	3	3	3	2	3
101.3	3	3	1	3	3	3	3	3	3	2	3
101.4	3	3	2	3	3	3	3	3	3	2	3
102.1	3	3	3	3	3	2	2		3	3	3
102.2	3	3	3	3	3	3	2	3	3	3	3
Average	3	3	2	3	3	2.83	2.66	2.5	3	2.33	3

CORE COURSE - BIOTECHNOLOGY-2 GENERAL MICROBIOLOGY	
CO#	After the successful completion of the course the student will be able to
103.1	Illustrate the knowledge of history, scope, classification, various approaches of study and microbial diversity
103.2	Compare and characterize prokaryotic and eukaryotic cells based on morphology; different groups of microorganisms based on their structures.
103.3	Give an account of microbial growth, reproduction and metabolism
103.4	Identify the microorganisms in water and food along with methods to control them
104.1	Exhibit skills in preparation of media and staining
104.2	Isolate bacteria from different sources and determine their count and cell size

CORE COURSE- GENERAL MICROBIOLOGY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
103.1	3	3	3	3	3	3	3	3	3	2	3
103.2	3	3	2	3	3	3	3	3	3	3	3
103.3	3	3	2	3	3	3	3	3	3	1	3
103.4	3	3	2	3	3	3	3	3	3	3	3
104.1	3	3	3	3	3	2	2	3	3	3	3
104.2	3	3	3	3	3	3	2	3	3	3	3
Average	3	3	2.5	3	3	2.83	2.66	3	3	2.5	3

GENERIC ELECTIVE -ZOOLOGY -1 CELL BIOLOGY	
CO#	After the successful completion of the course the student will be able to
101.1	Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
101.2	Understand how these cellular components are synthesized and degraded in cells
101.3	Explain the structure and function of prokaryotic cell & its components
101.4	Describe the various models and solute transporter systems belonging to cell membrane and will explain cell cycle and apoptosis
102.1	Prepare slides of animal and plant cells and cell division
102.2	Conduct the morphomatric analysis of chromosomes

GENERIC ELECTIVE-CELL BIOLOGY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
101.1	3	3	2	3	3	2	2	2	2	2	3
101.2	3	3	2	3	3	2	2	2	2	2	3
101.3	3	3	2	3	3	2	2	2	2	2	3
101.4	3	3	2	3	3	2	2	2	2	2	3
102.1	3	3	3	3	3	3	3	3	3	3	3
102.2	3	3	3	3	3	2	3	3	2	3	3
Average	3	3	2.33	3	3	2.16	2.33	2.33	2.16	2.33	3

CORE COURSE - BIOTECHNOLOGY-3 **ENZYMOLOGY**	
CO#	After the successful completion of the course the student will be able to
201.1	Define various characteristics of enzymes, classify them and elaborate the role of cofactors in enzyme catalysis
201.2	Correlate the structure of enzymes to their functions, mechanism of enzyme catalysis and describe various approaches for purification of enzymes
201.3	Exhibit the knowledge of enzyme kinetics of unisubstrate reactions, various kinetics parameters (Km, Vmax etc.) and describe different types of enzyme inhibitions.
201.4	Correlate different ways of enzyme regulation to cellular metabolism: discuss and analysethe industrial importance of enzymes and the techniques to use them.
202.1	Extract and quantitatively estimate the enzyme activity and protein content of the samples
202.2	Exhibit skills in studying various characteristics of enzymes like pH optima, temperature optima, Km, Vmax

CORE COURSE-**ENZYMOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
201.1	3	3	1	3	3	3	3	3	2	2	3
201.2	3	3	2	3	3	3	3	3	3	3	3
201.3	3	3	2	3	3	3	3	3	3	1	3
201.4	3	3	1	3	3	3	3	3	3	3	3
202.1	3	3	3	3	3	1	3	3	3	3	3
202.2	3	3	3	3	3	1	1	3	3	3	3
Average	3	3	2	3	3	2.33	2.66	3	2.83	2.5	3

CORE COURSE - BIOTECHNOLOGY-4 GENETICS	
CO#	After the successful completion of the course the student will be able to
203.1	Exhibit conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
203.2	Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders.
203.3	Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
203.4	Analyze the effect of mutations on gene functions and dosage
204.1	Identify various stages of mitotic and meiotic cell cycles
204.2	Analyze the effect of mutations on gene functions

CORE COURSE- **GENETICS**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
203.1	3	3	2	3	3	2	3	3	2	3	3
203.2	3	3	2	3	3	3	3	3	3	3	3
203.3	3	3	2	3	3	3	3	3	3	2	3
203.4	3	3	2	3	3	3	3	3	3	3	3
204.1	3	3	2	3	3	1	3	3	3	3	3
204.2	3	3	3	3	3	2	2	3	3	3	3
Average	3	3	2.16	3	3	2.33	2.83	3	2.83	2.83	3

GENERIC ELECTIVE -ZOOLOGY -2 MAMMALIAN PHYSIOLOGY	
CO#	After the successful completion of the course the student will be able to
201.1	Gain in-depth understanding and appropriate functioning of digestive and cardiovascular system in animals
201.2	Describe the Physiology of human respiration & excretion
201.3	Understand the functioning of nerve impulse&reflex action and will explain about different types ofmuscles and their physiology in human
201.4	Explain the mechanism of action of hormones and related molecules involved in various physiological processes and will describe about human reproductive system
202.1	analyse blood sample for total blood cell count, TLC, DLC
202.2	Analyze urine sample and identify various tissues

GENERIC ELECTIVE- MAMMALIAN PHYSIOLOGY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
201.1	3	3	2	3	3	3	3	2	3	2	3
201.2	3	3	2	3	3	3	3	2	3	2	3
201.3	3	3	2	3	3	3	3	2	3	2	3
201.4	3	3	2	3	3	3	3	2	3	2	3
202.1	3	3	3	3	3	3	3	3	3	3	3
202.2	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.33	3	3	3	3	2.33	3	2.33	3

CORE COURSE - BIOTECHNOLOGY-5 METABOLISM	
CO#	After the successful completion of the course the student will be able to
301.1	Apply the knowledge of biological redox reactions, coupled reactions, energy rich compounds and the energy transactions in studying metabolism; describe the metabolic pathways *i.e.* glycolysis (catabolism), gluconeogensis (anabolism), and TCA cycle and their regulations
301.2	Discuss the reactions, regulation and importance of pentose phosphate pathway, glycogen metabolism, glyoxylate, ETC and apply the concept of oxidative phosphorylation to calculate energy production by oxidation of carbohydrates
301.3	Describe the reactions and regulation of lipid biosynthesis and catabolism by beta, alpha and omega oxidative pathways: ketone bodies metabolism and integration to the metabolism of other biomolecules
301.4	Analyse how amino acid catabolism leads to formation of diverse type molecules including ketone bodies, glucose, urea: discuss the catabolism and anabolismof nucleic acids and porphyrins.
302.1	Determine biomolecules in the samples quantitatively.
302.2	Isolate and characterize carbohydrates, lipids and proteins from the natural sources

CORE COURSE- **METABOLISM**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
301.1	3	3	3	3	3	3	3	3	2	3	3
301.2	3	3	3	3	3	3	3	3	3	3	3
301.3	3	3	2	3	3	3	3	3	3	2	3
301.4	3	3	2	3	3	3	3	3	3	3	3
302.1	3	3	3	3	3	3	3	2	3	3	3
302.2	3	3	3	3	3	3	3	2	3	3	3
Average	3	3	2.66	3	3	3	3	2.66	2.83	2.83	3

CORE COURSE - BIOTECHNOLOGY-6 PLANT ANATOMY AND PHYSIOLOGY	
CO#	After the successful completion of the course the student will be able to
303.1	Exhibit the knowledge of fundamentals of plant anatomy and examine the internal anatomy of plant organs
303.2	Correlate the concept of water relation of plants to various physiological processes and nutrition of plants
303.3	Explain the process and significance of Photosynthesis and nitrogen metabolism
303.4	Illustrate various phases of plant growth and factors affecting them
304.1	Prepare stained mounts of anatomy and demonstrate physiological processes: plasmolysis, stomata opening, guttation of leaf tips,aerobic respiration
304.2	Separate photosynthetic pigments and prepare mounts of root nodules .

CORE COURSE- PLANT ANATOMY AND PHYSIOLOGY											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
303.1	3	3	2	3	3	3	3	2	2	3	3
303.2	3	3	2	3	3	3	3	2	3	3	3
303.3	3	3	2	3	3	3	3	2	3	2	3
303.4	3	3	2	3	3	3	3	2	3	2	3
304.1	3	3	3	3	3	3	3	3	3	3	3
304.2	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.33	3	3	3	3	2.33	2.83	2.66	3

GENERIC ELECTIVE -ZOOLOGY -3 DEVELOPMENTAL BIOLOGY	
CO#	After the successful completion of the course the student will be able to
301.1	Gain detail understanding of various developmental processes including gametogenesis, fertilization and different pattern and mechanism of fertilized cell cleavage,
301.2	Understand the concept of germ layers, their formation and differentiation and will describe about early phase of embryonic development
301.3	Explain about the concept of differentiation and embryonic induction
301.4	Describe the development of organ including eye and fate of primary germ layers and will explain the process of aging & senescence in vertebrates
302.1	Differentiate various life stages of mosquito/frog and will identify chick embryo stages
302.2	Able to prepare permanent histological slides

GENERIC ELECTIVE- DEVELOPMENTAL BIOLOGY											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
301.1	3	3	3	3	3	3	2	2	2	2	3
301.2	3	3	3	3	3	3	2	2	2	2	3
301.3	3	3	3	3	3	3	2	2	2	2	3
301.4	3	3	3	3	3	3	2	2	2	2	3
302.1	3	3	3	3	3	3	2	2	3	3	3
302.2	3	3	3	3	3	3	2	2	2	3	3
Average	3	3	3	3	3	3	2	2	2.16	2.33	3

CORE COURSE - BIOTECHNOLOGY-8 **MOLECULAR BIOLOGY**	
CO#	After the successful completion of the course the student will be able to
401.1	Elaborate the central dogma of life at molecular level and the general principles of gene organization, DNA supercoiling; nucleases and various approaches of sequencing of DNA
401.2	Describe the structure and functions of proteins involved in replication and mechanism of DNA replication and correlate molecular basis of different types of DNA mutations with the repair systems of the mutations
401.3	Give an insight of the process of gene expression, mechanism of transcription, post-transcriptional processing of RNA in prokaryotes; Describe and correlate the concept of genetic code and mechanism of translation in prokaryotes
401.4	Describe the process of regulation of gene expression in prokaryotes and exhibit the knowledge of basics of recombinant technology for the manipulation of genetic information stored in the cells with the help of diverse cloning vectors
402.1	Isolate and quantify genetic material from plant/animal sources by colorimetric methods
402.2	Exhibit the skill in separating the fragments of DNA by electrophoresis and characterizing by absorption spectrum. .

CORE COURSE- **MOLECULAR BIOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
401.1	3	3	2	3	3	3	3	3	3	3	3
401.2	3	3	2	3	3	3	3	3	3	3	3
401.3	3	3	2	3	3	3	3	3	3	3	3
401.4	3	3	2	3	3	3	3	3	3	2	3
402.1	3	3	2	3	3	3	2	2	3	3	3
402.2	3	3	2	3	3	3	2	2	3	3	3
Average	3	3	2.33	3	3	3	3	2.33	2.83	2.66	3

CORE COURSE - BIOTECHNOLOGY-9 **ANIMAL BIOTECHNOLOGY**	
CO#	After the successful completion of the course the student will be able to
403.1	Describe the scope, application of animal biotechnology and elaborate the techniques of gene transfer in mammalian cells
403.2	Explain the concept of animal transgenesis and their applications in pathogenesis
403.3	Describe about cloning, artificial insemination, their role in animal propagation and will understand the role of biotechnology including IVF and stem cells in conservations of livestock diversity
403.4	Elaborate the gene therapy, its type and their role in bioengineering
404.1	Prepare different media, culture and cryopreserve the animal cells.
404.2	Perform gene transfer technique and demonstrate about animal cloning and IVF. .

CORE COURSE- **ANIMAL BIOTECHNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
403.1	3	3	3	3	3	3	3	3	3	3	3
403.2	3	3	3	3	3	3	3	3	3	3	3
403.3	3	3	3	3	3	2	3	3	3	2	3
403.4	3	3	3	3	3	2	3	3	3	2	3
404.1	3	3	3	3	3	2	2	3	2	3	3
404.2	3	3	3	3	3	2	2	3	3	3	3
Average	3	3	3	3	3	2.33	2.66	3	2.83	2.66	3

GENERIC ELECTIVE -ZOOLOGY -4 ANIMAL DIVERSITY	
CO#	After the successful completion of the course the student will be able to
401.1	Describe unique characters, diversity and ecological role of phylum Protozoa, Porifera, Coelenterate & Helminthes
401.2	Explain in detail about the characters, diversity and ecological role of phylum Arthropoda, Mollusca&Echinodermata
401.3	Identify different Urochordates, Cephalochordates, about their adaptations and associations in relation to their environment.
401.4	Identify (based on morphological characters) and understand adaptations in vertebrate class including amphibians, reptiles, birds, and mammals
402.1	Identify invertebrates and vertebrate specimeas well as classify them
402.2	Prepare slides of different parts as was whole mounts of vertebrate and Invertebrate

GENERIC ELECTIVE- ANIMAL DIVERSITY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
401.1	3	3	1	3	3	3	3	2	2	2	3
401.2	3	3	1	3	3	3	3	2	2	2	3
401.3	3	3	1	3	3	3	3	2	2	2	3
401.4	3	3	1	3	3	3	3	2	2	2	3
402.1	3	3	1	3	3	3	3	2	2	3	3
402.2	3	3	1	3	3	3	3	2	2	2	3
Average	3	3	1	3	3	3	3	2	2	2	

CORE COURSE – BIOTECHNOLOGY-11 **RECOMBINANT DNA TECHNOLOGY**	
CO#	After the successful completion of the course the student will be able to
501.1	Understand the concept and scopes of Genetic Engineering and central role of recombinant DNA technology in all fields of Biotechnology
501.2	Learn about enzymes, vectors, and their types to be used in the recombinant DNA technology
501.3	Describe about different methodologies to be used for the isolation and analysis of genomic and nuclear DNA
501.4	Illustrate about the PCR, their types along with strategies required for gene cloning purpose including preparation of competent cell, introduction of foreign DNAs into competent cells and selection of recombinants
502.1	Isolate nucleic acids, quantify and analyze by gel electrophoresis.
502.2	Exhibit the skill in designing primers and exploring restriction enzymes by using online database and will also carry out restriction digestion and perform PCR based analysis to study recombinant genes .

CORE COURSE- **RECOMBINANT DNA TECHNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
501.1	3	3	3	3	3	2	3	3	3	3	3
501.2	3	3	3	3	3	3	3	3	3	3	3
501.3	3	3	3	3	3	3	3	3	3	3	3
501.4	3	3	3	3	3	2	3	3	3	3	3
502.1	3	3	3	3	3	2	2	3	2	3	3
502.2	3	3	3	3	3	2	3	3	3	3	3
Average	3	3	3	3	3	2.33	2.83	3	2.83	3	3

CORE COURSE - BIOTECHNOLOGY-12 **PLANT BIOTECHNOLOGY**	
CO#	After the successful completion of the course the student will be able to
503.1	Elaborate the concept of plant tissue culture, totipotency, differentiation and somaclonal variation..
503.2	Describe different techniques of micropropagation in plants, their applications and limitations
503.3	Give an insight of vector mediated and vectorless methods of plant cell transformation, along with merits and demerits.
503.4	Correlate the plant genome organization with different types of transformations
504.1	Prepare and sterilize different media required for plant tissue culture
504.2	Perform micro-propagation with different explants. .

CORE COURSE- **PLANT BIOTECHNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
503.1	3	3	2	3	3	3	3	3	3	3	3
503.2	3	3	2	3	3	2	3	3	3	3	3
503.3	3	3	2	3	3	2	3	3	3	3	3
503.4	3	3	2	3	3	3	3	3	3	3	3
504.1	3	3	3	3	3	2	2	3	2	3	3
504.2	3	3	3	3	3	2	3	3	3	3	3
Average	3	3	2.33	3	3	2.33	2.83	3	2.83	3	3

DISCIPLINE SPECIFIC ELECTIVE- BIOTECHNOLOGY-1 FOOD TECHNOLOGY	
CO#	After the successful completion of the course the student will be able to
505.1	Gain the knowledge about different food and dietary supplements such as food from fungi, algae and bacteria and their large scale production and genetically modified (GM) foods.
505.2	Learn about food additives & its classification and functions along with diverse methods of food preservation.
505.3	Understand about various packing materials, their properties and functioning in food industries
505.4	Learn the concept of safety, quality assurance and food adulteration along with the role of national and international food regulatory bodies their standards for maintaining food quality and safety.
506.1	check the quality of packed and unpacked foods and role of preservation techniques
506.2	Analyse the unknown samples qualitatively for the presence of various biomolecules

DISCIPLINE SPECIFIC ELECTIVE - FOOD TECHNOLOGY

CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
505.1	3	3	1	3	3	3	3	3	3	2	3
505.2	3	3	2	3	3	3	3	3	3	2	3
505.3	3	3	1	3	3	3	3	3	3	2	3
505.4	3	3	2	3	3	3	3	3	3	2	3
506.1	3	3	3	3	3	3	3	3	3	3	3
506.2	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2	3	3	3	3	3	3	2.33	3

DISCIPLINE SPECIFIC ELECTIVE - BIOTECHNOLOGY-1 BIOMATHEMATICS	
CO#	After the successful completion of the course the student will be able to
507.1	Understand the basics of mathematics and its use in biological sciences.
507.2	Learn about complex numbers and matrices which can help them to understand various biological models involving variables i.e. frequencies of multiple alleles, population dyanamics, image processing and bioinformatics etc.
507.3	Learn about differential equation and its application which can be used in modeling.
507.4	Gain knowledge related to partial differential equations which help them to understand regulatory feedbacks and transport processes in multicellular biological systems
508.1	apply operation on complex number and matrices
508.2	apply composite functions and differential equation

DISCIPLINE SPECIFIC ELECTIVE - BIOMATHEMATICS											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
507.1	3	3	2	3	3	2	3	3	2	3	3
507.2	3	3	2	3	3	2	3	3	2	3	3
507.3	3	3	2	3	3	2	3	3	2	3	3
507.4	3	3	2	3	3	2	3	3	2	3	3
508.1	3	3	1	3	3	1	2	2	2	3	3
508.2	3	3	1	3	3	1	2	2	2	3	3
Average	3	3	1.66	3	3	1.66	2.66	2.5	2	3	3

DISCIPLINE SPECIFIC ELECTIVE - BIOTECHNOLOGY-2 MEDICAL BIOTECHNOLOGY	
CO#	After the successful completion of the course the student will be able to
511.1	Understand chromosomal, gene and mitochondrial disorders and will describe about various biotechnology tools to detect these disorders.
511.2	Learn about various invasive and non-invasive techniques to diagnose human disorders during prenatal period.
511.3	Understand metabolic disorders and their management by using diverse therapeutic approaches.
511.4	Describe and appraise broad knowledge of the use of gene products as vaccines
512.1	analyse DNA damage and modifications
512.2	give an insight of development of disease causing agents and diagnostic tools

DISCIPLINE SPECIFIC ELECTIVE - MEDICAL BIOTECHNOLOGY											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
511.1	3	3	2	3	3	3	3	3	3	2	3
511.2	3	3	3	3	3	3	3	3	3	2	3
511.3	3	3	2	3	3	3	3	3	3	2	3
511.4	3	3	3	3	3	2	3	3	3	2	3
512.1	3	3	3	3	3	2	2	3	3	3	3
512.2	3	3	3	3	3	2	3	3	3	3	3
Average	3	3	2	3	3	2.5	2.83	3	3	2.33	3

GENERIC ELECTIVE -ZOOLOGY -5 EVOLUTIONARY BIOLOGY	
CO#	After the successful completion of the course the student will be able to
501.1	Understand the conditions conducive for origin of life on earth and also about various theories related to origin of life and evolutionary biology.
501.2	Differentiate between micro, macro and mega evolution and will understand interrelation amongst various species and can develop the phylogeny trees accordingly
501.3	Explain the concept of variations in the species and will describe about the population genetics and role of migration and mutation in the evolution
501.4	Understand the concept of selection, types and their impact on evolution
502.1	Understand the process of adaptations and variations
502.2	Identify fossils

GENERIC ELECTIVE- EVOLUTIONARY BIOLOGY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
501.1	3	3	2	3	3	3	2	2	2	2	3
501.2	3	3	2	3	3	3	2	2	2	2	3
501.3	3	3	2	3	3	3	2	2	2	2	3
501.4	3	3	2	3	3	3	2	2	2	2	3
502.1	3	3	2	3	3	3	2	2	2	3	3
502.2	3	3	2	3	3	3	2	2	2	3	3
Average	3	2	2	3	3	3	2	2	2	2.33	3

CORE COURSE - BIOTECHNOLOGY-13 GENOMICS & PROTEOMICS	
CO#	After the successful completion of the course the student will be able to
601.1	Determine the function of genes and elements that regulate genes throughout the genome and apply sequence for analysis of organism genome.
601.2	Perform on various web based softwares for genome analysis
601.3	Correlate the findings of protein techniques to the structures of proteins
601.4	Analyse proteomes using various tools and techniques
602.1	Perform on various databases of genome analysis by using online tools.
602.2	Perform on various tools of proteome analysis

CORE COURSE- **GENOMICS & PROTEOMICS**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
601.1	3	3	3	3	3	1	3	3	3	3	3
601.2	3	3	1	3	3	1	3	3	3	3	3
601.3	3	3	2	3	3	2	3	3	3	3	3
601.4	3	3	2	3	3	2	3	3	3	3	3
602.1	3	3	1	3	3	2	3	3	3	3	3
602.2	3	3	1	3	3	2	3	3	3	3	3
Average	3	3	1.66	3	3	1.66	3	3	3	3	3

CORE COURSE - BIOTECHNOLOGY-14 IPR, BIOETHICS AND BIOSAFETY	
CO#	After the successful completion of the course the student will be able to
603.1	Learn the concept of Intellectual property rights, national institutes belonging to the IPRs, patent laws, IPR's regulatory affairs and their applications in modern world and also will understand about commercialization of inventions in the biotechnology sector
603.2	Understand about start-ups and business strategies by taking account of IPRs and will gain the importance of innovative research
603.3	Understand the concepts, its laws and the importance of regulatory bodies in bioethics and will describe about ethical practices appropriate to the scientific disciplines at all times
603.4	Gain the concept about the biosafety, its levels and government guidelines while working with microorganisms, animal blood/tissue/cells, other hazardous & non-hazardous samples and will understand about other safe working practices relevant to the fields of research & different biotechnology industries.
604.1	Demonstrate the knowledge of the intellectual property rights and its utility in the securing inventor's rights against new innovation and in initiating start-ups
604.2	Exhibits skill when and how to handle biological and non-biological; hazardous and non-hazardous samples

CORE COURSE- **IPR, BIOETHICS AND BIOSAFETY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**P6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
603.1	3	3	2	3	3	1	3	3	3	3	3
603.2	3	3	3	3	3	1	3	3	3	3	3
603.3	3	3	3	3	3	3	3	3	3	3	3
603.4	3	3	3	3	3	3	3	3	3	3	3
604.1	3	3	2	3	3	2	3	3	3	3	3
604.2	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.66	3	3	2.16	3	3	3	3	3

DISCIPLINE SPECIFIC ELECTIVE - BIOTECHNOLOGY-3 IMMUNOLOGY	
CO#	After the successful completion of the course the student will be able to
605.1	Exhibit the knowledge of basic components
605.2	Illustrate the attributes of antigens
605.3	Explain the mechanisms generating diversity and specificity in immune system alongwith principles and applications of several immunotools (RIA, ELISA, FACS etc) which can be used to quantify the interaction between antigen and antibody of the immune system.
605.4	Describe about the immunization
606.1	perform various immunoassays such as Radial immunoassay FACS
606.2	separate and quantify proteins from blood/serum/ plasma samples

DISCIPLINE SPECIFIC ELECTIVE - IMMUNOLOGY											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
605.1	3	3	1	3	3	2	3	3	3	2	3
605.2	3	3	2	3	3	2	3	3	3	2	3
605.3	3	3	2	3	3	2	3	3	3	3	3
605.4	3	3	2	3	3	3	3	3	3	2	3
606.1	3	3	3	3	3	2	3	3	3	3	3
606.2	3	3	3	3	3	3	2	3	3	3	3
Average	3	3	2.16	3	3	2.33	2.83	3	3	2.5	3

DISCIPLINE SPECIFIC ELECTIVE - BIOTECHNOLOGY-3 BIOINFORMATICS	
CO#	After the successful completion of the course the student will be able to
607.1	Understand the fundamentals, importance and limitation of bioinformatics and biological databases.
607.2	Describe the concept of sequence alignment, its types and importance of scoring matrices and will understand about bioinformatics tools such as BLAST, FASTA, clustal-w etc. that will help in generating accurate prediction about gene and its product.
607.3	Learn about molecular phylogenetic tools which will help to depict the probable evolution of various organisms by building a "relationship tree".
607.4	Learn about biological macromolecular structures and structure prediction methods.
608.1	search, use and download various biological database
608.2	perform prokaryotic, eukaryotic gene analysis: prosite, motif and rna structure prediction

DISCIPLINE SPECIFIC ELECTIVE - BIOINFORMATICS

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
607.1	3	3	1	3	3	1	2	3	2	3	3
607.2	3	3	1	3	3	1	2	3	2	3	3
607.3	3	3	1	3	3	2	2	3	2	3	3
607.4	3	3	2	3	3	2	3	3	2	2	3
608.1	3	3	2	3	3	2	2	3	2	3	3
608.2	3	3	3	3	3	2	2	3	2	3	3
Average	3	3	1.66	3	3	1.66	2.16	3	2	2.83	3

DISCIPLINE SPECIFIC ELECTIVE - BIOTECHNOLOGY-4 MOLECULAR DIAGNOSTICS	
CO#	After the successful completion of the course the student will be able to
609.1	Know about uses of enzymes and antibodies (monoclonal & polyclonal) for diverse immunooassays and their applications in medical diagnostic purpose
609.2	Gain the knowledge of various molecular approaches (PCR, RFLP etc.) and chemotherapy tests which can be used in clinical testing.
609.3	Explain about automation in microbial diagnosis and other rapid diagnostic approaches based on the concept of idiotypes.
609.4	Describe and appraise various diagnostic tools which can help to study in details about cell biology such as RIA, immunoflorescence, chromatrography, microscopy etc and associated with medical science.
610.1	use different diagnostic tools like Immunobloting, PCR, PAGE etc.
610.2	quantify cells by cytometry, nucleic acid by southern hybridization and determine MIC

DISCIPLINE SPECIFIC ELECTIVE - MOLECULAR DIAGNOSTICS											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
609.1	3	3	3	3	3	2	3	3	3	3	3
609.2	3	3	2	3	3	2	3	3	3	3	3
609.3	3	3	3	3	3	3	3	3	3	3	3
609.4	3	3	2	3	3	3	3	3	3	3	3
610.1	3	3	2	3	3	2	3	3	3	3	3
610.2	3	3	2	3	3	3	3	3	3	3	3
Average	3	3	2.33	3	3	2.5	3	3	3	3	3

GENERIC ELECTIVE -ZOOLOGY -6 ECOLOGY AND ENVIRONMENT MANAGEMENT	
CO#	After the successful completion of the course the student will be able to
601.1	Understand the basic concepts of ecology and will describe about various factors including abiotic and biotic which affect environment.
601.2	Describe about ecosystem, ecological energetic, energy flow and biogeochemical cycles.
601.3	Explain about the biodiversity conservation of natural resources and population ecology
601.4	Understand different types of pollution, impact on environment and their management strategies.
602.1	Measure various physio-chemical parameters of water samples
602.2	Document biodiversity

GENERIC ELECTIVE- ECOLOGY AND ENVIRONMENT MANAGEMENT											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
601.1	3	3	1	3	3	3	3	2	3	2	3
601.2	3	3	1	3	3	3	3	2	3	3	3
601.3	3	3	1	3	3	3	3	2	3	3	3
601.4	3	3	2	3	3	3	3	2	3	3	3
602.1	3	3	1	3	3	3	3	2	3	3	3
602.2	3	3	1	3	3	3	3	2	3	3	3
Average	3	3	1.16	3	3	3	3	2	3	2.83	3

Programme Outcomes for PG courses of Faculty of Life Sciences

PO1: To acquaint students with recent knowledge and techniques in basic and applied biological sciences.

PO2: To develop understanding of organismal, cellular, biochemical and environmental basis of life

PO3: To provide insight into ethical implications of biological research for environmental protection and good laboratory practices and biosafety.

PO4:To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological ,environmental and nutritional sciences.

PO5: To understand application of biotic material in health, medicine, food security for human well-being and sustainable development.

PO6: To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self-reliance.

Programme specific Outcomes for PG courses in Biotechnology

After the successful completion of the programme the student will be able to

PSO1: acquaint with theoretical and practical knowledge in different areas of Biotechnology. They will be able to understand various biological aspects and will develop into Biotech savvy integrated personalities with scientific thinking.

PSO2: analyze, solve problems related to Biotechnology fields. They will be able to launch startups, become entrepreneurs for novel biotechnology products and processes in various industries

PSO3: understand biosafety measures, ethical issues and regulatory compliances in Biotechnology

PSO4: communicate effectively, work independently, imbibe the values of team spirit, write execute and manage their research project.

CORE COURSE - BIOTECHNOLOGY-15 ADVANCED MOLECULAR BIOLOGY	
CO#	After the successful completion of the course the student will be able to
701.1	Understand the concepts of gene regulation in prokaryotes, the importance of E. coli lac & trp operon models along with gene expression regulation in lamda phages
701.2	Learn about diverse regulatory sequences, transcriptional, post-transcriptional, translational and post-translation regulations in eukaryotes
701.3	Describe the concept of transposable elements and their role in living systems including in viruses and will understand about RNAs world which includes siRNAs & miRNAs and their potential as a gene silencing and therapeutic agent
701.4	Explain types of cancer, cancer causing agents, proto-oncogenes and mechanism for the activation of proto-oncogenes into oncogenes.
702.1	Isolate, quantify and analyze plant histone proteins using various techniques including microscopy & electrophoresis
702.2	Use diverse online tools to explore promoter sequences in given prokaryotic/ eukaryotic genes

CORE COURSE - ADVANCED MOLECULAR BIOLOGY										
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
701.1	3	3	2	3	3	2	3	3	2	3
701.2	3	3	3	3	3	2	3	3	3	3
701.3	3	3	3	3	3	3	3	3	3	3
701.4	3	3	3	3	3	3	3	3	3	3
702.1	3	3	2	3	3	3	3	3	2	3
702.2	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.66	3	3	2.66	3	3	2.66	3

CORE COURSE - BIOTECHNOLOGY-16 BIOPROCESS AND FERMENTATION TECHNOLOGY	
CO#	After the successful completion of the course the student will be able to
703.1	Describe the techniques of isolation, screening and improvement of industrially important microbial strains.
703.2	Describe the designing of a bioreactor with different modifications
703.3	Give an insight of upstream and downstream processing
703.4	Explore applications and achievements of fermentation technology in the field of medicine.
704.1	Isolate economically important microbes from environment and perform biomass and metabolite production in microbial cultures.
704.2	Demonstrate analysis of produced metabolites

CORE COURSE - BIOPROCESS AND FERMENTATION TECHNOLOGY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
703.1	3	3	2	3	3	3	3	3	2	3
703.2	3	3	3	3	3	3	3	3	3	3
703.3	3	3	3	3	3	3	3	3	3	3
703.4	3	3	3	3	3	3	3	3	3	3
704.1	3	3	2	3	3	3	3	3	2	3
704.2	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.66	3	3	3	3	3	2.66	3

CORE COURSE - BIOTECHNOLOGY-17 BIOSTATISTICS	
CO#	After the successful completion of the course the student will be able to
705.1	Comprehend the fundamental concepts related to descriptive and inferential biostatistics.
705.2	Develop skills in data tabulation, its treatment, analysis, interpretation and graphical representation of data.
705.3	Analyze the implications of inferential statistics in biology.
705.4	Develop their competence in hypothesis testing and interpretation
706.1	Solve the problems based on graphical Representation and measures of Central Tendency & Dispersion.
706.2	Solve the problems based on Distributions Binomial Poisson Normal, t, f, z and Chi-square

CORE COURSE - BIOSTATISTICS

CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
705.1	3	3	1	3	3	2	3	2	1	3
705.2	3	3	1	3	3	2	3	2	1	3
705.3	3	3	1	3	3	2	3	2	1	3
705.4	3	3	1	3	3	2	3	2	1	3
706.1	3	3	1	3	3	2	3	2	1	3
706.2	3	3	1	3	3	2	3	2	1	3
Average	3	3	1	3	3	2	3	2	1	3

DISCIPLINE SPECIFIC ELECTIVE- BIOTECHNOLOGY-5 NANOTECHNOLOGY	
CO#	After the successful completion of the course the student will be able to
707.1	Describethe basic fundamentals of nanobiotechnology with detail understanding of different nanomaterials, their types and properties.
707.2	Acquire the knowledge on different nano-fabarication methods and will be skilled in various visualization and characterization techniques requires for nanomaterials.
707.3	Understand about the principles of interaction of biomolecules to the surfaces of different nanomaterials and their relevance in the biomedical sciences.
707.4	Explain use of nanoparticals in medical care and will understand the possible impact of nanotechnology on society, industry and environment.
708.1	Synthesize nanoparticals by diverse methods
708.2	characterize nanoparticals byUV-Vis, FTIR, XRD and prepare samples for electron microscopy

DISCIPLINE SPECIFIC ELECTIVE- NANOTECHNOLOGY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
707.1	3	3	1	3	3	3	3	3	2	3
707.2	3	3	1	3	3	3	3	3	2	3
707.3	3	3	2	3	3	3	3	3	3	3
707.4	3	3	3	3	3	3	3	3	3	3
708.1	3	3	3	3	3	2	3	3	3	3
708.2	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.16	3	3	2.83	3	3	2.66	3

DISCIPLINE SPECIFIC ELECTIVE- BIOTECHNOLOGY-5 MEDICINAL MICROBIOLOGY	
CO#	After the successful completion of the course the student will be able to
709.1	Describe basic principles of medical microbiology
709.2	Understand the morphology
709.3	Explain about viral pandemic
709.4	Understand the importance of pathogenic microorganisms (fungal and protozoan) in human disease with respect to systemic
710.1	Isolate and characterize pathogens from clinical samples
710.2	determine antibacterial activity by different methods

DISCIPLINE SPECIFIC ELECTIVE- MEDICINAL MICROBIOLOGY										
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
709.1	3	3	3	2	3	2	3	2	2	3
709.2	3	3	3	2	3	2	3	2	2	3
709.3	3	3	3	3	3	2	3	3	3	3
709.4	3	3	3	3	3	3	3	3	3	3
710.1	3	3	3	3	3	3	3	3	3	3
710.2	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	2.66	3	2.5	3	2.66	2.66	3

CORE COURSE - BIOTECHNOLOGY-18 ADVANCED RECOMBINANT DNA TECHNOLOGY	
CO#	After the successful completion of the course the student will be able to
801.1	Learn in-depth understanding about gene library and their types along with diverse procedures required for selection of rDNA clones and their expression products including In-situ hybridization and Protein-protein interactions
801.2	Understand the concept of mutagenesis, types and their impact on gene modification.
801.3	Learn about different approaches to be used for studying gene expression, its regulation and manipulation of recombinant gene expression in Prokaryotes
801.4	Describe about heterologous protein production in diverse eukaryotic cell systems and will elucidate wide applications of rDNA technology including in medical care and food industry
802.1	Exhibit the skill to study any damage and mutations in the isolated DNA
802.2	Demonstrate analysis of Cre-Lox and CRISPR/Cas9 systems used for production of recombinant gene products.

CORE COURSE - ADVANCED RECOMBINANT DNA TECHNOLOGY										
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
801.1	3	3	3	3	3	3	3	3	3	3
801.2	3	3	3	3	3	3	3	3	3	3
801.3	3	3	3	3	3	3	3	3	3	3
801.4	3	3	3	3	3	3	3	3	3	3
802.1	3	3	3	3	3	3	3	3	3	3
802.2	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3

CORE COURSE - BIOTECHNOLOGY-19 ANIMAL CELL CULTURE	
CO#	After the successful completion of the course the student will be able to
803.1	Describe the biology of cultured cells and basic requirements of animal cell culture
803..2	Elaborate the diverse media require for animal cell culture with their merits & demerits and will extend the diverse applications of animal cell culture.
803.3	Illustrate about the primary cell culture, sub-culture along with various parameters of cell line characterizations
803.4	Understand the concept of cell cloning, techniques to scale up production of cell, organ culture and will explain diverse types of stem cells including satellite cells, iPS and their impact in future therapy against incurable diseases
804.1	Prepare and sterilize media used in animal cell culture
804.2	Culture, check viability, iPS and animal cell culture process

CORE COURSE - ANIMAL CELL CULTURE										
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
803.1	3	3	3	3	3	3	3	3	3	3
803..2	3	3	3	3	3	3	3	3	3	3
803.3	3	3	3	3	3	3	3	3	3	3
803.4	3	3	3	3	3	3	3	3	3	3
804.1	3	3	2	3	3	3	3	3	2	3
804.2	3	3	2	3	3	3	3	3	2	3
Average	3	3	2.66	3	3	3	3	3	2.66	3

CORE COURSE - BIOTECHNOLOGY-20 BIOENTERPRENEURSHIP DEVELOPMENT	
CO#	After the successful completion of the course the student will be able to
805.1	Exhibit the knowledge of structure, management and role of innovations in an organization
805..2	Discuss the government schemes for commercialization of biotechnology
805.3	Describe various elements of operational research and management
805.4	Compare and analyse the characteristics of biotech enterprises, various parameters of quality control and government regulations
806.1	Analyse his personality and ability as an entrepreneur
806.2	Plan and analyse the requirement and status of Biotech industry

CORE COURSE - BIOENTERPRENEURSHIP DEVELOPMENT

CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
805.1	3	3	2	3	2	3	3	3	2	3
805..2	3	3	3	3	3	3	3	3	3	3
805.3	3	3	3	3	2	3	3	3	3	3
805.4	3	3	3	3	2	3	3	3	3	3
806.1	3	3	2	3	2	3	3	3	2	3
806.2	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.66	3	2.33	3	3	3	2.66	3

CORE COURSE - BIOTECHNOLOGY-21 **BIOINSTRUMENTATION**	
CO#	After the successful completion of the course the student will be able to
901.1	Describe the principles and types of various techniques like spectroscopy, centrifugation and chromatography
901.2	Elaborate the applications of advanced techniques in isolation and purification of biomolecules
901.3	Describe the principles and applications of various techniques of multiplication and characterization of nucleic acids
901.4	Give an insight of applications of immunotechniques and biosensors
902.1	Isolate subcellular organelles from animal and plant tissues.
902.2	Perform electrophoresis, zymography and analyse the results

CORE COURSE - BIOINSTRUMENTATION										
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
901.1	3	3	2	3	2	3	3	3	2	3
901.2	3	3	3	3	2	3	3	3	3	3
901.3	3	3	3	3	2	3	3	3	3	3
901.4	3	3	3	3	3	3	3	3	3	3
902.1	3	3	3	3	2	3	3	3	3	3
902.2	3	3	2	3	3	3	3	3	2	3
Average	3	3	2.66	3	2.33	3	3	3	2.66	3

CORE COURSE - BIOTECHNOLOGY-22 RESEARCH METHODOLOGY	
CO#	After the successful completion of the course the student will be able to
903.1	Elaborate the concept of research and different types of research in the context of biology
903.2	Develop laboratory experiment related skills.
903.3	Develop competence on data collection and process of scientific documentation
903.4	Analyze the ethical aspects of research and evaluate the different methods of scientific writing, reporting and focuses on plagiarism
904.1	Design, plan and write up the research proposals
904.2	Demonstrate skill in critically analyzing the observations to draw inference

CORE COURSE RESEARCH METHODOLOGY										
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
903.1	3	3	3	3	2	3	3	3	3	3
903.2	3	3	3	3	2	3	3	3	3	3
903.3	3	3	2	3	2	3	3	3	2	3
903.4	3	3	3	3	2	3	3	3	3	3
904.1	3	3	2	3	2	3	3	3	2	3
904.2	3	3	2	3	3	3	3	3	2	3
Average	3	3	2.3	3	2.16	3	3	3	2.3	3

CORE COURSE - BIOTECHNOLOGY-23 ENVIORNMENTAL BIOTECHNOLOGY	
CO#	After the successful completion of the course the student will be able to
905.1	Describe various dimensions of ecology, biodiversity and their importance.
905.2	Analyse the causes of air pollution and their control mechanisms.
905.3	Analyse the causes of water pollution and their control mechanisms using biotechnological processes
905.4	Give an insight of application of biosources as the solution to various environmental concerns
906.1	Qualitatively analyse the soil samples and isolate microbes from soil
906.2	Analyse the water samples for TDS, DO and COD

CORE COURSE - ENVIORNMENTAL BIOTECHNOLOGY

CO#	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
905.1	3	3	2	3	2	3	3	3	2	3
905.2	3	3	2	3	2	3	3	3	2	3
905.3	3	3	2	3	2	3	3	3	2	3
905.4	3	3	2	3	2	3	3	3	2	3
906.1	3	3	2	3	2	3	3	3	2	3
906.2	3	3	2	3	2	3	3	3	2	3
Average	3	3	2	3	2	3	3	3	2	3

B. Tech Instrumentation Engineering
Syllabi for Examinations

3rd YEAR (SEMESTER–V) (w.e.f. 2020-21)

<table>
<tr><td>Course no: IN-HSM-301</td><td colspan="5">Course title: Ethics and Value</td></tr>
<tr><td>Year and Semester</td><td colspan="2">3rd year
5th Semester</td><td colspan="3">Contact hours per week: 2 hrs
Examination Duration: 3 hrs</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td colspan="2">Evaluation</td></tr>
<tr><td>2</td><td>-</td><td>-</td><td>2</td><td>Minor test + Curricular activities: 40</td><td>Major test: 60</td></tr>
<tr><td colspan="6">Course Objectives:</td></tr>
<tr><td colspan="6">1. To create an awareness on Engineering Ethics and Human Values.</td></tr>
<tr><td colspan="6">2. To understand social responsibility of an engineer.</td></tr>
<tr><td colspan="6">3. To appreciate ethical dilemma while discharging duties in professional life</td></tr>
<tr><td colspan="6">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="5">Understand the ethical theories and concepts</td></tr>
<tr><td>CO2</td><td colspan="5">Understand an engineer’s work in the context of its impact on society</td></tr>
<tr><td>CO3</td><td colspan="5">Understand and analyze the concepts of safety and risk</td></tr>
<tr><td>CO4</td><td colspan="5">Understand the professional responsibilities and rights of Engineers</td></tr>
<tr><td>CO5</td><td colspan="5">Understand the concepts of ethics in the global context.</td></tr>
</table>

Module-I

HUMAN VALUES : Morals, Values and Ethics – Integrity – Work Ethic – Honesty – Courage –Empathy – Self-Confidence – Character .

ENGINEERING ETHICS AND THEOREMS: Senses of 'Engineering Ethics' - variety of moral issueds- types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - Professional and professionalism, moral reasoning and ethical theories, virtues, professional responsibility, integrity, self-respect, duty ethics, ethical rights, self-interest, egos, moral obligations. Theories Co-operation – Commitment.

Module-II

SOCIAL ETHICS and ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - Legal aspects of social ethics, the challenger case study, Engineers duty to society and environment.

Module-III

SAFETY, RESPONSIBILITIES AND RIGHTS: Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the Three Mile Island and Chernobyl case studies. Bhopal (MIC), Visakhapatnam (Polystyrene) case studies

RESPONSIBILITIES AND RIGHTS OF ENGINEERS: Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – Intellectual Property Rights (IPR) – discrimination.

Module-IV

GLOBAL ISSUES AND ENGINEERS AS MANAGERS, CONSULTANTS AND LEADERS: Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership- Engineers as trend setters for global values.

Text Books:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

Reference Books:

1. Charles D. Fleddermann, "Engineering Ethics", Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.

B. Tech Instrumentation Engineering

3rd YEAR (SEMESTER–V) (w.e.f. 2020-21)

Course no: IN-PC-303	**Course title: Power Electronics-II**				
Year and Semester	**3rd year 5th Semester**		**Contact hours per week: 4 hrs Examination Duration: 3 hrs**		
L	**T**	**P**	**C**	**Evaluation**	
3	**1**	**-**	**4**	**Minor test + Curricular activities: 40**	**Major test: 60**
Course Objectives:					
1. To introduce the concept of Choppers.					
2. To introduce the concept of Inverters and types of inverters.					
3. To study the modulation & harmonics and techniques to remove harmonics.					
4. To study various types of chopper drives and its applications.					
Course Outcomes: On completion of the course, student would be able to:					
CO1	To Familiarize with control strategies of choppers, types of choppers.				
CO2	To understand the working of Inverters.				

CO3	To Familiarize with inverters, types of choppers and their mode of angles of operations.
CO4	To understand the applications of choppers and at different stages.

Module-I

Choppers: Principle of choppers, Control strategies; Constant frequency system and Variable frequency system. Step-up choppers, Types of chopper Circuits; First Quadrant or Type-A choppers, Second-Quadrant or Type-b choppers, Two-Quadrant Type-a Chopper or Type-C chopper, Two-Quadrant Type-b Chopper or Type-D chopper, Four-Quadrant Type-a Chopper or Type-E chopper, Thyristor Chopper Circuits; Voltage commutated choppers, Current-commutated choppers and Load commutated choppers.

Module-II

Inverters: operating Principle of Single Phase Voltage source inverter; Single –Phase bridge inverter, steady state analysis of Single–Phase bridge inverter, Fourier analysis of Single–Phase inverter Output voltage, Force-commutated thyristor inverter; Modified Mcmurray Half-bridge Inverter, Modified Mcmurray Full-bridge Inverter, Modified Mcmurray-Bedford Half-bridge Inverter, Modified Mcmurray-Bedford Full-bridge Inverter, Three Phase Bridge Inverter; Three –Phase 180^0 Mode VSI and Three –Phase 120^0 Mode VSI.

Module-III

Modulation and Harmonics; Pulse Width Modulated Inverter; Single-Phase Modulation, Multiple Phase Modulation, Sinusoidal Pulse Modulation (Sin M), Reduction Of Harmonics in the inverter output Voltage; Harmonics Reduction by PWM, Harmonics Reduction by Transformer connection, Harmonics Reduction by Stepped wave Inverter, Current Source inverter; Single phase with ideal switching, Basic Series Inverter, Basic Parallel Inverter(Single Phase).

Module-IV

Electric Drives and Applications: Chopper Drives; Power Control or Motoring Control, Regenerative-Breaking control, Two Quadrant chopper control and Four Quadrant Chopper control, Speed Control of three Phase Induction Motor; Stator Voltage control, Stator Frequency control, Stator Voltage and Frequency control, Stator Current control, Static Kramer Drives, Static Scherbius Drive. (No quantitative analysis)

Text Books;

1. VendamSubramanium, ‘Power Electronics’ New Age Publishers-New Delhi
2. P.C.Sen, ’Power Electronics’ Tata McGraw-Hill Publishing Co Ltd-New Delhi
3. Mohan/Underland/Robbins, ‘Power Electronics’JohnWiley& Sons Pvt ltd-
4. Ramamurthy,’Thyristor and Its Applications’
5. Rashid ‘Power Electronics’
6. Gupta/Singh ‘Power Electronics and Introduction to Drives’DhanpatRaiPubl.Co
7. P.S.Bhimbhra ’Power Electronics’ Khanna Publishers.

3^{RD} YEAR (SEMESTER–V) (w.e.f. 2020-21)

<table>
<tr><td colspan="2">Course no:
IN-PC-305</td><td colspan="4">Course title: MICROPROCESSORS</td></tr>
<tr><td colspan="2">Year and Semester</td><td colspan="2">3rd year
5th Semester</td><td colspan="2">Contact hours per week: 4 hrs
Examination Duration: 3 hrs</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td colspan="2">Evaluation</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td><td>Minor test + Curricular activities: 40</td><td>Major test: 60</td></tr>
</table>

Course Objectives:

1. To equip the students with architecture and working of basic microprocessors.
2. To make the students understand the instructions sets of basic microprocessors and various assembly language programs.
3. To impart the knowledge of various programmable interfacing chips.
4. To design and study the various instrumentation systems with programmable chips.

Course Outcomes: On completion of the course, student would be able to:

CO1	Understand the basic of the internal organisation of 8086 Microprocessor.
CO2	Understand different addressing modes and instructions of 8086, design and develop assembly language programs using software interrupts, subroutines, macros.
CO3	Understand to interface memory and I/O devices with 8086 through programmable interface chips
CO4	Understand interrupt structure in 8086 and few case studies using interfacing chips useful in instrumentation systems.

Module - I

Introduction to Microprocessors, Microcomputer systems, Computer languages. Microprocessor Architecture, Microprocessor operation with memory and input / output devices. 8085 based microprocessor systems.

Module - II

Instructions: Basic Instructions, Format, classification, Status flags, Writing Assembly Language Programs. Additional Instructions and Programming techniques: Logic Operators, Data transfer and 16 bit Arithmetic Instructions.

Module - III

Looping, counting, Indexing. Stack, Subroutines, conditional call and Return. Code Conversions: BCD to binary, Binary to BCD. BCD Arithmetic's and data operations: BCD Addition and subtraction, Introduction to advanced Instructions and applications, Multiplication. Timing diagrams, machine cycle.

Module - IV

Basic interfacing concepts, Memory mapped and Peripheral mapped I/O. Interrupts and interrupts structure of 8085. Basic concepts in serial I/O's, Programmable Peripheral Interface (PPI), Direct Memory Access(DMA) and DMA controller(8257). Keyboard & display interface

(8279). Introduction to8086 Microprocessor - Architecture and signals, Pin diagram, Memory organisation,, Minimum mode and Maximum Mode 8086 system.

References:

1. Microprocessor Architecture Programming and Applications by Gaonkar, Penram International
2. Microprocessors and its Applications byTheagrajan. PHI
3. Microprocessors and interfacing by D.V.Hall.
4. Microprocessor system: The 8086/8088 family IInd ed. By Yu.Cheng& Gibson

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3RD YEAR (SEMESTER–V) (w.e.f. 2020-21)

Course no: IN-PC-307	**Course title: Analogue Communication Engineering**				
Year and Semester	**3rd year 5th Semester**		**Contact hours per week: 4 hrs Examination Duration: 3 hrs**		
L	**T**	**P**	**C**	**Evaluation**	
3	**1**	**-**	**4**	**Minor test + Curricular activities: 40**	**Major test: 60**

Module-I

Signal Analysis: Introduction, Classification of signals, Singularity or elementary functions, representation of signals, Convolution, properties of signal systems, Fourier series and applications in **LTI system**, trigonometric Fourier series, Fourier transform; its properties and applications in **LTI system**

Module-II

Noise: classification of noise, voltage-current models of a noisy resistor, noise in reactive circuits, Signal to noise ratio, Noise figure, noise temperature

Amplitude Modulation: amplitude modulation, spectrum and modulation index of AM, over modulation, power content in AM, Generation of AM, Double side band suppressed carrier modulation, Single side band modulation, AM demodulation, vestigial side band modulation systems, frequency division multiplexing.

Module-III

Frequency Modulation: angle modulation, phase and frequency modulation, FM Spectrum, effect of variation of MI on spectrum of FM, Narrow band and wide band frequency modulation, FM generation using parametric variation and Armstrong method, FM demodulation, noise in FM Systems

Module-IV

Transmitter: Classification of radio transmitters, block diagram of AM Transmitter, carrier frequency requirements of radio transmitter, privacy systems,FM transmitters

Receivers: Classification of receivers, TRF receivers, superhetrodyne receivers, frequency mixers, IF Amplifiers, Tracking and alignment of receivers, Automatic gain control and automatic frequency control.

Reference Books:

1. Principles of Communication systems, McGraw Hill, By Taub and Schilling.
2. Electronic Communication system, PHI, By G Kennedy.
3. Electronic communications, PHI, By Roddy and Coolen.

3RD YEAR (SEMESTER–V) (w.e.f.2020-21)

Course no: IN-PE-309		**Course title: Linear Automatic Control System**			
Year and Semester		**3rd year 5th Semester**		**Contact hours per week: 4 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
3	**1**	**-**	**4**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:
1. Study the time response of various types (0, 1, 2, 3, etc.) of system Execute time response analysis of a second order control system using MATLAB/ simulation software
2. Study the Stability analysis of Linear system, Analyze and interpret stability of the system through Root Locus, Bode plot and Nyquist plot.
3. Study Lag, Lead, Lead-Lag compensators and verify experimental results using MATLAB.
4. Study the concept of state, state variables and various state models techniques and concept of controllability and observability, pole placement by state feedback

Course Outcomes: On completion of the course, student would be able to:	
CO1	Ability to derive Mathematical Modeling various types (0, 1, 2, 3, etc.) of system and anayze their time responses
CO2	Able to Analyze the effect of P, PI, PD and PID controllers on a control system and design suitable controller for a typical process
CO3	Ability to Analyze and interpret stability of the systemthroughRoot Locus, Bode plot and Nyquist plot.
CO4	Able to design lead, lag, lead-lag compensators using time domain and frequency domain analysis techniques.
CO5	An ability to understand concept of state, state variables and the design output feedback controller in state space.

Module – I

TIME DOMAIN ANALYSIS: Standard test signal (step, ramp, impulse, parabolic) time response of various types (0, 1, 2, 3, etc.) of system. Steady state error analysis, effect of adding zero to a system. Design consideration of 2nd order system, design of higher order system, performance indices

Module - II

STABILITY OF A CONTROL SYSTEM : Concept of stability, necessary conditions of stability, Hurwitz Stability criterion, Routh stability criterion, relative stability analysis, more on the Routh stability criterion, The Root locus technique: The root locus concept construction of root loci, root contours, system with transportation Lag, sensitivity of the roots of the characteristic equation.

Module - III

FREQUENCY DOMAIN ANALYSIS: Correlation between time and frequency response, polar plots, bode plots, all- pass and minimum- phase system experimental determination of transfer functions, log magnitude versus phase plots. Stability in frequency domain: mathematical preliminaries, Nyquist stability criterion, assessment of relative stability using Nyquist criterion, closed-loop frequency response, sensitivity analysis in frequency domain.

Module-IV

STATE VARIABLE ANALYSIS AND DESIGN: Concept of state, state variables and state models, state models for linear continuous time system, diagonization, solution of state equations, concept of controllability and observability, pole placement by state feedback, state variables and linear desecrate-time systems.

Reference Books:

1. Automatic Control System ByKuo
2. Feedback Control System ByD'Azzo and Houpis
3. Modern Control Engineering ByOagata
4. Control Systems Engineering By Nagrath&Gopal.

3RD YEAR (SEMESTER–VI) (w.e.f.2020-21)

Course no: IN-PC-302	**Course title: Instrument & System Design**				
Year and Semester	**3rd year 6h Semester**			**Contact hours per week: 3 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1.	To provide a coherent knowledge about concepts of instrument system design
2.	to develop knowledge about system characteristics and performance attributes
3.	To elaborate relevant issues of physical, architecture design at printed circuits board level of complex electronic systems
4.	To understand the fundamentals circuit layout
5.	To develop concept of power distributions systems
Course Outcomes: On completion of the course, student would be able to:	
CO1	Apply basic principles and guidelines of physical architecture design for complex electronic systems
CO2	Analyze the various system attributes and their impact on system performance
CO3	Analyze the influence of interconnects at different levels on electronic system performance

CO4	Develop system model on the basis of learned concepts

Module - I

Introduction - overview of system engineering, system perspective, documentation, concept development, requirements, design development, rapid pro totyping and field testing, validation, verification and integration, maintenance and life-cycle costs, failure, iteration and judgment.
Packaging and Enclosures: Packaging influence, packaging design, wiring, temperature, vibration and shock, component packaging, mechanical issues, case studies of a New Chassis and Housing Design Concept for Electronic Equipment, and Robot.

Module-II

Grounding and Shielding: Safety, Noise, principle of energy coupling, Grounding, filtering, shielding, electrostatic discharge and it protection, general rules for design; Case study-EMC design of an oscilloscope.

Module - III

Circuit Design: Fundamentals of circuit design, high speed design, low power design, noise and error limitation, standard data buses and networks, reset and power failure detection, input/output interfaces.

Module -IV

Circuit layout and Power: Circuit boards, component placement, routing of signals and traces, grounds, returns and shields, connectors and cables, design for manufacture, testing and maintenance; Power: Power requirements, sources of power, power conversion, definitions and specifications, power distribution and conditioning, electromagnetic interfaces.

Reference Books:

1. Noise reduction techniques in electronic systems, 2nd ed. New York: Wiley By H.W.Ott
2. Electronic Instrument Design, Oxford Univ. Press, By Him R. Fowler
3. Intuitive Operational Amplifiers, MeGraw-Hill, By T.M.Frederiksen
4. Printed Circuit Boards, CEDT Series TMH By Walter C. Bosshart

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3RD YEAR (SEMESTER–VI) (w.e.f. 2020-21)

Course no: IN-PC-304	**Course title: Digital Communication Engineering**				
Year and Semester	**3rd year 6^{h} Semester**		**Contact hours per week: 3 hrs Examination Duration: 3 hrs**		
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:
1. To introduce students with the need for electronic communication.
2. To familiarize with digital modulation and its formats.
3. To have understanding of angle modulation and its types.

4. To have knowledge of pulse modulation and digital modulation.	
5. To gain analytical skills based information theory.	
6. To have basic knowledge about source coding and error controlling codes.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Acquire knowledge about the analog modulation and its different formats including power and current relations in and AM wave.
CO2	Have good understanding of angle modulation including frequency modulation and phase modulation and respective demodulation techniques.
CO3	Acquire knowledge about pulse analog modulation and digital modulation and respective demodulation techniques.
CO4	To have acquaint about the basics of information theory and associated codes.
CO5	Acquire basic knowledge about source coding and error control coding techniques together with solving simple numerical problems.

Module-I

Pulse Modulation: Sampling Theorem ,natural sampling, flat top sampling, quantization process , Pulse amplitude modulation ,TDM,PWM, PCM, DPCM,DM,ADM

Module-II

Digital modulation Techniques: Digital modulation formats, types of digital modulation: ASK, BPSK, BFSK, DPSK, QPSK and Minimum Shift Keying

Module-III

Information theory: Introduction, Information rate, source coding theorem, Huffman coding, discrete memory less channel, mutual information channel capacity, channel coding theorem, channel capacity theorem shanon's theorem and shanon-hartley theorem.

Module-IV

Coding theory: Introduction, Linear block codes, cyclic codes convolution codes, decoding of convolution codes, distance properties of convolution codes.

Data Networks: Communication Networks, Circuit Switching, Store and forward switching, layered architecture, packet networks, and multiple access communication.

Reference Books:

1. Principles of communication systems, Pub.-McGraw Hill, by Taub And Schilling
2. Digital communication, Pub.- John Willy and sons, by Simon Hykin.
3. Communication Systems – B P Lathi
4. Communication Switching Systems and Networks, Pub.-PHI, by Thiagrajan Vishwanathan.

3RD YEAR (SEMESTER–VI) (w.e.f.2020-21)

Course no: IN-PE-306	**Course title: Fuzzy Logic Control**

Year and Semester		**3^{rd} year 6^{h} Semester**		**Contact hours per week: 3 hrs** **Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
To study and acquire the basic knowledge of fuzzy logic.	
To study the basic architecture of FKBC and its design parameters	
To study nonlinear & adaptive fuzzy controllers.	
To identify, formulate and solve the neuro fuzzy logic based problems.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand working of basic fuzzy system and its architecture.
CO2	Able to fuzzy techniques in different field, which involve perception, reasoning and learning.
CO3	Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
CO4	Assess the results obtained by FKBC and Neuro fuzzy systems.

Module-I

INTRODUCTION : Introduction to Fuzzy control, Fuzzy logic controller components, Construction of Fuzzy sets, Fuzzy logic controller and its applications.Fuzzy control from an industrial perspective, knowledge- based controller, knowledge representation in KBC's.

Module-II

Introduction to Fuzzy sets, Crisp sets, Basic concepts of Fuzzy sets, L-fuzzy sets, level 2-fuzzy sets, type 2-fuzzy sets. Fuzzy sets Vs. Crisp sets. Fuzzy Arithmetic, Algebraic operations, set-theoretic operations, fuzzy relation on sets & fuzzy set compositions of Fuzzy relations, properties of the minimum-maximum composition.

Module-III

FKBC DESIGN PARAMETERS: The FKBC architecture, choice of variables and contents of rules, Derivation of rules, Choice of membership functions, choice of scaling factors, Choice of fuzzification procedure, Choice of defuzzification procedure, comparison and evaluation of defuzzification methods.

Module-IV

ADAPTIVE FUZZY CONTROL**:** Design and performance evaluation, Approaches to Design such as membership function tuning using gradient descent, Membership function tuning using performance criteria, the self-organizing controller, Model based controller.

BOOKS FOR REFERENCE :

1. Fuzzy control system by Abraham Kandel and Gideon Imngholz, Narosa.
2. Fuzzy logic control system by T.Ross

3. Fuzzy Control system by D. Drainkov& M. Reienfrank.
4. Klir George J. " Fuzzy sets and Fuzzy Logic Theory and Applications", PHI

3^{RD}YEAR (SEMESTER–VI) (w.e.f.2020-21)

Course no: IN-PC-308	**Course title: Digital Signal Processing**				
Year and Semester	**3^{rd} year 6^{h} Semester**			**Contact hours per week: 4 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
3	**1**	**-**	**4**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1.	To study the basic of Z transform and its application in LTI discrete-time systems.
2.	To study the Discrete linear Time Invariant systems in Z domain and in frequency domain.
3.	To study different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
4.	To study the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its application.
5.	To study the digital filters for filtering applications.
Course Outcomes: On completion of the course, student would be able to:	
CO1	To learn the basic of Z transform and its application in LTI discrete-time systems.
CO2	To analyze the Discrete linear Time Invariant systems in Z domain and in frequency domain.
CO3	To understand the different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
CO4	To learn the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its applications.
CO5	To Design digital filters for filtering applications.

Module-I

Z-TRANSFORM & ANALYSIS: The Z-transform, properties of Z-transform, inverse of Z-transform, region of convergence and properties, analysis of LTI system in Z-Domain and in frequency domain, transient response, steady-state response, causality and stability.

Module-II

Discrete and Fast Fourier Transform (DFT & FFT):DFT and its properties, IDFT, DFT and Z-transform relationship, linear filtering using DFT , linear and circular convolution. FFT: FFT decimation-in-time (DIT) algorithm and FFT decimation-in-frequency(DIF) algorithm (Radix-2).Effect of finite Word length in Digital filter: Coefficient Quantization, product quantization, Finite Register length effect in IIR and FIR realization.

Module-III

Reliasation of Digital Filters: FIR Filter: Direct form, cascade form, frequency selective and lattice structurerealizations.IIR Filter: Direct form-I ,Direct form-II, cascade form ,parallel and lattice structure realizations Comparison between FIR and IIR filter.

Module-IV

Digital filter Design: Advantages and disadvantages of digital filters, FIR digital filter design: Characteristics and properties of FIR digital filter, FIR digital filter design using Fourier series method, Use of window functions method, frequency sampling method. IIR filter design: Design of IIR filter from analog filter by derivative approximations method, Invariant-Impulse-response method, Bilinear - transformation method and Matched Z- transformation method.

Reference Books:

1. Digital Filter Analysis & Design by Andreas Antoniou
2. Digital Signal Processing by David J. Defalta& Joseph G. Lucas
3. Digital Signal Processing by Sanjit K Mitra .
4. Digital Signal Processing by Proakis, Masnolakis
5. Digital Signal Processing by Farooq Hussain

3RD YEAR (SEMESTER–VI) (w.e.f.2020-21)

Course no: IN-PC-310	**Course title: Microcontroller & Embedded System**				
Year and Semester	**3rd year 6h Semester**			**Contact hours per week: 4 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
3	**1**	**-**	**4**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1.	In depth study of 8051 Architectures and programming of microcontrollers: embedded system applications.
2.	Use of assembler directives and programming in assembly language using Assembler
3.	This course concerns with Embedded systems basic knowledge: embedded architectures:
4.	To analyze and design the RTOS and applications.
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the fundamental concepts of Microcontroller Organization and Architecture (Intel 8051), Data Representation and Memory Usage
CO2	Apply the basic programming skills of microcontrollers for Problem Solving and Algorithm Development, Assembling/Compiling and Execution
CO3	Understand the basic of Embedded system, Understand the Embedded Product Development Life Cycle, Design embedded system in RTOS
CO4	Illustrate and design the hardware using Embedded System.
CO5	Apply various algorithms in solving sorting problems.
CO6	After study of this course it is expected that students will be able to develop interface for real time industrial process and write programs for different applications, Further it is expected that students will be able to do of their own for higher processors and microcontrollers.

Module-I

Introduction to Embedded Systems: Definitions and Classification, Overview of Embedded Systems, Embedded Software, Embedded System on Chip (SoC), Use of VLSI Designed Circuits; Processor and Memory Organization: Structural Units in Processor, Memory Devices, Processor and Memory Selection, Memory Map and Applications, Memory Blocks for Different Structures.

Module-II

Devices and Buses for Devices Networks: I/O Devices I/O Types and Examples, Parallel Port and Serial Port Devices and Communication Buses; Device Drivers, Device Servicing by Interrupt and Service Routines Linux Internals as Device Drivers and Network Functions, Writing Physical Device Deriving ISRs in a System and Some Examples, Context Switching, Deadline, Latency Priorities Programming in Assembly Language (ALP) Vs High Level Language, Basic C Program Elements, Concept of Embedded Programming in C++, Embedded Programming in C++, C program compiler, Cross Compiler.

Module-III

Microcontrollers:- Introduction; comparison of microprocessors & microcontrollers; A survey of microcontrollers, 8051 microcontroller hardware: Input/Output Pins; Ports and Circuits; External memory; counter & timers; serial data input/output; & Interrupts. Introduction to instructions of 8051: For moving data, logical operations, arithmetic operations and jump & call.

Module-IV

8051 programming with examples of study of input/output ports of 8051, use of 8051 in closed loop system, study of Internal/External Interrupts of 8051, and study of Internal counter using Internal/External clock of 8051. Interfacing: Interfacing with display, memory, keyboard, AD/DA, generation of PWM output for proportional control using timer & counter and serial data communication.

REFERENCE BOOKS:

1. The 8051 Microcontroller Architecture Programming & Application by Kenneth J. Ayala, Penram Inter.
2. The 8051 Microcontroller and Embedded Systems- Muhammad Ali Mazidi; Pearson Education India
3. Microcontroller Architecture, Programming, Interfacing and System Design by Raj Kamal, Pearson Education India
4. Programming and Customizing the 8051 Microcontroller by Fredko Mike, TMH
5. Embedded Systems Architecture, Programming, and Design by Raj Kamal, TMH

B. Tech Instrumentation Engineering
Syllabi for Examinations
4th YEAR (SEMESTER–VII) (w.e.f. 2021-22)

Course no: IN-PE-401		**Course title:**		**OPTIONAL – I ARTIFICIAL INTELLIGENCE**	
Year and Semester		**4th year 7th Semester**		**Contact hours per week: 3 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:
1. To explore the basics of Artificial Intelligence.
2. To introduce the concepts of a Rational Intelligent Agent and that can be designed to solve problems.
3. To gain knowledge on blind and heuristic search in AI.
4. To create an understanding of the basic issues of knowledge representation and Logic.
5. To be able to design expert systems with intelligence.

Course Outcomes: On completion of the course, student would be able to:	
CO1	Recognize the role of AI to solve real world problems
CO2	Explain and implement representation of knowledge, problem solving methods in AI.
CO3	Know how to build simple knowledge-based systems.
CO4	Solve complex engineering and real-world problems using AI.

Module - I

Introduction: History, the turning test, overview of AI application are as problem & problem spaces, problems characteristics.

Module - II

Knowledge Representation Logic: Proportional & first order prediction logic, inference rules, resolution limitation of logic. Production system: Definition & history, examples of search in production system, advantages.

Module -III

Search: Informal and informal, algorithms of depth 1st, breadth 1st, hill climbing, beat 1st, search and bound; game playing - minimax search, alpha and beta pruning. Forward and backward reasoning.

Module - IV

Expert system: Introduction & examples, architecture (rule board system), development, knowledge engineering process, limitations. Programming in PROLOG.

Reference Books:

1. Artificial Intelligence by George F.luger & William A.
2. Stubblefeild, The Benjamin/Cummings Pub. Comp., Inc.
3. Principle of A.I by Nils J. Nilsson, Narosa.
4. A.I By Elaine Tich & Kevin Knoght, TMH
5. Introduction to Artificial Intelligence & Expert systems by Dass W. Patterson, PHI
6. A.I: an engineering approach by Robert J. Schlkoff, McGraw Hill.

4th YEAR (SEMESTER–VII) (w.e.f. 2021-22)

Course no: IN-PE-403	Course title: BIO-MEDICAL INSTRUMENTATION				
Year and Semester	**4th year 7th Semester**		**Contact hours per week: 3 hrs Examination Duration: 3 hrs**		
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1.	To introduce the concept of Bio Medical Instrumentation.
2.	To introduce Bio Potential Electrodes and Biomedical Recorders.
3.	To introduce the Heart Sound and Ultrasound.
4.	To study the Imaging System.
Course Outcomes: On completion of the course, student would be able to:	
CO1	To Familiarize with Bio Medical Instrumentation.
CO2	To understand with Bio Potential Electrodes and Biomedical Recorders.
CO3	To understand the Heart Sound and Ultrasound.
CO4	To understand the Imaging System.

Module- I

Introduction: Bio-electric potential and electrode: Instrumentation system, Living Instrumentation system, Bio-metric, the anatomy of nervous system, origin of bio-potentials, resting and action potentials, propagation of action potentials, the Bio-electric potentials, bio-potential electrode: Microelectrodes, skin surface electrode, Needle electrodes.

Module -II

Biomedical recorders: Basic functioning of heart, Electrocardiograph Block diagram of ECG, ISOLATION AMPLIFIER, the ECG leads, Microprocessor based ECG Machine, multi-channel ECG Machine, vector cardiograph, Apex cardiograph, Ballistocardio graph, PCG, Microphones for PCG, amplifier for PCG, EEG: Electrode for EEG, Block diagram of EEG Machine, EMG Recording, pre amplifier for EMG, low frequency and high frequency filters, display signal delay & Trigger unit, EMG recording method.

Module -III

Ultrasonic Imaging system: Physics of ultrasonic waves, Medical ultrasound,(Basic Pulse-Echo apparatus), A-scan, Echocardiograph (M-mode), B-scanner, Real time ultrasonic imaging systems (Requirements, Mechanical Sector scanner, Multi-Element Linear Array Scanners, Phase Array system, Duplex Scanner and Annular Array Scanner), Display devices for ultrasonic imaging system, Biological effect of ultrasound.

Module-IV

Imaging System: X-ray Machine and Computed Tomography: X-ray machine, X-ray image Intensifier T.V. system, X-ray computed Tomography (CT Scanner). NMR imaging system : Imager system. Application of NMR Imaging, Advantage & disadvantage of NMR Imaging system.

Reference Books:

1. Introduction to Biomedical Equipment Technology By Carr & Brown.
2. Biomedical Instrumentation and Measurement by Cromwell, PHI.
3. Handbook of Biomedical Instrumentation by R.S.Khandpur, TMH.

4th YEAR (SEMESTER–VII) (w.e.f.2021-22)

Course no: IN-PC-405	**Course title: Computer Graphics & CAD CAM**				
Year and Semester	**4th year 7th Semester**			**Contact hours per week: 3 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1.	To learn and understand Graphics fundamentals.
2.	To develop the algorithm design capability for creating different 2-D and 3-D graphical objects To learn creation of animated scenes for virtual objects creations
3.	To further the acquired knowledge to utilize it in different research works on Pattern Recognition and Image Processing.
4.	To learn and understand Graphics fundamentals.
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand how to write algorithms for generating different 2-D and 3-D graphical objects.
CO2	Apply the knowledge to create and filling polygon (solid area fill),
CO3	Implement the different techniques of 2-D
CO4	Implement different line and polygon clipping algorithms,
CO5	Draw different types of projections in 3-D vector algebra, different 3-D transformation techniques, curves and surfaces and rendering methods
CO6	Animate scenes entertainment and apply the knowledge to research work.

Module-I

Introduction of computer Graphics and its applications, Overview of Graphics systems, Video display devices, Raster scan display, Raster scan systems, video controller, Raster scan display processor, Random scan display, random scan systems, color CRT monitor, Flat panel display, Interactive input devices, Logical classification of input devices, Keyboard, mouse, Trackball and spaceball, Joysticks, Image scanner, Light pens, Graphics software, Coordinates representations, Graphics primitives and functions.

Module-II

Points and lines, Line drawing algorithms, midpoint circle and ellipse algorithms. Filled area primitives: scan line polygon fill algorithm, boundary-fill and flood fill algorithms.

Translation, scaling, rotation, reflection and shear transformations, matrix representations and homogeneous coordinates, composite transforms, transformation between coordinate systems. 2-D Viewing: The viewing pipeline, viewing coordinate reference frame, window to viewport coordinate transformation, viewing functions, Cohen-Sutherland and Cyrus beck line clipping algorithms.

Module-III

Polygon surfaces, quadric surfaces, spline representation, Hermite Curve, Bezier Curve and BSpline curves, Bezier and B-Spline surfaces, sweep representations, 3-D Geometric Transformations: Translation, Rotation, Scaling, Reflection and Shear transformations, composite transformations, 3-D viewing, viewing pipeline, viewing coordinates, view volume and general projection transforms and clipping.

Module-IV

Classification, back-face detection, depth-buffer, scan line, depth sorting, BSP- tree methods, are subdivision and octree methods Illumination models and surface rendering methods: Basic illumination models, polygon rendering methods.

Design of animation sequence general computer animation functions, raster animation, computer animation languages, key frame systems, motion specifications.

TEXT & REFERENCE BOOKS :

1. COMPUTER GRAPHICS C VERSION by Donald Hearn and M. Pauline Baker, Pearsosn Education.
2. Principles of Interactive Graphics, Neuman and Sproul, TMH
3. Computer Graphics second edition "Zhigand Xiang, Roy Plastock, Schaum's outlines Tata McGraw Hill Edition.
4. Computer Graphics Principles & Practice", Second Edition in C, Foley, VanDam, Feiner and Hughes, Pearson Education.
5. Procedural Elements for Computer Graphics, David F Rogers, Tata McGraw Hill, 2nd edition.
6. An Integrated Introduction to Computer Graphics and Geometric Modelling, R. Goldman, CRC Press, Taylor & Francis Group.

4th YEAR (SEMESTER–VII) (w.e.f. 2021-22)

Course no: IN-PC-407	**Course title: ADVANCE PROCESS DYNAMICS & CONTROL**				
Year and Semester	**4th year 7th Semester**		**Contact hours per week: 3 hrs Examination Duration: 3 hrs**		
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1.	Acquire knowledge Process dynamics and various forms of mathematical models to express them
2.	To understand the multiloop systems
3.	To develop knowledge about controller tuning
4.	To develop understanding about PI diagrams
5.	To analyze samples data control systems
Course Outcomes: On completion of the course, student would be able to:	
CO1	Formulate mathematical model of various systems
CO2	Design and develop multiloop control systems
CO3	Compute the tuning parameters of controllers
CO4	Construct PI diagrams
CO5	Develop the sample data control systems

Module-1

MATHEMATICAL MODELLING: Need of mathematical modelling, lumped and distributed parameters, state variables and state equations of chemical processes, mathematical modelling of CSTR, interacting system and non-interacting system.

ANALYSIS OF COMPLEX PROCESSES: Control of jacketed kettle systems, dynamic response of gas absorber, heat conduction into solids , heat exchanger.

Module-II

ANALYSIS AND DESIGN OF ADVANCED CONTROL SYSTEMS: Review and limitation of single loop control, need of multi loops, cascade, selective override, auctioneering, split range , feed forward, feed forward feedback, adaptive, inferential, ratio control, Self adaptive control: MRAC,STR.

Module-III

Controller Tuning: Tuning of PID controller, Zeigler – Nichols methods, Process reaction curve, Ultimate gain and period method, quarter decay ratio advance method of tuning, IAE, ISE, IATE tuning of controllers. Effect of measurement and transportation lag on process response, Effect of disturbances.

Module-IV

P-I Diagrams: Standard Instrumentation Symbols for Devices, Signal Types, Representation of a Process Control Loop using PI diagram.

Sampled data Control Systems : Sampling, open loop and closed loop response, Stability, Sampled data control of first order process with transport lag, Design of sampled data controllers.

BOOKS RECOMMENDED:

1. Kane-Handbook of Advanced Process Control System
2. Curtis Johnson-Process Control: Instrumentation Technology
3. Chemical Process Controll by George Stephanopoulos
4. Process dynamics and Control by Donald P. Eckman
5. Process systems Analysis and Control Donald R. Coughanowr

4th YEAR (SEMESTER–VIII) (w.e.f.2021-22)

Course no: IN-PE-402	**Course title: (OPTIONAL – II) ROBOTICS**				
Year and Semester		**4th year 8th Semester**		**Contact hours per week: 3 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1.	To develop the student's knowledge in various robot structures and their workspace.
2.	To develop student's skills in performing spatial transformations associated with rigid body motions.
3.	To develop student's skills in perform kinematics analysis of robot systems.
4.	To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
5.	To provide the student with some knowledge and analysis skills associated with trajectory planning.
6.	To provide the student with some knowledge and skills associated with robot control
Course Outcomes: On completion of the course, student would be able to:	
CO1	Outline the structure of a typical robotic system, understand its link and joint parameters, and perform robot kinematics.
CO2	Identify the geometric parameters of a robot by applying the knowledge of robot kinematics and generalized differential model of the robot.
CO3	Analyse planar and spatial parallel robots in context to its forward and inverse kinematics, and evaluate its singularity, condition number and maneuverability.
CO4	Identify the dynamic parameters of a robot by applying the knowledge of general form of dynamic equation of motion.
CO5	Identify the independent joint control and torque
CO6	Design a robotic manipulator and evaluate its primary and secondary workspace. Evaluate the performance of a robot.

Module-I

Introduction to Robotics, terminology and definitions, Classification: Cylindrical, Spherical, Revolute, Rectangular; Components of Robotic Systems: Actuators, Sensors, Controllers, Manipulators. Position and Orientation Description & frames, Rotation, Homogeneous transform, Translations, Transformation matrix.

Module-II

Forward Kinematics: Denavit-Hartenberg (D-H) representation, Link parameters, Link frame assignment, Example of Manipulation Kinematics. Inverse Kinematics: Solvability, Solution Approaches and examples; Velocities of link motion, Jacobian transformation.

Module-III

Manipulator Dynamics: Euler-Lagrange Equation, KE and PE Expressions, Equations of motion, Newton-Euler transformation, some examples; Independent Joint control: Actuator Dynamics, set point tracking, Trajectory Interpolation

Module-IV

Robot Hardware: Robot End Effectors, Grippers, grippers selection & Design; Vision: Introduction, visual sensing, Machine vision & its applications and other optical methods and Robot Applications.

Reference Books:

1. Robot and Controls By Mittal and Nagarath, TMH
2. Introduction to Robotics: Mechanics and control By J.J.Craig, Addision Weslay Pub. Co.
3. Robot Dynamics and Control, By W.Sponge & M.Vidyasagar, John Wiley and Sons, New York, 1989.
4. Robotics: Control, Sensing, Vision and Intelligence By K.S.Fu, R.C.Gonzalez and C.S.G.Lee, McGraw Hill, 1987.

4th YEAR (SEMESTER–VIII) (w.e.f.2021-22)

Course no: IN-PE-404	**Course title: ANALYTICAL INSTRUMENTATION**				
Year and Semester	**4th year 8th Semester**			**Contact hours per week: 3 hrs Examination Duration: 3 hrs**	
L	**T**	**P**	**C**	**Evaluation**	
2	**1**	**-**	**3**	**Minor test + Curricular activities: 40**	**Major test: 60**

Course Objectives:	
1. Understand the interaction of electromagnetic radiations with matter	
2. To Understand the concepts of spectroscopy	
3. To study the various methods of instrumental analysis	
4. Select an Instrument for a particular analysis with idea of its merits, demerits and limitations	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Apply analytical techniques to accurately determine the elements present in the given sample
CO2	How to decide the particular spectroscopic method
CO3	Understand the air water and soil quality monitoring instruments
CO4	Apply chromatography in real time industrial environment

Module - I

Basic Components of a Spectrophotometer, different types of excitation sources, single and double monochromator components and mounting; materials for lens, prism, sample holder, filters etc for various wavelengths, optical sensors for different wavelength ranges. UV-VIS Spectrophotometers (Optical & Electronic Instrumentation) double wavelength spectrophotometer.

Module- II

Fluorescence & Phosphorescence Spectrometry (Basic principle, optical & electronic Instrumentation) Atomic Absorption & Emission Spectroscopy (Sample preparation, photometer instrumentation). Laser Raman Spectrometer Instrumentation & application.

Module - III

Basic consideration, Instrumentation, Qualitative & Quantitative elemental data analysis, limitations and applications of i) X-Ray Fluorescence, ii) Neutron activation, iii) Auger Electron and iv) ESCA techniques.

Module - IV

Basic principle of NMR phenomenon, NMR spectrometer Instrumentation and application Electron spin resonance (ESR) Spectroscopy basic principle, spectrometer instrumentation and applications. Basic principle of chromatography - Gas & Liquid column chromatograph instrumentation and applications; water pollution monitoring instrumentation.

Reference Books:

1. Instrumental Methods Of Analysis By Williard, Merrit, Dean
2. Handbook Of Analytical Instrumentation By R.S. Khandpur
3. Instrumental Methods For Chemical Analysis By E.W.Ewing
4. Introduction To Instrumental Analysis By Robert D. Braun
5. Essentials of Instrumental analysis by Skoog, Holler & Nieman, Thomson Publ.

4th YEAR (SEMESTER–VIII) (w.e.f.2021-22)

<table>
<tr><td colspan="2">Course no: IN-PC-406</td><td colspan="4">Course title: INDUSTRIAL PROCESS CONTROL</td></tr>
<tr><td colspan="2">Year and Semester</td><td colspan="2">4th year 8th Semester</td><td colspan="2">Contact hours per week: 3 hrs
Examination Duration: 3 hrs</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td colspan="2">Evaluation</td></tr>
<tr><td>2</td><td>1</td><td>-</td><td>3</td><td>Minor test + Curricular activities: 40</td><td>Major test: 60</td></tr>
<tr><td colspan="6">Course Objectives:</td></tr>
<tr><td colspan="6">1. Basic concept and Study of FC and FO type control valve and their applications with examples, Gain of valve and concept of control valve sizing for liquid, Gas, vapour and steam. (Special reference to Masoneillian & Fisher Equation) and study control valve cavitation and flashing phenomenon</td></tr>
<tr><td colspan="6">2. Study control Valve noise, its calculation & reduction techniques and Design & Construction of Globe Valve.</td></tr>
<tr><td colspan="6">3. Study the characteristic function of PLC, its Architecture and various PLC programming languages and Demonstrate various PLC programming skill for industrial applications.</td></tr>
<tr><td colspan="6">4. Detail study and applications of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS</td></tr>
<tr><td colspan="6">5. Study DCS supervisory control techniques & considerations(Algorithms), Concept of field buses and their applications</td></tr>
<tr><td colspan="6">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="5">Able to understand FC and FO type control valve and Able to learn and analyze the various principles & concepts involved in valve sizing for liquid, Gas, vapour and steam and control valve cavitation and flashing phenomenon</td></tr>
<tr><td>CO2</td><td colspan="5">Able to understand control Valve noise, its calculation, reduction techniques and Acquire the knowledge and demonstrating the constructional details of Globe Valve.</td></tr>
<tr><td>CO3</td><td colspan="5">Acquire the knowledge of performance characteristic function of PLC and its Architecture.</td></tr>
<tr><td>CO4</td><td colspan="5">Able to learn the various PLC programming languages and Demonstrate various PLC</td></tr>
</table>

	programming skill for industrial applications.
CO5	Able to learn and analyze the various principles & concepts of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS
CO6	Acquire the knowledge of DCS supervisory control techniques, the concept of field buses and their Industrial applications.
CO7	To implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution for industry problems.

Module-I

CONTROL VALVE DESIGN: Control valve flow characteristics, valve & process characteristics, effect of distortion coefficient on linear and percentage valve, range-ability of control valve, control valve sizing for liquid vapor and steam. (Special reference to Masoneillian & Fisher Equation) control valve cavitation and flashing: flow control cavitation index, vibration curve cavitation index, calculation of flash fraction. Control valve gain, sequencing of control valve and viscosity correction of control valve.

Module-II

Valve noise calculation & reduction: Sources of valve noise, noise control: path treatment source treatment valve noise calculation. Design & construction of Globe Valve: Valve trends, trim design, trim flow characteristics, flow rangeability, standard trim configuration, valve plug stems, Body form of single & double seated Globe valve, construction & flow characteristics of Butterfly valve.

Module-III

Discrete State Process Control System: Development & analysis of ladder diagram, logic diagram from ladder diagram, Functional description of PLC difference between PLC & computer. Sizing & selection, PLC peripherals, programming & documentation tools. Communication networking: Universal communications networking, Peer to Peer communications, PLC installations. Programming the Programmable controller: Programming languages, ladder diagram instructions, special functions, data transfer and data manipulation operations, arithmetic operations, flow control operations, Boolean mnemonics. Functional blocks data transfer operations arithmetic and logic operations, Programmable controller's industrial applications.

Module-IV

Distributed process control system: Functional requirement of DPCS, DCS configurations, control console equipment: Video display, keyboard, peripherals device & display. Software configuration: Operating system configuration, controller function configuration, algorithm, libraries, relay rec. mounted equipment, communication between the components. DCS data high ways, field buses, multiplexers & party line system, Multiplexing & scanning, Multiplexer design. DCS Supervisory computer and configurations: Supervisory computer functions, supervisory control techniques & considerations, DCS & Supervisory computer display, DCS. DCS system integration with PLC & computer.

References Books :

1. Microprocessor in process control: C.D.Johnson
2. Instrumentation for process measurement and control by N.A. Anderson.
3. Principles and practice of automatic process control: Carlos by A Smith.
4. Instrument Engineers' handbook - Process control by Bela G. Liptak.
5. Computer based Industrial Control by Krishan Kant

Kurukshetra University, Kurukshetra

(Established by the State Legislature Act XII of 1956)
('A+' Grade, NAAC Accredited)

।। योगस्थः कुरु कर्माणि ।।
समबुद्धि व योग युक्त होकर कर्म करो

(Perform Actions while Steadfasting in the State of Yoga)

DEPARTMENT OF INSTRUMENTATION (DOI)

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: B. Tech.-Electrical and Instrumentation Engineering
(For the Batches from 2020-2021 in phased manner)

(UTD Only)

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: B. Tech.-Electrical and Instrumentation Engineering
(For the Batches Admitted From 2020-2021)

VISION

Be globally acknowledged as a distinguished centre of academic excellence.

MISSION

To prepare a class of proficient scholars and professionals with ingrained human values and commitment to expand the frontiers of knowledge for the advancement of society.

DEPARTMENT VISION AND MISSION

VISION

- To become a model department as a Centre of quality education, research with innovation and recognition at National and International level for serving society.

MISSION

- **M1:** To provide quality education to aspiring young minds for improving their skills, inculcating values, creating leadership qualities and enhance research with innovative methods.
- **M2:** To produce young engineers capable to be utilized in the areas of New Technological Design, Environment, ethics and sustainable technologies.
- **M3:** To develop Teaching-Learning methods which can produce socially committed good professional human being who can contribute effectively in Nation building and represent Country Internationally.

Mapping of University Vision and Mission to Department Vision and Mission

Acclaimed as modal Centre of Learning and Research by

University Vision and Mission	**Department Vision and Mission**
High quality knowledge delivery through state of art infrastructure and ethical values to the students	**Yes**
Students excellence will makethem professionals and innovators emerging as global leaders	**Yes**
Research and development will help in furtherance of Faculty knowledge	**Yes**

Programme Educational Objectives (PEOs):

The Department of Instrumentation in consultation with various stakeholders have formulated the Programme Educational Objectives (PEO's) that are broad statements that describe the career and professional accomplishments that the program is preparing its graduates to achieve in few years, subsequent to receiving the degree. The PEO's of the B. Tech. programme in Electrical and Instrumentation Engineering are as follows:

- **PEO1:**The graduates will become competent by applying their technical and managerial skills.
- **PEO2:**The graduates will be able to adapt to any environment and succeed in higher positions in contemporary rapidly evolving technologies in Electrical and Instrumentation engineering field.
- **PEO3:**The graduates will engage themselves in the life-long learning by pursuing higher education and participation in research and development activitiesto meet all challengesto transform them as responsible citizens of the nation

Program Specific Outcomes (PSO’s):

- **PSO1:** Clearly understand the fundamental concepts of Electrical and Instrumentation Engineering
- **PSO2:** Graduates will be able to formulate and solve real life problems in the area of Electrical and Instrumentation Engineering
- **PSO3:** Graduate will possess the skills to communicate effectively in both oral and written forms, demonstrating the practice of professional ethics, and responsive to societal and environmental needs.

PEOs to Mission statement mapping

PEO’s	MISSION OF THE DEPARTMENT		
	M1	**M2**	**M3**
PEO1	3	3	1
PEO2	2	3	2
PEO3	2	2	3

Program Outcomes (PO) with Graduate Attributes

Programme Outcomes are attributes of the graduates from the programme that are indicative of the graduates' ability and competence to work as an engineering professional upon graduation. Program Outcomes are statements that describe what students are expected to know or do by the time of graduation, they must relate to knowledge and skills that the students acquire from the programme. The achievement of all outcomes indicates that the student is well prepared to achieve the program educational objectives down the road. The Department of Instrumentation engineering has following twelve PO's. The course syllabi and the overall curriculum are designed to achieve these outcomes:

S. No	Graduate Attributes	Program Outcomes (POs)
1	Engineering Knowledge	**PO1:** Able to understand the fundamentals of mathematics, science, Electrical and Instrumentation Engineering and apply them to provide solution of complex engineering problems.
2	Problem Analysis	**PO2:** Ability to analyze, identify, formulate and solve engineering problems in Electrical and Instrumentation Engineering using basic fundamental principles of mathematics and science.
3	Design and Development of Solutions	**PO3:** Design a system, component or process to meet the desired needs and standards within realistic constraints such as public health and safety, social and environmental considerations.
4	Investigation of Problem	**PO4:** Design and conduct experiments, as well as do research, analyze and interpret data and give clear solutions.
5	Modern Tool usage	**PO5:** Use and learn the recent techniques, skills and modern engineering and IT tools necessary for engineering practicewith an understanding of the limitations.
6	Engineer and society	**PO6**: To give basic knowledge of social, economic, safety and cultural issues relevant to professional engineering.
7	Environment and sustainability	**PO7:** To impart knowledge related to the design and development of modern systems which are environmentally sensitive and to understand the importance of sustainable development.
8	Ethics	**PO8:** Apply ethical principles and professional responsibilities in engineering practice.
9	Individual & team work	**PO9:** Ability to visualize and function as an individual and as a member in a team of a multi-disciplinary environment.
10	Communication	**PO10:** Ability to communicate effectively on complex engineering ideas to the engineering community & the society at large. (i.e. being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions)
11	Lifelong learning	**PO11:** To impart education to learn and to engage in independent and life – long learning in the technological change.
12	Project management and finance	**PO12:** Ability to handle administrative responsibilities, manage projects & handle finance related issues in a multidisciplinary environment.

Mapping of PEO's with PO's

S. No.	*Program Educational Objectives*	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	The graduates will become competent by applying their technical and managerial skills.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2	The graduates will be able to adapt to any environment and succeed in higher positions in contemporary rapidly evolving technologies in Electrical and Instrumentation engineering field.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3	The graduates will engage themselves in the life-long learning by pursuing higher education and participation in research and development activities to meet all challenges to transform them as responsible citizens of the nation			√	√		√	√	√	√		√	√	√	√	√

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: B. Tech.-Electrical and Instrumentation Engineering
Undergraduate Degree Program

General, Course structure & Theme & Semester-wise credit distribution

A. Definition of Credit:

1 Hour Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit
1 Hour Practical (P) per week and/or 2 Hours Practical(Lab)/week	0.5 credits 1 credit

B. Total credits:

Total credits for a student to be eligible to get Under Graduate degree in Engineering are 174.0 credits. A student will be eligible to get Under Graduate degree with Honors' or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

C. Structure of Undergraduate Engineering program:

S. No.	Category	Breakup of Credits (Total 174.0)
1	**Humanities, Social Sciences and Management Courses**	**07.0**
2	**Basic Science Courses**	**17.0**
3	**Engineering Science Courses** including workshop, drawing, basics of Electrical/ Mechanical/ Computer etc.	**17.0**
4	**Professional Core Courses**	**83.0**
5	**Program Elective Courses** relevant to the branch	**18.5**
6	**Open Elective Courses**: Electives from other technical and /or emerging subjects	**22.5**
7	**Project work**, Seminar and Internship in Industry etc.	**09.0**
8	**Mandatory Courses:** [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge].	**(non-credit)**
	Total	**174.0**

D. Course code and definition:

Category of Course/ Code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credit
CIE	Continuous Internal Evaluation
SEE	Semester End Examination

BS	Basic Science Courses
ES	Engineering Science Courses
HSM	Humanities, Social Sciences and Management Courses
EI	Electrical and Instrumentation Engineering
PC	Professional core courses
PE	Professional Elective courses
OE	Open Elective courses
PRBS/ PRPC/ PRES/PRPE/ PROE/ PRHSM	Practical Basic Science/Professional Core/ Engineering Science/ Program Elective/ Open Elective/Humanities, Social Sciences and Management Courses
MC	Mandatory courses
PROJ	Project

E. Details of Structure and distribution of credits to various courses:

S. No	Category	Course No.	Course Title	C	Teaching Schedule			
					L	T	P	Cont. Hrs.
			Humanities, Social Sciences and Management Courses					
1	**HSM**	**EI-HSM-107**	English	2.0	2	-	-	2
2	**PRHSM**	**EI-PRHSM-07**	Language Lab	1.0	-	-	2	2
3	**HSM**	**EI-HSM-211**	Basics of Industrial Sociology, Economics and Management	2.0	2	0		2
4	**HSM**	**EI-HSM-212**	Project Planning Estimation and Assessment	2.0	2	0		2
			Total	**7.0**	**6**	**0**	**2**	**8**
			Basic Science Courses					
1	**BS**	**EI-BS-101**	Physics	4.0	3	1	-	4
2	**PRBS**	**EI-PRBS-01**	Physics Lab	1.5	-	-	3	3
3	**BS**	**EI-BS-103**	Mathematics-I	3.0	2	1	-	3
4	**BS**	**EI-BS-102**	Chemistry	4.0	3	1		4
5	**PRBS**	**EI-PRBS-02**	Chemistry Lab	1.5			3	3
6	**BS**	**EI-BS-104**	Mathematics-II	3.0	2	1		3
			Total	**17.0**	**10**	**4**	**6**	**20**
			Engineering Science Courses					
1	**ES**	**EI-ES-105**	Basic Electrical Engineering	4.0	3	1	-	4
2	**PRES**	**EI-PRES-03**	Engineering Drawing lab	1.5	-	-	3	3
3	**PRES**	**EI-PRES-05**	Basic Electrical Lab	1.0	-	-	2	2
4	**ES**	**EI-ES-106**	Programming for Problem Solving	4.0	3	1		4
5	**ES**	**EI-ES-108**	Basic Electronics Engineering	3.0	2	1		3
6	**PRES**	**EI-PRES-04**	Computer programming Lab	1.5	-	-	3	3
7	**PRES**	**EI-PRES-06**	Basic Electronic lab	1.0	-	-	2	2
8	**PRES**	**EI-PRES-08**	Workshop Practice Lab.	1.0	-	-	2	2

			Total	**17.0**	**8**	**3**	**12**	**23**
Professional Core Courses								
1	**PC**	**EI-PC-201**	Power Systems -I	3.0	2	1	--	3
2	**PC**	**EI-PC-203**	Basic Instrumentation Engineering	3.0	2	1		3
3	**PC**	**EI-PC-205**	Network Analysis	3.0	2	1		3
4	**PC**	**EI-PC-207**	Transducers and Applications	3.0	2	1		3
5	**PRPC**	**EI-PRPC-09**	Network Analysis Lab	1.0	--	--	2	2
6	**PRPC**	**EI-PRPC-11**	Transducers lab	1.5	--	--	3	3
7	**PRPC**	**EI-PRPC-15**	Power System-I Lab	1.0			2	2
8	**PC**	**EI-PC-202**	Power Electronics-I	4.0	3	1	--	4
9	**PC**	**EI-PC-204**	Electrical Measurements & Instrumentation	4.0	3	1	--	4
10	**PC**	**EI-PC-208**	Electrical Machines-I	4.0	3	1	--	4
11	**PRPC**	**EI-PRPC-10**	Power Electronics-I Lab	1.0	--		2	2
12	**PRPC**	**EI-PRPC-12**	Electrical Measurements & Instrumentation Lab	1.0	--		2	2
13	**PRPC**	**EI-PRPC-16**	Electrical Machines –I lab	1.5	--		3	3
14	**PC**	**EI-PC-303**	Power Electronics-II	4.0	3	1	--	4
15	**PC**	**EI-PC-307**	Power System- II	4.0	3	1	--	4
16	**PC**	**EI-PC-309**	Linear Automatic Control System	4.0	3	1	--	4
17	**PRPC**	**EI-PRPC-17**	Power Electronic Lab-II	1.5	--	--	3	3
18	**PRPC**	**EI-PRPC-19**	Power System Lab- II	1.5	--	--	3	3
19	**PRPC**	**EI-PRPC-23**	Control System Lab	1.5	--	--	3	3
20	**PRPC**	**EI-PRPC-25**	Industrial Training-I	**			$1^{\$}$	1
21	**PC**	**EI-PC-304**	Electrical Machines-II	4.0	3	1	--	4
22	**PC**	**EI-PC-306**	Power Plant Engineering	3.0	2	1	--	3
23	**PC**	**EI-PC-308**	Digital Signal Processing	4.0	3	1	--	4
24	**PRPC**	**EI-PC-310**	Microcontroller & Embedded System	4.0	3	1	--	4
25	**PRPC**	**EI-PRPC-18**	Electrical Machines Lab-II	1.5	--	--	3	3
26	**PRPC**	**EI-PRPC-20**	Micro-controller Lab	1.5	--	--	3	3
27	**PRPC**	**EI-PRPC-22**	Digital Signal Processing Lab	1.5	--	--	3	3
28	**PC**	**EI -PC-405**	Electric Drives	4.0	3	1	--	4
29	**PC**	**EI-PC-407**	Advance Process Dynamics and Control	4.0	3	1	--	4
30	**PRPC**	**EI-PRPC-27**	Electric Drives Lab	1.5	--	--	3	3
31	**PRPC**	**EI-PRPC-31**	Industrial Training-II	**			$1^{\$}$	$1^{\$}$
32	**PC**	**EI-PC-406**	Industrial Process Control	4.0	3	1	--	4
33	**PRPC**	**EI-PRPC-24**	Process Control Lab	1.5	--	--	3	3
34	**PRPC**	**EI-PRPC-28**	Seminar	1.0	--	--	2	2
			Total	**83**	**46**	**17**	**42**	**105**

Program Elective Courses								
1	**PE**	**EI-PE-206**	Program Elective- I	3.0	2	1	--	3
			i. Control System Components					
			ii. Electrical Energy Conservation and Auditing					
2	**PE**	**EI-PE-305**	Program Elective- II	4.0	3	1	--	4
			i. Microprocessors					
			ii. Analog and Digital Communication					
			iii. Switch Gear and Protection					
3	**PRPE**	**EI-PRPE-21**	Program Elective- II Lab	1.5	--	--	3	3
			i. Microprocessors					
			ii. Analog and Digital Communication					
			iii. Switch Gear and Protection					
4	**PE**	**EI-PE-302**	Program Elective-III	3.0	2	1	--	3
			i. Electrical Machine Design					
			ii. Mechanical Measurements in Instrumentation					
			iii. Electrical and Hybrid Vehicles					
5	**PE**	**EI -PE-403**	Program Elective- IV	3.0	2	1	--	3
			i. Biomedical Instrumentation					
			ii. Reliability Engineering					
			iii. Wind and Solar Energy Systems					
			iv. Power Quality and FACTS					
6	**PE**	**EI-PE-404**	Program Elective- V	4.0	3	1	--	4
			i. Utilization of Electrical Energy					
			ii. Instrumentation and System Design					
			iii. Fuzzy Logic Control					
			iv. Optical Instrumentation					
			v. Remote Sensing					
			Total	**18.5**	**12**	**5**	**3**	**20**
Open Elective Courses								
1	**OE**	**EI-OE-209**	Open Elective-I	3.0	2	1		3
			i. Linear Integrated Circuits					
			ii. Computer Networks					
2	**PROE**	**EI-PROE-13**	Open Elective- I Lab	1.5	--	--	3	3
			i. Linear Integrated Circuits					
			ii. Computer Networks					
3	**OE**	**EI-OE-210**	Open Elective-II	3.0	2	1	--	3
			i. Digital Techniques					

			ii. Computer Organization					
4	**PROE**	**EI-PROE-14**	Open Elective- II Lab	1.0	--		2	2
			i. Digital Techniques					
			ii. Computer Organization					
5	**OE**	**EI-OE-301**	Open Elective- III	4.0	3	1	--	4
			i. Environment Monitoring Instrumentation					
			ii. Electromagnetic Field Theory					
			iii. Mathematics-III					
			iv. Energy Efficient Systems					
6	**OE**	**EI-OE-401**	Open Elective- IV	4.0	3	1	--	4
			i. Computer Graphics & CAD CAM					
			ii. IoT and IT'S APPLICATIONS					
			iii. Introduction to Python Programming					
7	**PROE**	**EI-PROE-29**	Open Elective- IV lab	1.5	--	--	3	3
			i. Computer Graphics & CAD CAM					
			ii. IoT and IT'S APPLICATIONS					
			iii. Introduction to Python Programming					
8	**OE**	**EI-OE-402**	Open Elective- V	3.0	2	1	--	3
			i. Artificial Intelligence					
			ii. Robotics					
			iii. High Voltage Engineering					
9	**PROE**	**EI-PROE-26**	Open Elective- V Lab	1.5	--	--	3	3
			i. Artificial Intelligence					
			ii. Robotics					
			iii. High Voltage Engineering					
			Total	**22.5**	**12**	**5**	**11**	**28**
Project Work								
1	**PROJ**	**EI-PROJ-02**	Minor Project	3.0	--	--	6	6
2	**PROJ**	**EI-PROJ-01**	Case Study (Project Work)	2.0	--	--	4	4
3	**PROJ**	**EI-PROJ-04**	Major Project	4.0	--	--	8	8
			Total	**9.0**			**18**	**18**
Mandatory Courses								
1	**MC**	**EI-MC-112**	Environmental Science	**--**	**3**	**0**		**3**

Detailed First Year Curriculum Contents

B. Tech Electrical and Instrumentation Engineering

SCHEME OF EXAMINATIONS

B. Tech. 1st YEAR (SEMESTER–I) (w.e.f. 2020-21)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-BS-101	Physics	4	3	1	-	4	40	60	100	3 Hrs
EI-BS-103	Mathematics-I	3	2	1	-	3	40	60	100	3 Hrs
EI-ES-105	Basic Electrical Engineering	4	3	1	-	4	40	60	100	3 Hrs
EI-HSM-107	English	2	2	-	-	2	40	60	100	3 Hrs
EI-PRBS-01	Physics Lab	1.5	-	-	3	3	30	45	75	3 Hrs
EI-PRES-03	Engineering Graphics and Design lab	1.5	-	-	3	3	40	60	100	3 Hrs
EI-PRES-05	Basic Electrical Lab	1	-	-	2	2	20	30	50	3 Hrs
EI-PRHSM-07	Language Lab	1	-	-	2	2	--	--	--	--
	Total	**18**	**10**	**3**	**10**	**23**	**250**	**375**	**625**	

B.Tech. 1stYEAR (SEMESTER–II) (w.e.f.2020-21)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-BS-102	Chemistry	4	3	1		4	40	60	100	3 Hrs
EI-BS-104	Mathematics-II	3	2	1		3	40	60	100	3 Hrs
EI-ES-106	Programming for Problem Solving	4	3	1		4	40	60	100	3 Hrs
EI-ES-108	Basic Electronics Engineering	3	2	1		3	40	60	100	3 Hrs
EI-MC-112	Environmental Science	**	3	0		3	40**	60**	100**	3 Hrs
EI-PRBS-02	Chemistry Lab	1.5			3	3	30	45	75	3 Hrs
EI-PRES-04	Computer programming Lab	1.5	-	-	3	3	30	45	75	3 Hrs
EI-PRES-06	Basic Electronic lab	1	-	-	2	2	20	30	50	3 Hrs
EI-PRES-08	Workshop Practice Lab.	1	-	-	2	2	20	30	50	3 Hrs
	Total	**19**	**13**	**4**	**10**	**27**	**260**	**390**	**650**	

** Industrial training is noncredit, audit pass course which will not counted towards marks/grade calculations

B. Tech Electrical and Instrumentation Engineering

SCHEME OF EXAMINATIONS

B. Tech. 2nd YEAR (SEMESTER–III) (w.e.f. 2021-22)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-PC-201	Power Systems-I	3	2	1	--	3	40	60	100	3 Hrs
EI-PC-203	Basic Instrumentation Engineering	3	2	1		3	40	60	100	3 Hrs
EI-PC-205	Network Analysis	3	2	1		3	40	60	100	3 Hrs
EI-PC-207	Transducers and Applications	3	2	1		3	40	60	100	3 Hrs
EI-OE-209	**Open Elective-I**	3	2	1		3	40	60	100	3 Hrs
EI-HSM-211	Basics of Industrial Sociology, Economics and Management	2	2	0		2	40	60	100	3 Hrs
EI-PRPC-09	Network Analysis Lab	1	--	--	2	2	20	30	50	3 Hrs
EI-PRPC-11	Transducers lab	1.5	--	--	3	3	20	30	50	3 Hrs
EI-PROE-13	**Open Elective- I Lab**	1.5	--	--	3	3	20	30	50	3 Hrs
EI-PRPC-15	Power System-I Lab	1			2	2	20	30	50	3 Hrs
	Total	**22**	**12**	**5**	**10**	**27**	**320**	**480**	**800**	

Open Elective –I	
i.	Linear Integrated Circuits
ii.	Computer Networks

B.Tech. 2nd YEAR (SEMESTER–IV) (w.e.f. 2021-22)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-PC-202	Power Electronics-I	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-204	Electrical Measurements & Instrumentation	4	3	1	--	4	40	60	100	3 Hrs
EI-PE-206	**Program Elective- I**	3	2	1	--	3	40	60	100	3 Hrs
EI-PC-208	Electrical Machines-I	4	3	1	--	4	40	60	100	3 Hrs
EI-OE-210	**Open Elective-II**	3	2	1	--	3	40	60	100	3 Hrs
EI-HSM-212	Project Planning Estimation and Assessment	2	2	0		2	40	60	100	3Hrs
EI-PRPC-10	Power Electronics-I Lab	1	--		2	2	20	30	50	3 Hrs
EI-PRPC-12	Electrical Measurements & Instrumentation Lab	1	--		2	2	20	30	50	3 Hrs
EI-PROE-14	**Open Elective- II Lab**	1	--		2	2	20	30	50	3 Hrs
EI-PRPC-16	Electrical Machines –I lab	1.5	--		3	3	30	45	75	3 Hrs
	Total	**24.5**	**15**	**5**	**09**	**29**	**330**	**495**	**825**	

Program Elective- I		**Open Elective- II**	
i.	Control System Components	i.	Digital Techniques
ii.	Electrical Energy Conservation and Auditing	ii.	Computer Organization

B. Tech Electrical and Instrumentation Engineering
SCHEME OF EXAMINATIONS

B. Tech. 3rd YEAR (SEMESTER–V) (w.e.f. 2022-23)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-OE-301	**Open Elective- III**	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-303	Power Electronics-II	4	3	1	--	4	40	60	100	3 Hrs
EI-PE-305	**Program Elective- II**	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-307	Power System- II	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-309	Linear Automatic Control System	4	3	1	--	4	40	60	100	3 Hrs
EI-PRPC-17	Power Electronic Lab-II	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PRPC-19	Power System Lab- II	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PRPE-21	**Program Elective- II Lab**	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PRPC-23	Control System Lab	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PRPC-25	Industrial Training-I	**			1$	1	40**	60**	100**	
	Total	**26**	**15**	**5**	**13**	**33**	**320**	**480**	**800**	

$ Evaluation seminar for Industrial Training-I

** Industrial training is noncredit, audit pass course which will not counted towards marks/grade calculations

Open Elective- III	**Program Elective- II**
i. Environment Monitoring Instrumentation	i. Microprocessors
ii. Electromagnetic Field Theory	ii. Analog and Digital Communication
iii. Mathematics-III	iii. Switch Gear and Protection
iv. Energy Efficient Systems	

B. Tech. 3rd YEAR (SEMESTER–VI) (w.e.f. 2022-23)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-PE-302	**Program Elective-III**	3	2	1	--	3	40	60	100	3 Hrs
EI-PC-304	Electrical Machines-II	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-306	Power Plant Engineering	3	2	1	--	3	40	60	100	3 Hrs
EI-PC-308	Digital Signal Processing	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-310	Microcontroller & Embedded System	4	3	1	--	4	40	60	100	3 Hrs
EI-PRPC-18	Electrical Machines Lab-II	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PRPC-20	Micro-controller Lab	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PRPC-22	Digital Signal Processing Lab	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PROJ-02	Minor Project	3	--	--	6	6	50	100	150	3 Hrs
	Total	**25.5**	**13**	**5**	**15**	**33**	**340**	**535**	**875**	

Program Elective- III
i. Electrical Machine Design
ii. Mechanical Measurements in Instrumentation
iii. Electrical and Hybrid Vehicles

B. Tech Electrical and Instrumentation Engineering
SCHEME OF EXAMINATIONS

B. Tech. 4th YEAR (SEMESTER–VII) (w.e.f. 2023-24)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-OE-401	**Open Elective- IV**	4	3	1	--	4	40	60	100	3 Hrs
EI -PE-403	**Program Elective- IV**	3	2	1	--	3	40	60	100	3 Hrs
EI -PC-405	Electric Drives	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-407	Advance Process Dynamics and Control	4	3	1	--	4	40	60	100	3 Hrs
EI-PRPC-27	Electric Drives Lab	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PROE-29	**Open Elective- IV lab**	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PROJ-01	Case Study (Project Work)	2	--	--	4	4	40	60	100	3 Hrs
EI-PRPC-31	Industrial Training-II	**			1$	1$	40**	60**	100**	3 Hrs
	Total	**20**	**11**	**4**	**11**	**26**	**260**	**390**	**650**	

$ Evaluation seminar for Industrial Training-I

** Industrial training is noncredit, audit pass course which will not counted towards marks/grade calculations

Open Elective- IV	Program Elective- IV
i. Computer Graphics & CAD CAM	i. Biomedical Instrumentation
ii. IoT and IT'S APPLICATIONS	ii. Reliability Engineering
iii. Introduction to Python Programming	iii. Wind and Solar Energy Systems
	iv. Power Quality and FACTS

B. Tech. 4th YEAR (SEMESTER–VIII) (w.e.f. 2023-24)

Course No.	Course Title	C	Teaching Schedule				Allotment of marks			Exam Duration in Hrs.
			L	T	P	Cont. Hrs.	CIE	SEE	Total	
EI-OE-402	**Open Elective- V**	3	2	1	--	3	40	60	100	3 Hrs
EI-PE-404	**Program Elective- V**	4	3	1	--	4	40	60	100	3 Hrs
EI-PC-406	Industrial Process Control	4	3	1	--	4	40	60	100	3 Hrs
EI-PRPC-24	Process Control Lab	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PROE-26	**Open Elective- V Lab**	1.5	--	--	3	3	30	45	75	3 Hrs
EI-PRPC-28	Seminar	1.0	--	--	2	2	20	30	50	3 Hrs
EI-PROJ-04	Major Project	4	--	--	8	8	40	60	100	3 Hrs
	Total	**19**	**8**	**3**	**16**	**27**	**240**	**360**	**600**	

Open Elective V	Program Elective V
i. Artificial Intelligence	i. Utilization of Electrical Energy
ii. Robotics	ii. Instrumentation and System Design
iii. High Voltage Engineering	iii. Fuzzy Logic Control
	iv. Optical Instrumentation
	v. Remote Sensing

APPENDIX A

Outcome Based Education

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

There are three educational Outcomes as defined by the National Board of Accreditation:
Program Educational Objectives: The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

Mapping of Outcomes

COURSE OUTCOME
↓
PROGGRAM OUTCOME
↓
PROGRAM EDUCATIONAL OBJECTIVES
↓
DEPARTMENTAL MISSION
↓
DEPARTMENTAL VISION

APPENDIX B

The Graduate Attributes of NBA

Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Conduct investigations of complex problems: The problems that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline.
* That may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions. Hat require consideration of appropriate constraints/requirements not explicitly given in the problem statement (like: cost, power requirement, durability, product life, etc.) which need to be defined (modeled) within appropriate mathematical framework that often require use of modern computational concepts and tools.#

Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

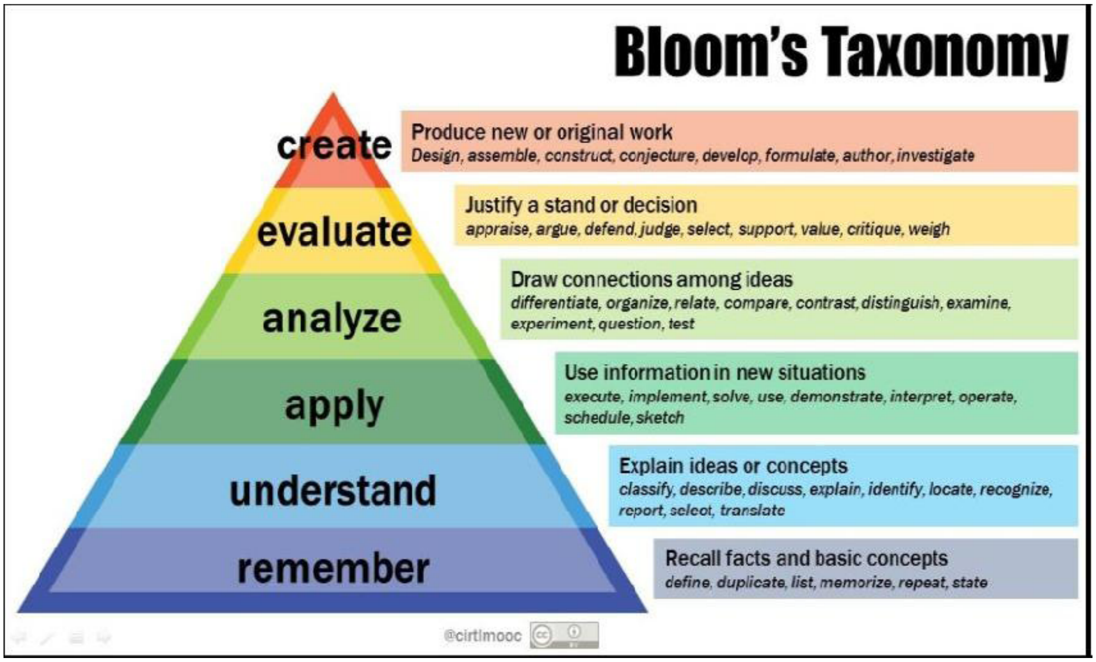
Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

APPENDIX C

BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of **assessments** (tests and other evaluations of student learning), **curriculum** (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies. **[eduglosarry.org]**



B. Tech Electrical and Instrumentation Engineering
SYLLABI OF EXAMINATIONS
B. Tech 1st Year (2020-21)

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-BS-101</td><td colspan="2" rowspan="2">Course Name: Physics</td><td>L</td><td>T</td><td>P</td><td colspan="2">C</td></tr>
<tr><td></td><td>3</td><td>1</td><td>-</td><td colspan="2">4</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
1st Semester</td><td colspan="6">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="6">Evaluation</td></tr>
<tr><td colspan="3">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td colspan="8">1. It aims to equip the students with basic concepts of physics principles.</td></tr>
<tr><td colspan="8">2. To provide adequate knowledge about tools at an intermediate to advanced level.</td></tr>
<tr><td colspan="8">3. To provide students to serve them well towards tackling more advanced level of physical problems.</td></tr>
<tr><td colspan="8">4. To provide knowledge and applications that they would find useful in their core subjects</td></tr>
<tr><td colspan="8">5. To provide knowledge about different applications of optics, EM-theory, solid state electronics etc.</td></tr>
<tr><td colspan="8">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="7">Understand the applications of Optics</td></tr>
<tr><td>CO2</td><td colspan="7">Understand components of a laser system and their applications</td></tr>
<tr><td>CO3</td><td colspan="7">Understand significance and normalization of wavefunction, Schrodinger wave equation</td></tr>
<tr><td>CO4</td><td colspan="7">Understand Classification of solids on the basis of band theory and how to measure conductivity by Hall measurements</td></tr>
<tr><td>CO5</td><td colspan="7">Understand Electro and magneto statics, Maxwell's equations</td></tr>
<tr><td>CO6</td><td colspan="7">Apply LASER and Optical fiber for various physical parameter measurements.</td></tr>
<tr><td>Module No</td><td colspan="5">COURSE SYLLABUS
CONTENTS OF MODULE</td><td>Hrs</td><td>CO'S</td></tr>
<tr><td>1</td><td colspan="5">Electrostatics and Magnetostatics: Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential, Electrostatic field and charge density. electrostatics problems in presence of dielectrics. Differential and integral calculus: Concept of gradient, operator, divergence and curl Line, surface and volume integrals, Gauss –Divergence theorem, Stokes theorem, Equation of continuity, Divergence of magnetic induction, Biot savarts law. Magnetic vector potential, Amperes circuital law, Faraday's law of electromagnetic induction, the basic equations of electromagnetism, generalization of amperes law, Maxwell's equations. Energy in an electromagnetic field; Flow of energy and Poynting vector with examples.</td><td>8</td><td>CO5</td></tr>
<tr><td>2</td><td colspan="5">PHYSICAL OPTICS: Interference: Division of wave front-Fresnel's biprism, Division of amplitude–Newton's rings, Michelson interferometer, applications. Diffraction: Difference between Fraunhofer and Fresnel diffraction. Fraunhofer diffraction through a slit. Plane transmission diffraction grating, its dispersive and resolving powers. Polarization, quarter wave plate, half wave plate, Nicol prism, Polarimeter</td><td>8</td><td>CO1</td></tr>
<tr><td>3</td><td colspan="5">Wave nature of particles, Solid state electronics and Semiconductor conductivity: Wave nature of Particles, Time-dependent and time-independent Schrodinger equation for wavefunction, Expectation</td><td>9</td><td>CO3
CO4</td></tr>
</table>

	values, Free-particle wavefunction and wave-packets, Uncertainty principle. Free electron theory, Band theory of solids, Classification of solids on the basis of band theory, Fermi-Dirac probability function, Position of Fermi level in intrinsic Temperature variation of carrier concentration in extrinsic semiconductors. Electron and hole concentrations in intrinsic semiconductors, Intrinsic density, Intrinsic conductivity, Extrinsic conductivity, Law of mass action, Fermi level in extrinsic semiconductors, Electrical conduction in Extrinsic semiconductors, Diffusion length and mean life time, Hall Effect.		
4	**Dielectric and Magnetic materials:** Introduction, Nonpolar molecules, Polar molecules, Polar and nonpolar molecules in an electric field, Electric polarization of matter, Electric polarization vector, Electric field in dielectrics, Gauss's law in dielectrics, Relation between three electric vectors D, E and P, Effect of dielectric on capacitance. Magnetisation of matter (Origin of Magnetic Moment, Diamagnetism, Paramagnetism, Ferromagnetism, B, H, M), B-H curve.	**4**	**CO5**
5	**LASER:** Spontaneous and stimulated emissions, Laser action, characteristics of laser beam-concepts of coherence, He-Ne and semiconductor lasers (simple ideas), applications. **FIBRE OPTICS:** Propagation of light in fibres, numerical aperture, single mode and multi-mode fibres, dispersion, applications.	**7**	**CO1** **CO2** **CO6**

Text Books:

1. Perspectives of Modern Physics - Arthur Beiser (TMH), 2001
2. A Text Book of Optics – Brij Lal & Subramanyam, Chand & Co.1981
3. David Griffiths, Introduction to Electrodynamics, PHI 2004
4. Eisberg and Resnick, Introduction to Quantum Physics, AP, 1985
5. Ghatak, Optics, PHI, 1995
6. Introduction to Solid State Physics (VII Ed.) - Charles Kittel (John Wiley)., 2007

Suggested Reference Books:

1. Halliday and Resnick,Physics, 1981
2. W. Saslow, Electricity, magnetism andlight
3. O. Svelto, Principles of Lasers
4. Introduction to Solid State Physics (VII Ed.) - Charles Kittel (John Wiley)., 2007
5. Quantum Mechanics – Powell and Crasemann (Oxford & IBH)

Reference Books:

1. Classical Electrodynamics, By J D Jacson, Wiley Publishers, 1970
2. Solid State Physics – A. J. Dekkar. ; Mac Millan India Limited, 1981
3. Fundamentals of Magnetism- B. Cullity – Addison-Wiley Publishing, 2008
4. Semiconductor devices, physics and technology, S. M. Sze Wiley, 1981
5. Introduction to solid state physics C. Kittel, Wiley, 20011

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks each.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-BS-103</td><td colspan="2" rowspan="2">Course Name: Mathematics-I</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>1st Year
Ist Semester</td><td colspan="5">Contact hours per week: (3 Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">The course requires prior knowledge of Differentiation, Integration and vector algebra.</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To apply Differentiation to geometric principles and expand functions into series.</td></tr>
<tr><td colspan="7">2. To understand Partial differentiation and apply to various mathematical situations.</td></tr>
<tr><td colspan="7">3. To gain knowledge on fundamentals of Multiple Integrals and their Applications.</td></tr>
<tr><td colspan="7">4. To explore how to differentiate and integrate Vectors. To provide good understanding of interrelation between vector differentiation and Integration through Basic Theorems.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Understand the Differentiation and Integration applications.</td></tr>
<tr><td>CO2</td><td colspan="6">Understand and solve Partial differentiation and Multiple integrals for various problems.</td></tr>
<tr><td>CO3</td><td colspan="6">Apply the knowledge of Differentiation to geometric principles and expand functions into series.</td></tr>
<tr><td>CO4</td><td colspan="6">Students should be able to use his knowledge of Vector analysis and relate it to fluid flows.</td></tr>
</table>

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Applications of Differentiation:** Taylor's & Maclaurin's series, Expansion by use of known series, Expansion by forming a differential equation, Asymptotes, Curvature, Tracing of Cartesian curves.	**6**	**CO1, CO2, CO3**
2	**Partial Differentiation & its Applications:** Euler's theorem, Jacobian, Errors and approximations, Maxima-minima	**6**	**CO1, CO2,**

	of functions of two variables, Lagrange's method of undetermined multipliers.		**CO3**
3	**Double Integral:** Change of order of integration Double integral in polar coordinates, Applications of double integral to find area enclosed by plane curves volume of solids of revolution. **Triple integral:** Volume of solids,	**6**	**CO1, CO2, CO3**
4	**Vector Calculus**: Differentiation of vectors: Gradient of a scalar field and directional derivative, divergence, and curl of a vector field, Del applied twice to point functions, Del applied to product of point functions. **Integration of vectors:** line integral, surface integral, volume integral, Green's, Stoke's and Gauss divergence theorems (without proof).	**6**	**CO1, CO2, CO3, CO4**

TEXT BOOKS:

1. Advanced Engineering Mathematics: E. Kreyszig. 10th Edition, John Wiley & sons,
2. Higher Engineering Mathematics: B.S. Grewal. 43rd Edition, Khanna Publications

REFERENCE BOOKS:

1. Engineering Mathematics Part-I: S.S. Sastry, 4th Edition, PHI.
2. Advanced Engineering Mathematics: R.K. Jain, S.R.K. Iyengar, 3rd Edition, Narosa Publications
3. Advanced Engineering Mathematics: Michael D. Greenberg, 2nd Edition, Pearson Publications.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-ES-105</td><td colspan="2" rowspan="2">Course Name: Basic Electrical Engineering</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>1st year
1st Semester</td><td colspan="5">Contact hours per week: (4Hrs)
Exam: (3hrs.)</td></tr>
<tr><td>Pre-requisite of</td><td>NIL</td><td colspan="5">Evaluation</td></tr>
</table>

course		CIE: 40	SEE: 60
Course Objectives:			
1. To study basics theory, laws and theorem of DC electrical networks.			
2. To study working of various electrical AC circuits, magnetic circuits and its parameters.			
3. To study the working theory of AC and DC electrical machines.			
4. To introduce the domestic wiring and earthing in electrical system.			
Course Outcomes: On completion of the course, student would be able to:			

CO1	To understand the basic concept of electrical circuits, electrical laws and network theorems.
CO2	To understand the basic components and working theory of DC and AC network.
CO3	To understand the parameters of electrical networks and equipments.
CO4	To understand the circuits and working of various electrical machines.
CO5	To impart basic technical knowledge of electrical wiring system and apply it to technological fields.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**DC Circuits:** Electrical circuit elements (Resistance, inductance and Capacitance), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.	7	CO1, CO2
2	**AC Circuits:** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, power factor improvement and its significance. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.3-phase power equation, measurement of three phase power by two wattmeter method.	7	CO1, CO2, CO3
3	**Transformers:** Magnetic materials, BH characteristics, working of ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.	7	CO3, CO4
4	**Electrical Rotating Machines:** Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Construction and working of Single-phase induction motor and torque-speed characteristic. Construction and working of DC machine and speed control of separately dc motor. Construction and working of synchronous generators.	8	CO3, CO4
5	**Electrical Installations:** Components of domestic wiring system, earthing system and its significance. Elementary calculations for energy consumption.	4	CO3, CO5

Suggested Text / Reference Books:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
3. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
4. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
5. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India,1989.
6. B.L. Theraja and A. K. Theraja,“Electrical Technology”,Vol-I, S.Chand.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-HSM-107</td><td colspan="3" rowspan="2">Course Name: English</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>-</td><td>-</td><td>2</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
1st Semester</td><td colspan="6">Contact hours per week: (2Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="6">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="4">SEE: 60</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td colspan="8">To make student understand the details of functional English.</td></tr>
<tr><td colspan="8">To make student learn the effective communication skills</td></tr>
<tr><td colspan="8">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="7">The student will acquire basic proficiency in English</td></tr>
<tr><td>CO2</td><td colspan="7">Writing and speaking skills</td></tr>
<tr><td>CO3</td><td colspan="7">Reading and listening skills</td></tr>
<tr><td>CO4</td><td colspan="7">Vocabulary enrichment</td></tr>
</table>

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Vocabulary Building:** The concept of Word Formation Root words from foreign languages and their use in English Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.	**3**	**CO1, CO2, CO3, CO4**

	Synonyms, antonyms, and standard abbreviations.		
2	**Basic Writing Skills:** Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely	**5**	**CO2**
3	**Identifying Common Errors in Writing:** Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés	**4**	**CO1**
4	**Nature and Style of sensible Writing:** Describing, Defining, Classifying, Providing examples or evidence, writing introduction and conclusion	**5**	**CO1, CO2**
5	**Writing Practices:** Comprehension, Précis Writing, Essay Writing	**3**	**CO1, CO2**
6	**Oral Communication** (This unit involves interactive practice sessions in Language Lab): Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations	**4**	**CO1, CO3**

Text Books:

1. Practical English Usage. Michael Swan. OUP.1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book.2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press.2006.
5. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press.2011.
6. ExercisesinSpokenEnglish.Parts.I-III.CIEFL,Hyderabad.OxfordUniversityPress

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRBS-01</td><td rowspan="2" colspan="3">Course Name: Physics Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>-</td><td>-</td><td>3</td><td>1.5</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
1st Semester</td><td colspan="6">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="6">Evaluation</td></tr>
<tr><td colspan="2">CIE: 30</td><td colspan="4">SEE: 45</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td colspan="8">1. Understand the applications of Optics</td></tr>
<tr><td colspan="8">2. Understand components of a laser system and their applications</td></tr>
<tr><td colspan="8">3. Understand to measure conductivity in semiconductors</td></tr>
<tr><td colspan="8">4. Understand basics of quantum principles</td></tr>
<tr><td colspan="8">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="7">Experiments in Optics/ principles</td></tr>
<tr><td>CO2</td><td colspan="7">Experiments in acoustics/ applications</td></tr>
<tr><td>CO3</td><td colspan="7">Experiments in Lasers/ optical principles</td></tr>
<tr><td>CO4</td><td colspan="7">Experiments in Magnetism/ applications</td></tr>
<tr><td>CO5</td><td colspan="7">Experiments in Semiconductor conductivity/ properties</td></tr>
</table>

<table>
<tr><td rowspan="2">Expt. No</td><td>COURSE SYLLABUS</td><td rowspan="2">COs</td></tr>
<tr><td>CONTENTS OF MODULE</td></tr>
<tr><td>1</td><td>Magnetic field from Helmholtz coil; To study the variation of magnetic field with distance and to find the radius of coil by Stewart and Gee's apparatus</td><td rowspan="19">CO1
CO2
CO3
CO4</td></tr>
<tr><td>2</td><td>To find the wavelength of sodium light by Newton’s rings experiment.</td></tr>
<tr><td>3</td><td>To find the wavelength of sodium light by Fresnel's biprism experiment.</td></tr>
<tr><td>4</td><td>To find the wavelength of various colours of white light with the help of a plane transmission diffraction grating.</td></tr>
<tr><td>5</td><td>To find the wavelength of sodium light by Michelson interferometer.</td></tr>
<tr><td>6</td><td>To find the resolving power of a telescope.</td></tr>
<tr><td>7</td><td>To find the specific rotation of sugar solution by using a polarimeter.</td></tr>
<tr><td>8</td><td>To compare the capacitances of two capacitors by Density bridge and hence to find the dielectric constant of a medium.</td></tr>
<tr><td>9</td><td>To find the frequency of A.C. mains by using sonometer.</td></tr>
<tr><td>10</td><td>To Find Value of high Resistance by substitution method</td></tr>
<tr><td>11</td><td>To Find the value of high resistance by leakage method</td></tr>
<tr><td>12</td><td>To Convert a galvanometer in to an Ammeter of given range.</td></tr>
<tr><td>13</td><td>To study laser beam characteristics, diffraction.</td></tr>
<tr><td>14</td><td>To find the value of e/m for electrons by Helical method, Measurement of Lorentz force in a vacuum tube.</td></tr>
<tr><td>15</td><td>To find the ionization potential of Mercury using a thyratron tube...</td></tr>
<tr><td>16</td><td>To find the value of Planck's constant by using a photo electric cell.</td></tr>
<tr><td>17</td><td>To find the value of Hall Co-efficient of semi-conductor.</td></tr>
<tr><td>18</td><td>To find the band gap of intrinsic semi-conductor using four probe method.</td></tr>
<tr><td>19</td><td>To calculate the hysteresis loss by tracing a B-H curve.</td></tr>
</table>

Text Books:

1. Advanced Practical Physics – B.L. Worshnop and H.T. Flint (KPH)
2. Practical Physics – S.L.Gupta &V.Kumar (Pragati Prakashan).
3. Advanced Practical Physics Vol.I& II – Chauhan &Singh (Pragati Prakashan).

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRES-03</td><td colspan="2" rowspan="2">Course Name: Engineering Graphics and Design lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>-</td><td>-</td><td>3</td><td>1.5</td></tr>
<tr><td>Year and Semester</td><td>1^{st} Yr.
1^{st} Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To make students understand about construction of various types of Curves and scales.</td></tr>
<tr><td colspan="7">2. To make students understand about orthographic projections of Point, Line, Plane and regular solids.</td></tr>
<tr><td colspan="7">3. To make students understand about sectional views and development of right regular solids</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">To learn about construction of various types of Curves and scales.</td></tr>
<tr><td>CO2</td><td colspan="6">To learn about orthographic projections of Point, Line and Plane</td></tr>
<tr><td>CO3</td><td colspan="6">To learn about orthographic projections of regular solids.</td></tr>
<tr><td>CO4</td><td colspan="6">To learn about sectional views and development of right regular solids</td></tr>
</table>

<table>
<tr><th>Module No</th><th>COURSE SYLLABUS
CONTENTS OF MODULE</th><th>COs</th></tr>
<tr><td>1</td><td>Introduction to Engineering Drawing covering: Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;</td><td rowspan="4">CO1, CO2, CO3, CO4</td></tr>
<tr><td>2</td><td>Orthographic Projections covering: Principles of Orthographic Projections-Conventions - Projections of Points and Projection of lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;</td></tr>
<tr><td>3</td><td>Projections of Regular Solids: those inclined to both the Planes- (Pyramid, Prism, Cone and Cylinder) Auxiliary Views. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.</td></tr>
<tr><td>4</td><td>Section of Solids: Sectional View of simple right regular solids, Development of Surfaces of right regular solids (Pyramid, Prism, Cone and Cylinder)</td></tr>
</table>

Suggested Text/Reference Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House

2. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMHPublication
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRES-05	**Course Name:** Basic Electrical Lab.	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Year and Semester	**1st Year** **1st Semester**	**Contact hours per week:** (2Hrs) **Exam:** (3hrs.)	
Pre-requisite of course	**Basic Science**	**Evaluation**	
		CIE: 20	**SEE: 30**

Course Objectives:

1. To study the different laws and theorems of electric networks.
2. To familiarize with different DC and AC electric networks
3. To study different electric equipments and their application.
4. Familiarize with the safety rules for electrical laboratory.

Course Outcomes: On completion of the course, student would be able to:

CO1	Impart the conceptual knowledge of electric circuit laws and network theorems and apply these to laboratory work.
CO2	Ability to analyze the performance of an electric circuits as well as handling of electric equipments.
CO3	Acknowledge the principles of operation and the main features of electric network and their applications.
CO4	Get an exposure to common electrical components and their ratings. Develop skills to use in different technological field.

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	To study and verify Kirchhoff's current law and Kirchhoff's voltage law.	**CO1** **CO2** **CO3** **CO4**
2	To study and verify Thevenin's theorem.	
3	To study and verify Norton's theorem.	
4	To study and verify Superposition theorem.	
5	To study and verify Maximum power transfer theorem.	
6	To study the operation of series RLC network and determine its parameters.	
7	To study the operation of parallel RLC network and determine its parameters.	
8	To study the characteristics of series RLC network under resonance condition and determine its resonance frequency from resonance curve.	
9	To study the characteristics of parallel RLC network under resonance condition and determine its resonance frequency from resonance curve.	
10	Perform three phase power measurement by using two wattmeter's method for balanced three phase load.	
11	To study the basic operation and equivalent circuit of a single-phase transformer.	
12	Perform Open Circuit & Short Circuit tests on single phase transformer.	
13	Perform Load test on single phase transformer.	
14	To study the characteristics of fluorescent lamps.	
15	To study the characteristics of tungsten filament lamps.	

Text/Reference Books:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRHSM-07</td><td rowspan="2" colspan="2">Course Name: Language Lab.</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>-</td><td>-</td><td>2</td><td>1</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
1st Semester</td><td colspan="5">Contact hours per week: (2Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Functional English</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 00</td><td colspan="3">SEE: 00</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Graduates will attain skills to conduct experiments/investigations and interpret data with reference to systems and standards</td></tr>
<tr><td colspan="7">2. Graduates will have ability to communicate effectively in written, oral and instrumentation formats to put forth solutions and prepare detailed engineering report in the process and automation industries.</td></tr>
<tr><td colspan="7">3. Graduates will be able to apply the knowledge, skill and attitude as a team player in initiating, executing and managing projects in the areas of design, manufacture, marketing and entrepreneurship in multi-disciplinary environments.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Imparting the role of communicative ability as one of the soft skills needed for placement</td></tr>
<tr><td>CO2</td><td colspan="6">Developing communicative ability and soft skills needed for placement</td></tr>
<tr><td>CO3</td><td colspan="6">Making students Industry-Ready through inculcating team-playing capacity</td></tr>
</table>

<table>
<tr><th>Expt. No</th><th>COURSE SYLLABUS
CONTENTS OF MODULE</th><th>COs</th></tr>
<tr><td>1</td><td>GRAMMAR IN COMMUNICATION: Grammar and Usage – Building Blocks, Homonyms, Subject and Verb Agreement, Error Correction - Grammar Application, Framing Questions – Question words, Verbal Questions, Tags, Giving Replies –Types of Sentences, Listening Comprehension –Listening and Ear training.</td><td rowspan="5">CO1, CO2, CO3</td></tr>
<tr><td>2</td><td>ASSERTIVE COMMUNICATION: Listening Comprehension in Cross–Cultural Ambience, Telephonic Conversations/Etiquette, Role Play Activities, Dramatizing Situations- Extempore – Idioms and Phrases</td></tr>
<tr><td>3</td><td>CORPORATE COMMUNICATION: Video Sensitizing, Communicative Courtesy – Interactions – Situational Conversations, Time Management, Stress Management Techniques, Verbal Reasoning, Current Affairs – E Mail Communication / Etiquette</td></tr>
<tr><td>4</td><td>PUBLIC SPEAKING: Giving Seminars and Presentations, Nuances of Addressing a Gathering - one to one/ one to a few/ one to many, Communication Process, Visual Aids & their Preparation, Accent Neutralization, Analyzing the Audience, Nonverbal Communication.</td></tr>
<tr><td>5</td><td>INTERVIEW & GD TECHNIQUES: Importance of Body Language –Gestures & Postures and Proxemics, Extempore, Facing the Interview Panel, Interview FAQs, Psychometric Tests and Stress Interviews, Introduction to GD, Mock GD Practices.</td></tr>
</table>

Text Books:

1. Bhatnagar R.P. & Rahul Bhargava, “English for Competitive Examinations”, Macmillian Publishers, India, 1989, ISBN: 9780333925591
2. Devadoss K. & Malathy P., “Career Skills for Engineers”, National Book Publishers, Chennai, 2013.
3. Aggarwal R.S., “A Modern Approach to Verbal & Non–Verbal Reasoning”, S.Chand Publishers, India, 2012, ISBN : 8121905516

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-BS-102</td><td colspan="2" rowspan="2">Course Name: Chemistry</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
2nd Semester</td><td colspan="5">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools.</td></tr>
<tr><td colspan="7">Technology is being increasingly based on the electronic, atomic and molecular level modifications.</td></tr>
<tr><td colspan="7">Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Analyze microscopic chemistry in terms of atomic and molecular orbitals and inter molecular forces.</td></tr>
<tr><td>CO2</td><td colspan="6">Apply the knowledge of conductance to explain various electrochemical phenomenon.</td></tr>
<tr><td>CO3</td><td colspan="6">Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques</td></tr>
<tr><td>CO4</td><td colspan="6">Rationalize bulk properties and processes using thermodynamic considerations.</td></tr>
<tr><td>CO5</td><td colspan="6">Rationalize periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.</td></tr>
<tr><td>CO6</td><td colspan="6">Distinguish between various stereoisomers.</td></tr>
</table>

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Atomic and molecular structure:** Schrodinger equation. Particle in a one-dimensional box solution and its applications for molecules. Molecular orbital theory and its applications to the formation of homonuclear (H_2, N_2) and heteronuclear diatomic molecules (NO, CO, CN) Energy level diagrams of diatomics. Pi (p)-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for $[Ni(CO)_4]$, $[Co(NH_3)_6]$, $[PtCl_2(NH_3)_2]$ and magnetic properties of transition metal complexes and their magnetic properties.	**10**	**CO1, CO2**

2	**Spectroscopic techniques and applications:** Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence spectroscopy and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI), surface characterization with Auger electron spectroscopy (AES), X-ray Photoelectron Spectroscopy (XPS) and Secondary Ion Mass Spectrometry (SIMS).	**10**	**CO3**
3	**Electrochemistry:** Conductance of electrolytic solutions, Transference number and its determination by Hittorf method and Moving boundary method, Kohlrausch's law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes. **Use of free energy in chemical equilibria:** Thermodynamic functions: Internal energy, enthalpy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, the Nernst equation and applications. pH, Acid-base, oxidation-reduction and solubility equilibria.	**10**	**CO4**
4	**Periodic properties:** Effective nuclear charge, penetration of orbitals, variations of *s*, *p*, *d* and *f* orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries of molecules: H_2O, NH_3, CCl_4, PCl_5, SF_6 and $Pt(NH_3)_2Cl_2$. **Stereochemistry:** Representations of 3-dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.	**8**	**CO4, CO5**

Text Books:

1. University chemistry, by B. H.Mahan
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
3. Fundamentals of Molecular Spectroscopy, by C. N.Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M.S. Krishnan
5. Physical Chemistry, by P. W. Atkins
6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-BS-104</td><td colspan="2" rowspan="2">Course Name: Mathematics-II</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>Ist Year
IInd Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">The course assumes prior knowledge of topics in Matrices, Differentiation, Partial Fractions, Partial Differentiation.</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To explore the Properties of Matrices.</td></tr>
<tr><td colspan="7">2. To know various basic Differential equations and solve them.</td></tr>
<tr><td colspan="7">3. To gain knowledge on Laplace transformations and ability to apply them in various problems</td></tr>
<tr><td colspan="7">4. To provide good understanding of Linear and non-linear Partial Differential equations.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Understand significance and Solve for different Matrix properties</td></tr>
<tr><td>CO2</td><td colspan="6">Differentiate between linear and non-linear differential equations and solve them.</td></tr>
<tr><td>CO3</td><td colspan="6">Understand and apply Laplace Transformations and use them to solve Differential equations.</td></tr>
<tr><td>CO4</td><td colspan="6">Differentiate between linear and non-linear partial differential equations, form them related to in hand problems and solve them.</td></tr>
</table>

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Matrices & its Applications:**, inverse using elementary transformations, consistency of linear system of equations, linear and orthogonal transformations, Eigen values and Eigen vectors, properties of Eigen values.	**6**	**CO1**
2	**Ordinary Differential Equations & its Applications:** Exact differential equations. Equations reducible to exact differential equations. **Linear differential equations of second and higher order**: complementary function and particular integral, method of variation of parameters to find particular Integral, Cauchy and Legendre linear differential equations, Simultaneous linear Differential equation with constant co-efficients.	**6**	**CO2**
3	**Laplace Transforms and its Applications:**Transforms of derivatives, transforms of integrals, multiplication by t^n, division by t. Evaluation of integrals by Laplace transforms. Laplace transform	**6**	**CO3**

	of Unit step function, unit impulse function and periodic function. **Inverse Laplace transforms**, convolution theorem, application to linear differential equations		
4	**Partial Differential Equations and Its Applications:** Formation of partial differential equations, Lagrange's linear partial differential equation, First order non-linear partial differential equation, Method of separation of variables and its applications.	**6**	**CO4**

TEXT BOOKS:

1. Advanced Engineering Mathematics: E. Kreyszig, 10th Edition, John Wiley & son
2. Higher Engineering Mathematics: B.S. Grewal. 43rd Edition, Khanna Publication

REFERENCE BOOKS:

1. Engineering Mathematics Part-I : S.S. Sastry, 4th Edition, PHI.
2. Advanced Engineering Mathematics: R.K. Jain, S.R.K. Iyengar, 3rd Edition, Narosa Publications
3. Advanced Engg. Mathematics: Michael D. Greenberg, 2nd Edition, Pearson Publications.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-ES-106</td><td rowspan="2" colspan="2">Course Name: Programming for Problem Solving</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Year and Semester</td><td colspan="2">1st Year
IInd Semester</td><td colspan="4">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2" colspan="2">NIL</td><td colspan="4">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="2">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To explain the problem solving concepts using a computer.</td></tr>
<tr><td colspan="7">2. To develop problem solutions for the computer by using problem solving tools.</td></tr>
</table>

3. To describe the Programming structure of C language.	
4. To convert an Algorithm, Pseudo code and Flowchart into a C program	
5. To find errors and execute a C program	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the fundamental concepts of computerhardware and number systems.
CO2	Apply the basic programming skills of C Language in problem solving.
CO3	Use different data types, decision structures, loops, arrays, strings and functions of C-programming to design a computer program.
CO4	Apply dynamic memory concepts with pointers.
CO5	Apply various algorithms in solving sorting problems.
CO6	Apply linear data structures like Stack, Queues and Trees in organizing and traversing data.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Generations and Classification of Computers** - Applications of Computers - Basic Organization of a Computer - Number system - Binary, Decimal, Octal and Hexadecimal – Problems **Introduction to C Language**: Algorithm, Flowchart, Pseudo-code solution to problem, Basic concepts of a C program, Declaration, Assignment & Print statement, Types of operators and expressions, Programming examples and exercise. **Branching and Looping:** Two-way selection (if, if- else, nested if-else, cascaded if-else), switch statement, ternary operator? Goto, Loops (For, do- while, while) in C, break and continue, programming examples and exercises.	**9**	**CO1, CO2, CO3**
2	**Functions:** User defined functions-function definition, function declaration,function call, Formal and actual parameters, Categories of functions, Passing parameters to functions- Pass by value, Pass by reference, Recursion- types of recursion, programming example s and exercises. **Arrays and Strings:** Arrays: Classification of arrays, Storing value in arrays, Using arrays with Functions- passing individual elements of array, passing the whole array, Multidimensional arrays-addition and multiplication of matrices, **Searching and Sorting**-Linear search, Binary search, Bubble sort, String: Declaring, Initializing, Printing and reading strings, String input and output functions, String handling functions, Arrays of strings, programming examples and Exercises.	**9**	**CO2, CO3, CO5**
3	**Structures and File Management**: Basics of structures-structure data types, type definition, accessing structures, Structure operations, Complex structures-nested structures, structures containing arrays, Array of structures, Structures and Functions, **File Management:** Creating a file, Declaring file pointer variable, Modes of a file, Opening and closing the files, Input and output operations, Programming examples and exercises.	**9**	**CO3, CO4**
4	**Pointers:** Pointers concepts, Pointers and functions, Arrays and	**9**	**CO4,**

	pointers, address arithmetic, Character pointer and functions, Pointers to pointer, Dynamic allocations methods- malloc(), calloc(), realloc(),free(), Array of pointers, **Introduction to Data Structures:** Primitive and non-primitive data types, Definition and applications of Stacks, Queues, Linked Lists and Trees		**CO6**

Text Books:

1. “The C ProgrammingLanguage”, BrianW. Kernighan and Dennis M. Ritchie, 2nd Edition, PHI, 2012.
2. "Problem Solving with C ", Jacqueline Jones &Keith Harrow, 1stEdition, Pearson2011.
3. “Let Us C” , by Yashavant Kanetkar, 5th Edition, BPB

Reference Books:

1. “Computer Concepts and C Programming”, Vikas Gupta, Dreamtech Press2013.
2. "Programming with C ", R. S. Bichkar, University Press,2012.
3. "Computer Programming in C ", V. Rajaraman, PHI, 2013.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-ES-108	**Course Name:** Basic Electronics Engineering		**L** 2	**T** 1	**P** -	**C** 3
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	EI-BS-101, Physics-I First Semester, Introduction to Solid State Physics	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To impart the basic concepts of Semi-Conductor Electronics.						
2. To lay the foundation to understand the various semi-conductor devices.						

3. To impart the basic concept of design and study of various circuits in Electronics.	
4. To lay the foundation for the advance courses in electronics.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the principles of semiconductor Physics and foundation of various semi-conductor devices.
CO2	Understand transistors as an amplifier and as a switch and various design parameter of an amplifier.
CO3	Know the concept of feedback in amplifier and oscillator and design of different oscillator.
CO4	Understand the constructional geometry of FET family and FET amplifier circuit with a view towards reduced power consumption.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Semiconductors p-type and n-type, pn junction diodes and energy band structure, pn junction as a circuit element and its characteristics, half wave and full wave rectifier circuits, basic filter circuits, clipper & clamper circuit. Zener diode and its applications as a voltage regulator. LED its characteristics construction & applications.	**6**	**CO1**
2	Transistor PNP and NPN- its fabrication and Characteristics in different configurations. Biasing in transistors, Concept of d.c. and a.c. load line and operating point selection. Transistor action as an amplifier and as a switch, Various amplifiers configurations, Design of amplifier and determination of parameters voltage gain current gain input resistance and output resistance & power gain.	**6**	**CO2**
3	Concept and need of feedback in amplifiers, Types of feedback in amplifiers, their effect on the amplifier parameters with their advantages and disadvantages, Cascading in amplifiers, Frequency response of RC Coupled amplifiers with explanation, Oscillators circuits and their types with explanation on their design difference, Multivibrators and their types, design and their applications.	**6**	**CO2** **CO3**
4	Field Effect Transistors, Constructions and their types, Characteristics of JFET, MOSFET their types and Various amplifier configurations using FET. Characteristics and Construction of SCR, TRIAC, UJT and their basic areas applications.	**6**	**CO4**

Reference Books:

1. Electronic Devices & Circuits - Boylstad & Nashelsky.
2. Integrated Electronics By Millman & Halkias.
3. Electronic Principles – Malvino
4. Principles of Electronics – V.K. Mehta, Shalu Melta.
5. Electronic Circuits – Donald L. Shilling & Charles Belowl

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-MC-112</td><td colspan="2" rowspan="2">Course Name: Environmental Science</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>-</td><td>-</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
2nd Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 40**</td><td colspan="4">SEE: 60**</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">To study concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.</td></tr>
<tr><td colspan="7">Study concepts and methods from ecological and physical sciences and their application in environmental problem solving.</td></tr>
<tr><td colspan="7">To study the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.</td></tr>
<tr><td colspan="7">To introduce roles and identities of citizens in a complex and interconnected world.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Understand key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.</td></tr>
<tr><td>CO2</td><td colspan="6">Appreciate concepts and methods from ecological and physical sciences and their application in environmental problem solving.</td></tr>
<tr><td>CO3</td><td colspan="6">Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.</td></tr>
<tr><td>CO4</td><td colspan="6">Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.</td></tr>
</table>

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	Cos
1	**The Multidisciplinary nature of environmental studies** Definition, scope and importance, Need for public awareness.	**3**	**CO1**
2	**Natural Renewable and non-renewable resources:** Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on	**6**	**CO1 CO2 CO3 CO4**

	forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. d) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. e) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources.		
3	**Ecosystems:** Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids,	**3**	**CO3**
4	**Biodiversity and its conservation:** • Introduction – Definition: genetic, species and ecosystem diversity. • Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. • Hot-spots of biodiversity. • Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. • Endangered and endemic species of India. • Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.	**4**	**CO4** **CO2**
5	**Environmental Pollution** Definition • Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards • Solid waste Management: Causes, effects and control measures of urban and industrial wastes. • Role of an individual in prevention of pollution. • Disaster management	**5**	**CO1** **CO2** **CO3** **CO4**
6	**Social Issues and the Environment** • From Unsustainable to Sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Resettlement and rehabilitation of people; its problems and concerns. Case studies. • Environmental ethics: Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. • Wasteland reclamation. • Consumerism and waste products. • Environment Protection Act.	**5**	**CO1** **CO2** **CO3** **CO4**

	• Air (Prevention and Control of Pollution) Act. • Water (Prevention and Control of Pollution) Act • Wildlife Protection Act • Forest Conservation Act • Issues involved in enforcement of environmental legislation • Public awareness.		
7	**Human Population and the Environment** • Population growth, variation among nations • Population explosion – Family Welfare Programme • Environment and human health. • Human Rights. • Value Education. • HIV/AIDS • Women and Child Welfare.		
8	**Field Work:** • Visit to a local area to document environmental assets-river / forest / grassland / hill / mountain. • Visit to a local polluted site–Urban/Rural / Industrial / Agricultural. • Study of common plants, insects, birds. • Study of simple ecosystems – pond, river, hill slopes, etc.		

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRBS-02	**Course Name:** Chemistry Lab		**L**	**T**	**P**	**C**
			-	**-**	**3**	**1.5**
Year and Semester	**1st Yr.** **2nd Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**NIL**	**Evaluation**				
		CIE: 30			**SEE: 45**	
Course Objectives:						

To teach the fundamentals of basic chemical sciences with hand on experience essential for the development of new technologies to Electrical and Instrumentation engineering.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Measuremolecular/system properties such as surfacetension,viscosity, conductance and pH of solutions, alkalinity, chloride content, dissolved oxygen, hardness of water,etc.
CO2	Identify the number of compounds in a mixture using TLC.
CO3	Synthesize a small drug molecule and polymer resin.
CO4	Determine the amount of solute in a solution using spectrophotometers.
CO5	Measure the kinematic viscosity, pour and cloud point of oil.

Expt. No	**COURSE SYLLABUS CONTENTS OF MODULE**	**COs**
1	To determine the relative viscosity of a given liquid using Ostwald viscometer.	
2	Using Redwood viscometer determine the viscosity of an oil sample.	
3	To determine the surface tension of a giving liquid using stalagmometer.	
4	To determine the alkalinity of a given water sample.	
5	To identify the number of components, present in a given organic mixture by Thin Layer Chromatography (TLC).	
6	Determination of strength of a given HCl solution by titrating it with a standardized NaOH solution using conductivity meter.	
7	To determine the strength of a given acid solution by titrating it with a base using pH meter.	
8	Synthesis of a drug (Aspirin/Paracetamol).	**CO1, CO2, CO3, CO4, CO5**
9	To prepare Phenol-formaldehyde and Urea formaldehyde resin.	
10	Determination of chloride content of a given water sample.	
11	To determine temporary and permanent hardness of a given water sample by EDTA method.	
12	Determination of the partition coefficient of a substance for its distribution between two immiscible solvents.	
13	To find out the content of sodium and potassium in a given salt solution by Flame Photometer.	
14	To verify Beer-Lambert law and determine the □max and concentration of unknown solution of KMnO4 using a spectrophotometer.	
15	To determine the amount of dissolved oxygen present in a given water sample.	
16	To find out the pour point and cloud point of a lubricating oil.	

SUGGESTED BOOKS:

1. A Text Book on Experimental and Calculation – Engineering Chemistry, S.S. Dara, S. Chand & Company (Ltd.)
2. Essential of Experimental Engineering Chemistry, Shashi Chawla, Dhanpat Rai Publishing Company.
3. Theory & Practice Applied Chemistry – O.P. Virmani, A.K. Narula (New Age)

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRES-04	**Course Name:** Computer Programming Lab		**L**	**T**	**P**	**C**
			0	**0**	**3**	**1.5**
Year and Semester	**1st Year IInd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		CIE: 30	**SEE: 45**			

Course Objectives:

1. To write C programs to solve the problems
2. To compile and execute programs in C
3. To identify the syntax errors and semantic errors
4. To debug the program in C
5. To write C programs to solve the problems

Course Outcomes: On completion of the course, student would be able to:

CO1	Use flowcharts to solve computational problems.
CO2	Create and develop algorithms with arithmetic and logical operators.
CO3	Analyse and implement an algorithm with data types, decision structures, loops, arrays, strings and functions.
CO4	Design and develop algorithms using predefined or user-defined functions to solve problems on sorting, searching and file processing.

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	Write a C program to compute roots of quadratic equation $ax^2+bx+c=0$, where a, b, and c are three coefficients of a quadratic equation are inputs.	
2	Design and develop an algorithm to find the *reverse* of an integer number.	
3	Design and develop an algorithm to check whether given number is PALINDROME or NOT, Implement a C program for the developed algorithm that takes an integer number as input and output the reverse of the same with suitable messages. Ex: Num: 2019, Reverse: 9102, Not a Palindrome.	
4	Design and develop a c program to implement simple calculator using switch case statement.	
5	Draw the flowchart and Write a C Program to compute Sin(x) using Taylor series approximation given by $\mathrm{Sin}(x) = x - (x^3/3!) + (x^5/5!) - (x^7/7!) + \ldots\ldots$	**CO1, CO2, CO3, CO4**
6	Develop, implement and execute a C program to search a Number in a list using *linear searching* Technique.	
7	Develop an algorithm, implement and execute a C program that reads *N* integer numbers and arrange them in ascending order using *Bubble Sort*.	
8	Design and develop a C program to read and print a matrix and check whether a given Matrix is a sparse Matrix or not.	
9	Write and execute a C program to display Pascal Triangle using for loop.	
10	Write a C program to implements the following string manipulation functions till the use wishes to continue (infinite loop): (i) *strcpy*() (ii) srrlen() (iii) strrev () (iv) strcmp() (v) strcat(). Read a sentence and print frequency of vowels and total count of consonants.	
11	Design and develop a C function *RightRotate (x, n)* that takes two integers *x*	

	and *n* as input and returns value of the integer *x* rotated to the right by *n* positions. Assume the integers are unsigned.	
12	Draw the flowchart and write a *recursive* C function to find the factorial of a number, *n*!, define by *fact*(*n*)=1, if *n*=0. Otherwise *fact* (*n*) =*n***fact* (*n*-1). Using this function, write a C program to compute the binomial coefficient $^{n}C_{r}$. Tabulate the results for different values of *n* and *r* with suitable messages	
13	Given two university information files such as "studentname.txt" and "usn.txt" that contains students Name and USN respectively. Write a C program to create a new file called "output.txt" and copy the content of files "studentname.txt" and "usn.txt" into output file in the sequence shown below. Display the contents of output file "output.txt" on to the screen. Student Name USN Name 1 USN1 Name 2 USN2…. ….	
14	**a.** Write a C program to maintain a record of n student details using an array of structures with four fields (Roll number, Name, Marks, and Grade). Assume appropriate data type for each field. Input & Print the members of the structure **b.** Write a C program to take 2 structures HH:MM: SS as T1 & T2 & display the time difference as structure as T3.	
15	Write a C program using pointers to compute the sum, mean and standard deviation of all elements stored in an array of n real numbers.	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRES-06	**Course Name:** Basic Electronic Lab.		**L**	**T**	**P**	**C**
			-	**-**	**2**	**1**
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week:** (2Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**NIL**	**Evaluation**				
		CIE: 20	**SEE: 30**			
Course Objectives:						
1. Ability to identify the basic electronic components.						
2. Ability to work on the basic electronic equipments.						
3. Ability to get the electronic circuit concepts.						
4. Ability to design the basic circuit in electronics.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Well verse with the use of the electronic components and equipments.					
CO2	Well verse with the fundamentals and the parameters of components related to their fabrication and construction.					
CO3	Able to start with the basic design concepts circuits operations.					

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	Familiarization of the basic electronic components and electronic lab equipment's like Functional Generators, CRO, Power supplies, multimeters etc.	

2	Draw and study the forward and reverse characteristics of the PN Diode.	**CO1, CO2, CO3**
3	To draw and study the clipping circuits in various modes.	
4	To draw and study the clamping circuits in positive and negative mode.	
5	To draw and study the differentiating and integrating circuits.	
6	To draw and study the low pass and high pass filters.	
7	To design and study the half and full wave rectifier	
8	To design and study the effect of various filter circuits on rectifiers performance.	
9	To study the characteristics of pnp and npn transistors in CE mode and determine h parameters from characteristics.	
10	To study the characteristics of pnp and npn transistors in CB mode and determine h parameters from characteristics.	
11	To design and study the RC coupled CE amplifier and measure its voltage and current gain.	
12	To design and study Hartley oscillator.	
13	To design and study Phase shift oscillator.	
14	To measure the effect of negative feedback on amplifier in RC coupled current series mode.	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRES-08	**Course Name:** Workshop Practice Lab	**L**	**T**	**P**	**C**
		-	**-**	**2**	**1**
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week:** (2Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**NIL**	**Evaluation**			
		CIE: 20		**SEE: 30**	

Course Objectives:

1. Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.
2. Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
3. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
4. By assembling different components, they will be able to produce small devices of their interest.

Course Outcomes: On completion of the course, student would be able to:

CO1	To provide the basics of manufacturing processes
CO2	To provide working knowledge of lathe machines
CO3	To provide the study of measuring tools
CO4	To study the machine tools

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	**Lectures & videos: Detailed contents** **(i.)** Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods **(2 lectures)** **(ii.)** CNC machining, Additive manufacturing **(1lecture)** **(iii.)** Fitting operations & power tools **(1lecture)** **(iv.)** Plastic molding, glass cutting **(1lecture)** **(v.)** Metal casting **(1lecture)** **(vi.)** Welding (arc welding & gas welding), brazing **(1 lecture)**	**CO1, CO2, CO3, CO4**
2	To study different types of measuring tools used in metrology and determine least counts of Vernier calipers, micrometers and Vernier height gauges.	
3	To study different types of machine tools (lathe, shape or planer or slotter, milling, drilling machines)	
4	To prepare a job on a lathe involving facing, outside turning, taper turning, step turning, radius making and parting-off.	
5	To study different types of fitting tools and marking tools used in fitting practice.	
6	To prepare lay out on a metal sheet by making and prepare rectangular tray, pipe shaped components e.g. funnel.	
7	To prepare joints for welding suitable for butt welding and lap welding.	
8	To perform pipe welding.	
9	To study various types of carpentry tools and prepare simple types of at least two wooden joints.	
10	To prepare simple engineering components/ shapes by forging.	
11	To prepare mold and core assembly, to put metal in the mold and fettle the casting.	
12	To prepare horizontal surface/ vertical surface/ curved surface/ slots or V-grooves on a shaper/ planner.	
13	To prepare a job involving side and face milling on a milling machine.	

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited,Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition,2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education,2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4thedition, Prentice Hall India,1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Appendix –I

Detailed first year curriculum contents

Guide to Induction Program

1. Introduction

(Induction Program was discussed and approved for all colleges by AICTE in March 2017. It was discussed and accepted by the Council of IITs for all IITs in August 2016. It was originally proposed by a Committee of IIT Directors and accepted at the meeting of all IIT Directors in March 2016.[1]This guide has been prepared based on the Report of the Committee of IIT Directors and the experience gained through its pilot implementation in July 2016 as accepted by the Council of IITs. Purpose of this document is to help institutions in understanding the spirit of the accepted Induction Program and implementing it.)

Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work formational needs and beyond.

The graduating student must have knowledge and skills in the area of his study. However, he must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he would understand and fulfill his responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.

There is a mad rush for engineering today, without the student determining for himself his interests and his goals. This is a major factor in the current state of demotivation towards studies that exists among UG students.

The success of gaining admission into a desired institution but failure in getting the desired branch, with peer pressure generating its own problems, leads to a peer environment that is demotivating and corrosive. Start of hostel life without close parental supervision at the same time, further worsens it with also a poor daily routine.

To come out of this situation, a multi-pronged approach is needed. One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character.

2. Induction Program

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Precious little is done by most of the institutions, except for an orientation program lasting a couple of days.

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[1]A Committee of IIT Directors was setup in the 152nd Meeting of IIT Directors on 6th September 2015 at IIT Patna, on how to motivate undergraduate students at IITs towards studies, and to develop verbal ability. The Committee submitted its report on 19th January 2016. It was considered at the 153rd Meeting of all IIT Directors at IIT Mandi on 26 March 2016, and the accepted report came out on 31 March 2016. The Induction Program was an important recommendation, and its pilot was implemented by three IITs, namely, IIT(BHU), IIT Mandi and IIT Patna in July 2016. At the 50th meeting of the Council of IITs on 23 August 2016, recommendation on the Induction Program and the report of its pilot implementation were discussed and the program was accepted for all IITs.

We propose a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. Its purpose is to make the students feel comfortable in the in new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.[2]

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it. The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) IIT Gandhinagar was the first IIT to recognize and implement a special 5-week Foundation Program for the incoming 1st year UG students. It took a bold step that the normal classes would start only after the five week period. It involved activities such as games, art, etc., and also science and other creative workshops and lectures by resource persons from outside.

(ii) IIIT Hyderabad was the first one to implement a compulsory course on Human Values. Under it, classes were held by faculty through discussions in small groups of students, rather than in lecture mode. Moreover, faculty from all departments got involved in conducting the group discussions under the course. The content is non-sectarian, and the mode is dialogical rather than sermonizing or lecturing. Faculty were trained beforehand, to conduct these discussions and to guide students on issues of life.

(iii) Counselling at some of the IITs involves setting up mentor-mentee network under which 1st year students would be divided into small groups, each assigned a senior student as a student guide, and a faculty member as a mentor. Thus, a new student gets connected to a faculty member as well as a senior student, to whom he/she could go to incase of any difficulty whether psychological, financial, academic, or otherwise.

The Induction Program defined here amalgamates all the three into an integrated whole, which leads to its high effectiveness in terms of building physical activity, creativity, bonding, and character. It develops sensitivity towards self and one’s relationships, builds awareness about others and society beyond the individual, and also in bonding with their own batch-mates and a senior student besides a faculty member. Scaling up the above amalgamation to an intake batch of 1000 plus students was done at IIT(BHU), Varanasi starting from July 2016.

Physical Activity

This would involve a daily routine of physical activity with games and sports. It would start with all students coming to the field at 6 am for light physical exercise or yoga. There would also be games in the evening or at other suitable times according to the local climate. These would help develop teamwork. Each student should pick one game and learn it for three weeks. There could also be gardening or other suitably designed activity where labour yields fruits from nature.

Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts.

[2]Induction Program as described here borrows from three programs running earlier at different institutions: (1) Foundation Program running at IIT Gadhinagar since July 2011, (2) Human Values course running at IIIT Hyderabad since July 2005, and (3) Counselling Service or mentorship running at several IITs for many decades. Contribution of each one is described next.

Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, flow into engineering design later.

Universal Human Values

It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting staff in the hostel and department, be sensitive to others, etc. Need for character building has been underlined earlier. A module in Universal Human Values provides the base.

Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging the mini dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values.

The teachers must come from all the departments rather than only one department like HSS or from outside of the Institute. Experiments in this direction at IIT (BHU) are noteworthy and one can learn from them.[3]

Discussions would be conducted in small groups of about 20 students with a faculty men to reach. It is too pen thinking towards these. If, Universal Human Values discussions could even continue for rest of the semester as a normal course, and not stop with the induction program.

Besides drawing the attention of the student to larger issues of life, it would build relationships between teachers and students which last for their entire4-year stay and possibly beyond.

Literary

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

Proficiency Modules

This period can be used to overcome some critical lacunas that students might have, for example, English, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially. We hope that problems arising due to lack of English skills, wherein students start lagging behind or failing in several subjects, for no fault of theirs, would, hopefully, become a thing of the past.

Lectures by Eminent People

This period can be utilized for lectures by eminent people, say, once a week. It would give the students exposure to people who are socially active or in public life.

Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized.

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[3]The Universal Human Values Course is a result of along series of experiments at educational institutes starting from IIT-Delhi and IIT Kanpur in the 1980s and 1990s as an elective course, NIT Raipur in late 1990s as a compulsory one-week off campus program. The courses at IIT (BHU) which started from July 2014, are taken and developed from two compulsory courses at IIIT Hyderabad first introduced in July 2005.

This would familiarize them with the area as well as expose them to the under privileged.

Familiarization to Dept./Branch &Innovations

The students should be told about different method of study compared to coaching that is needed at IITs. They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

3. Schedule

The activities during the Induction Program would have an Initial Phase, a Regular Phase and a Closing Phase. The Initial and Closing Phases would be two days each.

3.1 Initial Phase

Time	Activity
Day 0 Whole day	Students arrive - Hostel allotment. (Preferably do pre-allotment)
Day 1 *09:00am-03:00pm*	*Academic registration*
04:30 pm -06:00pm	Orientation
Day 2 09:00 am - 10:00 am	Diagnostic test (for English etc.)
10:15 am - 12:25 pm	Visit to respective depts.
12:30 pm - 01:55 pm	Lunch
02:00 pm - 02:55 pm	Director's address
03:00 pm - 03:30 pm	Interaction with parents
03:30 pm - 05:00 pm	Mentor-mentee groups - Introduction within group. (Same as Universal Human Values groups)

3.2 Regular Phase

After two days is the start of the Regular Phase of induction. With this phase there would be regular program to be followed everyday.

3.2.1 Daily Schedule

Some of the activities are on a daily basis, while some others are at specified periods within the Induction Program. We first show a typical daily timetable.

	Sessn. Time	***Activity***	***Remarks***
	Day 3 onwards		
	06:00am	Wake up call	
I	06:30 am -07:10am	Physical activity (mild exercise/yoga)	
	07:15am-08:55am	***Bath, Breakfast, etc.***	
II	09:00 am -10:55am	Creative Arts /Universal Human Value	Half the groups do Creative Arts
III	11:00 am -12:55pm	Universal Human Values /Creative Arts	Complementary alternate
	01:00pm-02:25pm	***Lunch***	
IV	02:30 pm - 03:55 pm	Afternoon Session	See below.

V	04:00 pm - 05:00 pm	Afternoon Session	See below.
	05:00 pm - 05:25 pm	***Break / light tea***	
VI	05:30 pm - 06:45 pm	Games / Special Lectures	
	06:50 pm - 08:25 pm	*Rest and Dinner*	
VII	08:30 pm - 09:25 pm	Informal interactions (in hostels)	

Sundays are off. Saturdays have the same schedule as above or have outings.

3.2.2 Afternoon Activities(Non-Daily)

The following five activities are scheduled at different times of the Induction Program, and are not held daily for everyone:

1. Familiarization to Dept./Branch & Innovations
2. Visits to Local Area
3. Lectures by Eminent People
4. Literary
5. Proficiency Modules

Here is the approximate activity schedule for the afternoons (may be changed to suit local needs):

Activity	***Session***	***Remarks***
Familiarization with Dept./Branch & Innovations	**IV**	For 3 days (Day 3 to 5)
Visits to Local Area	**IV, V and VI**	For 3 days - interspersed (e.g. 3 Saturdays)
Lectures by Eminent People	**IV**	As scheduled - 3-5 lectures
Literary (Play/Book Reading / Lecture)	**IV**	For 3-5days
Proficiency Modules	**V**	Daily, but only for those who need it

3.3 Closing Phase

Time	***Activity***
Last But One Day	
08:30 am -12noon	Discussions and finalization of presentation within each group
02:00 am -05:00pm	Presentation by each group in front of 4 other groups besides their own (about 100 students)
Last Day	
Whole day	Examinations (if any). May be expanded to last 2 days, in case needed.

3.4 Follow Up after Closure

A question comes up as to what would be the follow up program after the formal 3-week Induction Program is over? The groups which are formed should function as mentor- mentee network. A student should feel free to approach his faculty mentor or the student guide, when facing any kind of problem, whether academic or financial or psychological etc.(For every 10 undergraduate first year students, there would be a senior student as a *student guide*, and for every 20 students, there would be a *faculty mentor*.) Such a group should remain for the entire 4-5 year duration of the stay of the student. Therefore, it would be good to have groups with the students as well as teachers from the same department/discipline[4].

Here we list some important suggestions which have come up and which have been experimented with.

3.4.1 Follow Up after Closure – Same Semester

It is suggested that the groups meet with their faculty mentors once a month, within the semester after the 3-week Induction Program is over. This should be a scheduled meeting shown in the timetable. (The groups are of course free to meet together on their own more often, for the student groups to be invited to their faculty mentor's home for dinner or tea, nature walk, etc.)

3.4.2 Follow Up – Subsequent Semesters

It is extremely important that continuity be maintained in subsequent semesters. It is suggested that at the start of the subsequent semesters (upto fourth semester), three days be set aside for three full days of activities related to follow up to Induction Program. The students be shown inspiring films, do collective artwork, and group discussions be conducted. Subsequently, the groups should meet at least once a month.

4. Summary

Engineering institutions were setup to generate well trained man power in engineering with a feeling of responsibility towards oneself, one's family, and society. The incoming undergraduate students are driven by their parents and society to join engineering without understanding their own interests and talents. As a result, most students fail to link up with the goals of their own institution.

The graduating student must have values as a human being, and knowledge and meta-skills related to his/her profession as an engineer and as a citizen. Most students who get demotivated to study engineering or their branch, also lose interest in learning.

The *Induction Program* is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

The *Universal Human Values* component, which acts as an anchor, develops awareness and sensitivity, feeling of equality, compassion and oneness, draw attention to society and nature, and character to follow through. It also makes them reflect on their relationship with their families and extended family in the college (with hostel staff and others).It also connects students with each other and with teachers so that they can share any difficulty they might be facing and seek help.

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[4]We are aware that there are advantages in mixing the students from different depts. However, in mixing, it is our experience that the continuity of the group together with the faculty mentor breaks down soon after. Therefore, the groups be from the same dept. but hostel wings have the mixed students from different depts. For example, the hostel room allotment should be in alphabetical order irrespective of dept.

References:

1. *Motivating UG Students Towards Studies*, Rajeev Sangal, IITBHU Varanasi, Gautam Biswas, IIT Guwahati, Timothy Gonsalves, IIT Mandi, Pushpak Bhattacharya, IIT Patna, (Committee of IIT Directors), 31 March 2016, IIT Directors' Secretariat, IIT Delhi.

Contact: ***Prof. Rajeev Sangal,*** **Director, IIT(BHU), Varanasi (director@iitbhu.ac.in)**

B. Tech Electrical and Instrumentation Engineering
SYLLABI for EXAMINATIONS

B. Tech. 2nd YEAR

<table>
<tr><td rowspan="2">Course Code: EI-PC-201</td><td colspan="2" rowspan="2">Course Name: Power Systems-I</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>-</td><td>3</td></tr>
<tr><td>Year and Semester</td><td colspan="2">2nd year
IIIrd Semester</td><td colspan="4">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td colspan="2" rowspan="2">Basic Electrical Engineering</td><td colspan="4">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="2">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1.To introduce and study the basic concept, layout and structure of power system.</td></tr>
<tr><td colspan="7">2.To study types of transmission line and type of line conductors.</td></tr>
<tr><td colspan="7">3.To study the role of insulators and towers in transmission lines.</td></tr>
<tr><td colspan="7">4.To study the various parameters of transmission lines and its performance.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">To Familiarize with the basic concept, layout and structure of power system.</td></tr>
<tr><td>CO2</td><td colspan="6">To understand basics of transmission line and transmission line conductors.</td></tr>
<tr><td>CO3</td><td colspan="6">To understand the significance of insulators and towers in power system.</td></tr>
<tr><td>CO4</td><td colspan="6">To understand the models of transmission line and analyze the various parameters of transmission lines and its performance.</td></tr>
<tr><td>CO5</td><td colspan="6">To impart basic technical knowledge of power system and apply it to technological fields. To engage in independent and life – long learning in the technological change.</td></tr>
</table>

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**GENERAL SUPPLY SYSTEMS:** Introduction to Power System, Per unit system, Layout of power supply network, System interconnection, Importance of electric power, Power system components, power supply network, effect of voltage on conductor size, comparison of conductor volume in typical supply systems, elementary high voltage DC transmission and its advantages & disadvantages. **Types of conductors:** Hard drawn copper conductors, AAC, AAAC, ACSR and bundled conductors, Resistance, Skin effect, Proximity Effect.	7	**CO1, CO2**
2	**INSULATORS**: Types of insulators, voltage distribution across suspension insulators, string efficiency, methods of improving string efficiency. **MECHANICAL DESIGN:** Line supports- Towers and Poles, Vibration of conductors, Effect of vibration on transmission lines, Prevention of vibration, Sag and tension–Various methods of sag and tension calculations, Loading on conductors and it affects, Span of equal and unequal lengths, Effect of ice and wind, dampers.	7	**CO1, CO3**
3	**TRANSMISSION-LINE PARAMETERS** Conductance and Inductance: Solid Cylindrical Conductor, Inductance: Single-Phase Two-Wire Line and Three-Phase Three-Wire Line with Equal Phase Spacing, Composite Conductors, Unequal Phase Spacing, Bundled Conductors, Series Impedances: Three-Phase Line with	7	**CO2, CO4, CO5**

	Neutral Conductors and Earth Return, Electric Field and Voltage: Solid Cylindrical Conductor Capacitance: Single-Phase Two-Wire Line and Three-Phase Three-Wire Line with Equal Phase Spacing, Stranded Conductors, Unequal Phase Spacing, Bundled Conductors		
4	**PERFORMANCE OF TRANSMISSION LINES:** models of short, medium and long transmission lines, Transmission-Line Differential Equations and detailed performance analysis of these lines including A B C D parameters, Ferranti effect, capacity of synchronous condenser, voltage control, Reactive Compensation Techniques.	**7**	**CO4, CO5**

Text/Refrence Books:

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
4. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.
6. W.D.Stevenson, "Elements of power system analysis", MGH.
7. B.M.Weedy , "Electric Power System", John Wiley & Sons.
8. Transmission & Distribution of Electrical Engineering: Westing House & Oxford Univ. Press, New Delhi.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-203	**Course Name:** Basic Instrumentation Engineering		**L** **2**	**T** **1**	**P** **0**	**C** **3**
Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Physics, Mathematics**	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. Gaining factual knowledge that includes terminology, classifications and methods						
2. Learning fundamental principles, generalizations, or theories						

3. To introduce to the students the operation of various electronic Instruments which are used to measure the electronic parameters	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Analyze the characteristics of each instrument
CO2	Define terms associated with instrumentation
CO3	Categorize various types of instruments
CO4	Explain various types of indicating and recording instruments
CO5	Apply the knowledge of various transducers to measure the physical quantities of shaft speed and acceleration
CO6	Apply the knowledge of to identify instrument for measuring quantities like Power, field strength, phase, Q factor

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction:** Block diagram of measuring instruments, characteristics of instruments, classification of instruments, classification of standards, error in measurement, relative, systematic, random error, parabolic errors. Standards, True Value, Errors (Gross, Systematic, Random); Static Characteristic of Instruments (Accuracy, Precision, Sensitivity, Resolution & threshold).**Classification of Instruments**(Absolute & Secondary Instruments; Indicating, Recording & Integrating instruments; Based upon Principle of operation), Generalized Instrument (Block diagram, description of blocks).	**8**	**CO1, CO2, CO3**
2	**Indicating Instruments:**Three forces in Electromechanical indicating instrument, Comparison between gravity & spring controls; Comparison of damping methods & their suitability, bearing supports, pivot-less supports (Simple & taut-band), Scale information. **Recorders:** Strip chart recorders, galvanometric recorders, null type recorders, potentiometric recorders, X-Y recorders, ultraviolet recorders, magnetic tape recorders, FM recorders and their merits and demerits, pulse duration modulation (PDM) recorders & digital tape recorders (RB, RZ, NRZ-M and NRZ-C).	**6**	**CO1, CO4**
3	**Tachometers:** DC tachometers, AC tachometers, Bearing tachometers, magnetic speed sensors, impulse tachometers, stroboscopic tachometers, variable-reluctance tachometers, photoelectric tachometers, eddy current tachometers, hydraulic tachometers, vibration measurement. Accelerometers: Bonded strain gauge accelerometer, Piezoelectric accelerometer, seismic mass accelerometer, servo accelerometer and digital accelerometer.	**6**	**CO1, CO5**
4	**Potentiometers:** DC potentiometers, Basic potentiometer circuit, Compton type & multiple range potentiometer, constructional details & precision type potentiometers & their applications, AC potentiometer, Power meter, field strength meter, phase meter, vector impedance meter, Q meter, LCR bridge.	**6**	**CO1, CO6**

Reference Books:

1. Electronic Instrumentation ByH.S.Kalsi, TMH

2. Electronic Instrumentation Techniques By Cooper Halfrick, PHI

3. Electronic Instrumentation & Measurement By A. K.Sawhney, Dhanpat Rai& Sons
4. Electronic Instruments and Measurement By Jones & Chin
5. Principles of measurement &Instrumentation by Alan S. Morris
6. Electrical, Electronics measurement & Instrumentation, by JB Gupta

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-205	**Course Name:** Network Analysis		**L**	**T**	**P**	**C**
			2	**1**	**-**	**3**
Year and Semester	**2nd year 3rd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	Basic Electrical Engineering	**Evaluation**				
		CIE: 40		**SEE: 60**		

Course Objectives:
1. To introduce students with the fundamental concepts in graph theory
2. To familiarize about transient response of different type of circuits.
3. To explain concepts of network functions.
4. To introduce open circuit, short circuit, transmission, hybrid parameters and their interrelationship.
5. To understand and learn network filters
6. To learn the synthesize of network using passive elements.

Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the fundamental concepts of graph theory.
CO2	Understand and analyze the transient response of various type of circuits under different excitations.
CO3	Understand poles and zeroes of network functions and interpretations in terms of their stability.
CO4	Learn the various parameters and their interrelationship, able to solve numerical with series, cascade, and parallel connection using two port parameters.
CO5	Able to understand and solve problems related to low-pass, high–pass and band reject, constant K pass filters, m-derived
CO6	Understand and problem solving related to synthesization one port and two port networks.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Topology:** Principles of network topology, Graph matrices, network analysis using graph theory. **Transient Response**: Transient response of RC, RLC, RL circuits to various excitation signals such as step, ramp, impulse and sinusoidal excitations using Laplace transform.	**6**	**CO1, CO2**
2	**Network Functions:** Terminal pairs or ports, network functions for one port and two port networks, pole and zeros of network functions, restrictions on pole and zero locations for driving point functions and transfer functions, time domain behaviour from pole – zero plots, stability criteria of active networks.	**6**	**CO3,**
3	**Two Port Networks:** Characteristics and parameters of two port networks, short circuit admittance parameters, open circuit impedance parameters, transmission parameters, hybrid parameters, relationship between parameter sets, interconnection of two port networks, T and π networks.	**5**	**CO4**
4	**Filter Networks:** Fundamentals of filters, network equations, and characteristic impedance of low-pass, high–pass and band reject, constant K pass filters, m-derived.	**5**	**CO5**
5	**Network Synthesis**: Herwitz polynomial, positive real functions, elementary idea of active networks and frequency	**4**	**CO6**

Text Books:

1. Networks and Systems, D. Roy Choudhary, Wiley Eastern Ltd.
2. Network Analysis: A Sudhakar and S P Shyammohan, TMH.
3. Network Analysis and Synthesis, CL Wadhwa, New Age International Publishers.
4. Circuit Theory, A. Chakrabarti, Dhanpat Rai& Co.

Reference Books:

1. An Introduction to Modern Network Synthesis, M E Van Valkenburg, Wiley Eastern Ltd.
2. Circuit Theory, T.S.K.V. Iyer, Tata McGraw Hill

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-PC-207</td><td colspan="2">Course Name: Transducers and Applications</td><td>L
2</td><td>T
1</td><td>P
-</td><td>C
3</td></tr>
<tr><td>Year and Semester</td><td>2nd year
IIIrd Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Knowledge of Basic science, Basic Electrical Engineering</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To study the basic concept and fundamental of sensors and transducers.</td></tr>
<tr><td colspan="7">2. To study Basic principle of operation of strain gauge, piezoelectric sensors and its circuits.</td></tr>
<tr><td colspan="7">3. To study the different types of transducers/sensors for the measurement of non-electrical quantities.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Able to understand the fundamental concepts of sensors and transducers.</td></tr>
<tr><td>CO2</td><td colspan="6">Ability to analyze various electrical and non-electrical Sensors and Transducers by using their basic fundamental principles of mathematics and science.</td></tr>
<tr><td>CO3</td><td colspan="6">Familiarize to use sensors and transducers for the measurements of various electrical and non-electrical parameters.</td></tr>
<tr><td>CO4</td><td colspan="6">To impart technical knowledge of sensors and apply it to technological fields. To engage in independent and life – long learning in the technological change.</td></tr>
</table>

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Transducers:** Basic concepts of sensors and transducers and their classification, characteristics and choice of transducers, factors influencing the choice of transducers. Basic operating principle of resistance strain gauge, type of electrical strain gauges and their theories: wire gauges, unbounded strain gauges, foil gauges, semiconductor strain gauges and thin film gauges, Materials for strain gauges, strain gauge circuits.	7	**CO1, CO2**
2	**Displacement Transducers:**Resistive transducers, potentiometers, loading effect, construction of potentiometers. Variable inductance transducers, Linear Variable Differential Transformer (LVDT), Rotary Variable Differential Transformer (RVDT), Variable Reluctance, Variable Capacitive displacement Transducers and Hall Effect Transducers. Piezoelectric transducers: modes of operation of piezoelectric crystals, properties of piezoelectric crystals, equivalent circuit of piezoelectric transducers, loading effects and frequency response, impulse response of piezoelectric crystals.	7	**CO2, CO3, CO4**
3	**Force Transducers:** load Cell, Hydraulic Load Cell. **Pressure transducers:** Manometers, Elastic transducers, Mcloed Gauge, Pirani-gauge, Ionization gauge, **Temperature Transducers:** Resistance Temperature Detector, Thermistor, Thermocouple,Thermoelectric sensors, Pyrometers.	7	**CO2, CO3, CO4**
4	**Flow Transducers:** Classification of flow meter, Volume flow Sensors,Turbine type, Rotameters, Anemometers, Ultrasonic, Mass flow meters, Positive displacement type flow-meter, Open channel flow measurement, E.M. Flow-meter. **Level Transducers**: Thermal effect type, Electric methods, Ultrasonic	7	**CO2, CO3, CO4**

	method. **Acoustics sensors:** Ceramic microphones, capacitor microphones, electric microphones, magnetic microphone. **Humidity sensors**: Hair hygrometer, electrode hygrometer, moisture sensors.		

Text/References Books:

1. A. K.Sawhney, "A Course in Electrical and Electronics Measurement and Instrumentation,DhanpatRai & Co.
2. D.Patranabis, " Principles of Electronic Instrumentation,", PHI
3. D. Patranabis, "Sensors and Transducers", PHI.
4. D.A.Bell, "Electronic Instrumentation and Measurements", PHI.
5. Rangan, Sharma and Mani, "Instrumentation Devices and Systems", TMH.
6. Raman Pallas-Arency and J.G. Webster,"Sensors and Signal Conditioning", John Wiley & Sons.
7. Considine DM (ed),"Process Instruments and Controls Handbook", McGraw-Hill.
8. Jones B.E "Instrument Science & Technology", Adam Hilger.
9. Neubert H.K.P, "Instrument Transducers: An introduction to their performance and design", Oxford.
10. Norton H.N,"Sensors and Analyzer Handbook",Prentice Hall.
11. Usher M.J,"Sensors and Transducers", Macmillan.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-OE-209</td><td colspan="2">Course Name: Open Elective-I
(i) Linear Integrated Circuits</td><td>L
2</td><td>T
1</td><td>P
0</td><td>C
3</td></tr>
<tr><td>Year and Semester</td><td>2nd year
IIIrd Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">EI-ES-108 Basic Electronics Engineering</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To impart the basic concepts of Analog Electronics.</td></tr>
<tr><td colspan="7">2. To impart the basic concepts of one of the most widely used active components of analog electronics Operational Amplifier.</td></tr>
<tr><td colspan="7">3. To design and study various circuits using active components mainly OpAmp.</td></tr>
<tr><td colspan="7">4. To lay the foundation for the courses in electronics related to instrumentation.</td></tr>
</table>

Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the basic design of Operational amplifier and its parameters.
CO2	Understand the frequency response of Op-amp and various inverting and non-inverting Op amp based applications.
CO3	Understand the uses of opamp in Instrumentation.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	Basics of Operational Amplifier (Op-Amp)--emitter coupled differential amplifier, transfer characteristics of differential amplifier, Block Diagram of Op-amp, Op- amp parameters : offset voltages and currents, input bias current, CMRR and measurement of Op-Amp parameters	**6**	**CO1**
2	Frequency and Phase Response in Opamp, Op-Amp Circuit Bandwidth. OpAmp applications: Inverting, Concept of virtual ground, Non-inverting, adder, analog integration and differentiation, wave form generators (square wave, pulse and triangle wave generator)	**6**	**CO2**
3	Op-Amp Applications II: Instrumentation Amplifier, Precision Half Wave Rectifier, Precision Full Wave Rectifier, limiting Circuits, Clamping Circuits, Peak Detectors, Sample & Hold Circuits, logarithmic Amplifier, Phase Shift Oscillator, Oscillator Amplitude Stabilization, Wien-Bridge Oscillator.	**6**	**CO2** **CO3**
4	Regulated Power Supplies: Regulator Action, Regulator Performance, Voltage follower Regulator (Design & performance), Adjustable Voltage Regulator (Design & performance),Stabilization, Output Current limiting (Short circuit Protection) (Fold-back Current limiting), I.C. Regulators (Basic Idea). The 555 I.C. Timer, and its applications.	**6**	**CO2** **CO3**

Reference Books:

1. Integrated Electronics by MillmanHalkias, McGraw Hill
2. Op-Amps & Linear Integrated Circuits by R.A.Gayakwad
3. Op-Amps & Linear Integrated Circuits by David A.Bell

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-OE-209	**Course Name: Open Elective-I** **(ii)** Computer Networks	**L** 2	**T** 1	**P** 0	**C** 3
Year and Semester	**2nd Year** **IIIrd Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	The course does not assume prior knowledge of networking. However, Basic Computer Knowledge is desirable	**Evaluation** **CIE: 40**	**SEE: 60**		

Course Objectives:

5. To explore the basics of computer networks
6. To know various computer network protocols.
7. To gain knowledge on fundamentals of network administration.
8. To explore how tomanage the flow of information. To provide good understanding of Internet and networking design aspects

Course Outcomes: On completion of the course, student would be able to:

CO1	To understand the fundamental of computer networks
CO2	To understand the models of UDP and TCP models.
CO3	To apply the TCP/IP and OSI models with merits and demerits.
CO4	Students should be able to use his knowledge to develop/design at LAN

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**INTRODUCTION TO COMPUTER NETWORKS:** Components, Direction of Data flow Types of connections, topologies, protocols and standards of ISO/OSI model, TCP/IP Model. **PHYSICAL LAYER:**Transmission modes, Multiplexing, Transmission media, Switching, Circuit Switched Networks, Datagram Networks, Virtual Circuit Networks.	**7**	**CO1, CO2**
2	**DATA LINK LAYER:** Introduction, Framing, Error Detection and Correction-Parity-LRC-CRC Hamming code, flow and error control, Noiseless channels, Noisy Channels, HDLC, Point to Point Protocols. Medium Access Sub Layer: ALOHA, CSMA/CD, LAN-Ethernet IEEE802.5, IEEE 802.11, Random Access, Controlled Access, Channelization.	**5**	**CO2, CO3**
3	**NETWORK LAYER:** Logical Addressing, Internetworking, Tunneling, Address mapping, ICMP, IGMP, Forwarding, Unit-Cast Routing Protocols, Multicast Routing Protocols.	**5**	**CO2, CO3, CO5**
4	**TRANSPORT LAYER:** Process to Process Delivery, UDP and TCP protocols, Data traffic, congestion, congestion control, QoS in switched networks.	**5**	**CO3, CO4**
5	**APPLICATION LAYER:**Domain name space, DNS in Internet, Electronic Mail, SMPT, FTP, WWW, HTTP, SNMP	**5**	**CO4, CO6**

TEXT BOOKS

1. Computer Networking: A. Top-Down Approach Featuring the Internet, James F Kurose & Keith W. Ross. 3rdEdition Pearson Education.
2. Data Communications and Networking, Behrouz. A. Forouzan, Fourth Edition TMH, 2006.
3. Computer Networks, Andrew S Tanenbaum 4th Edition Pearson Education, PHI

REFERENCE BOOKS
1. Data Communication and Computer Networks, P.C. Gupta, PHI
2. An Engineering approach to Computer Networks, S. Keshav, 2nd Edition Pearson Education.
3. Understanding communications and Networks, 3rd edition, W.A. Shay, Cengage Learning.
4. Data and Computer Communication, William Stallings, 6th Edition, Pearson Education, 2000.

Note for Examiner(s): Question paper will comprise three sections,

4. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

5. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

6. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

3. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

4. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-HSM-211	**Course Name:** Basics of Industrial Sociology, Economics and Management		**L**	**T**	**P**	**C**
			2	**0**	**0**	**2**
Year and Semester	**2nd year IIIrd Semester**	**Contact hours per week:** (2Hrs) Exam: (3 Hrs)				
Pre-requisite of course	NIL	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. Acquire basic knowledge of social processes of society, social institutions and patterns of social behavior						
2. Acquire knowledge of economics to facilitate the process of economic decision making						
3. Acquire knowledge of basic management aspects						
4. Develop cognizance of the importance of management principles						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Demonstrate knowledge of core sociological concepts					
CO2	Evaluate the economic theories, cost concepts and pricing policies					
CO3	Describe the role of economics in the decision making process					
CO4	Demonstrate the roles, skills and functions of management					

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	Meaning of social change, nature of social change, theories of social change. The causes of social change, the process of social change. Factors of social change - the technological factors, the cultural factors, the effect of technology on major social institutions, social relations in industry.	**6**	**CO1**
2	Introduction to Industrial Economic, production function and its type;	**10**	**CO2**

	least cost combination, law of variable proportion, law of return increasing, constant and diminishing. Fixed and variable costs in short run and long run, opportunity costs. Perfect competition – meaning and characteristics, Monopoly – meaning and characteristics, concept of equilibrium of a firm.		
3	Meaning of management, characteristics of management, Fayol's principles of management. Personnel management - meaning and functions, manpower – process of manpower planning, recruitment and selection – selection procedure. Training – Objectives and types of training, various methods of training. Marketing research – meaning, objectives. Purchasing management – meaning and objectives, purchase procedure, inventory control techniques. Financial management- Introduction, objectives of financial decision.	**10**	**CO3, CO4**

TEXT BOOKS

1. An introduction to Sociology by D.R.Sachdeva and VidyaBhusan,
2. Society- An introductory Analysis by R.N.MaclverCharls H. Page
3. Microeconomics- Theory and Applications by D. N. Dwivedi, Vikas Publishing House
4. Modern Economics Theory by K.K.Dewett, S.Chand and Co.
5. Economic Analysis by K.P.Sundharam and E.N.Sundharam, Sultan Chand & Sons
6. Micro Economic Theory by M.L.Jhingam, Konark Publishers Pvt. Ltd.
7. Principle of Economics by M.L. Seth, LakshamiNarain Aggarwal Educ. Pub.- Agra
8. Principle & Practices of Management by R.S.Gupta, B.D.Sharma, N.S.Bhalla, Kalyani Pub.
9. Organization and Management by R.D.Aggarwal TMH
10. Business Organization and Management by N.C.Shukla.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-09	**Course Name:** Network Analysis Lab		**L** 0	**T** 0	**P** 2	**C** 1
Year and Semester	**2nd Year IIIrd Semester**	**Contact hours per week:** (2 Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Basic Electrical Engg**	**Evaluation**				
		CIE: 20		**SEE: 30**		

Course Objectives:	
1. To familiarize with different components and equipments used in the laboratory.	
2. To study RLC combination circuits practically.	
3. To familiarize and practical understanding of two port network.	
4. To understand various filter circuits practically.	
Course Outcomes: On completion of the course, student would be able to	
CO1	Analyse circuit combinations of R, L and C for transient behaviors.
CO2	Work with two port networks for practical understanding of Y, Z , and ABCD parameters.
CO3	Analyse low pass, high pass filters based on their characteristics.

Expt. No	**COURSE SYLLABUS CONTENTS OF MODULE**	**COs**
1	To find resonance frequency, Bandwidth, Q factor of RLC series circuit.	**CO1, CO2, CO3,**
2	To study and plot the transient response of RL circuit	
3	To study and plot the transient response of RC circuit	
4	Determination of driving point and transfer functions of a two port ladder network and verify with theoretical values.	
5	To calculate and verify 'Z' parameters of two-port network	
6	To calculate and verify 'Y' parameters of two-port network.	
7	To calculate and verify 'ABCD' parameters of two-port network.	
8	To determine equivalent parameters of parallel connection of two-port network	
9	To plot the frequency response of High pass filter and determine the half-power frequency	
10	To plot the frequency response of Low pass filter and determine the half- power frequency.	
11	To plot the frequency response of High pass filter and determine the half-power frequency	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-11	**Course Name:** Transducers Lab	**L** 0	**T** 0	**P** 3	**C** 1.5
Year and Semester	**2nd Year III rd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Basic Science, Basic Electrical Engineering Lab**	**Evaluation** CIE: 20	**SEE: 30**		

Course Objectives:	
1. To study the basic operation of different type of sensors/transducers.	
2. To familiarize with transducers circuits and their application.	
3. Familiarize with the safety rules for transducers laboratory.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Impart the conceptual knowledge of transducers /sensors and apply these to laboratory work.
CO2	Ability to analyze the performance as well as handling of transducer equipments.
CO3	Acknowledge the principles of operation and the main features of sensors/transducers.
CO4	Develop skills to use these measuring devices in different technological field.

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	To study the characteristics of strain gauge for pressure measurement.	**CO1 CO2 CO3 CO4**
2	To study the characteristics of Load cell for force measurement.	
3	To study the characteristics of Thermistor for temperature measurement.	
4	To study the characteristics of Resistance temperature detector (RTD) for temperature measurement.	
5	To study the characteristics of Thermocouple for temperature measurement.	
6	To study the characteristics and loading effect of Potentiometer.	
7	To study the characteristics of Elastic transducers.	
8	To study the characteristics and calibration of linear variable differential transformer (LVDT) transducer for displacement measurement.	
9	To study the characteristics of Piezo-electric Transducer.	
10	To study the characteristics of Hall-effect Transducer.	
11	To Study and calibration of a flow sensors for flow measurement.	
12	To Study the characteristics and calibration of electrical transducers for level measurement.	
13	To Study the characteristics and calibration of acoustics sensors for sound measurement.	
14	To Study the characteristics of light sensors for light measurement.	
15	To Study the characteristics of hygrometer transducers for moisture measurement.	

Reference Books:

1. Sawhney. A.K, "A Course in Electrical and Electronics Measurements and Instrumentation", 18th Edition, DhanpatRai& Company Private Limited, 2007.
2. Renganathan. S,"Transducer Engineering", 4th edition Allied Publishers, Chennai, 2003.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PROE-13	**Course Name: Open Elective- I Lab** (i) Linear Integrated Circuits Lab		**L** **0**	**T** **0**	**P** **3**	**C** **1.5**
Year and Semester	**2nd Year** **IIIrd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	EI-PRES-06, Basic Electronic Lab	**Evaluation** **CIE: 20** | **SEE: 30**				
Course Objectives:						
1. To impart the basic practical aspects of one of the most widely used active components of analog electronics Operational Amplifier.						
2. To design and study various circuits using active components mainly OpAmp.						
3. To lay the experimental foundation for the courses in electronics related to instrumentation.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Understand the basic design of Operational amplifier and its parameters.					
CO2	Understand the basic circuit design using IC opamp for different applications .					
CO3	Understand the uses of opamp in Instrumentation.					
CO4	Understand the advantages of the applications when performed using active components in integrated form like opamp.					

	COURSE SYLLABUS	
Expt. No	**CONTENTS OF MODULE**	**COs**
1	Study opamp as inverter and scale changer.	**CO1, CO2, CO3, CO4**
2	Study opamp as non inverting amplifier and unity gain amplifier.	
3	Study of Opamp as Differentiator.	
4	Study of opamp as Integrator.	
5	Study and measurement of Opamp Parameters Offset voltages and currents.	
6	Measurement of CMRR for Opamp.	
7	Design and study of Opamp as half wave rectifier.	
8	Design and study of opamp as full wave rectifier.	
9	Design and study of opamp as Logarithmic amplifier.	
10	Design and study of opamp as square wave generator.	
11	Design and study of opamp as triangular wave generator.	
12	Design and study of opamp as Astable multivibrator.	
13	Design and study of opamp as monostable multivibrator.	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PROE-13	**Course Name:** Open Elective V Lab (ii) Computer Networks		**L** 0	**T** 0	**P** 3	**C** 1.5
Year and Semester	**2nd Year III rd Semester**	**Contact hours per week:** (3 Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	The course does not assume prior knowledge of networking.	**Evaluation**				
		CIE: 20	**SEE: 30**			
Course Objectives:						
1. To understand the functionalities of various layers of OSI model						
2. To understand the operating system functionalities.						
3. To give comprehensive knowledge of TCP/IP layers.						
4. To provide good understanding of Internet and networking design aspects.						
Course Outcomes: On completion of the course, student would be able to						
CO1	Understand the encryption and decryption concepts in Linux environment					
CO2	Apply appropriate algorithm for the finding of shortest route					
CO3	Configure the routing table.					
CO4	Students should be able to use his knowledge to develop/design at LAN.					

System/ Software Requirement

Intel based desktop PCs LAN connected with minimum of 166 MHZ or faster process with at least 64 MB RAM and 100 MB free disk space.

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	Implementing the data link layer framing methods such as character, stuffing and bit stuffing.	**CO1, CO2, CO3, CO4**
2	Implement on a data set of characters the three CRC polynomials- CRC 12, CRC 16 and CRC CCIP.	
3	Practice the basic network commands and network configuration commands.	
4	Configure a network topology using packet tracer software.	

5	Configure a network using dynamic source distance vector (DSDV) routing protocol.	
6	Configure a network using link state routing (LSR) protocol.	
7	Configure a network using dynamic source routing (DSR) protocol.	
8	Configure a network using open shortest path first (OSPF) protocol.	
9	Write program for DES Encryption.	
10	Write program for DES decryption.	
11	Write program for RSA Encryption.	
12	Write program for RSA decryption.	

Text Books: Linux Manuals and Lab Manuals

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-15	**Course Name:** Power System-I Lab		**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**
Year and Semester	**2nd Year IIIrd Semester**	**Contact hours per week:** (2Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Basic Electrical Engineering Lab**	**Evaluation**				
		CIE: 20	**SEE: 30**			
Course Objectives:						
1. To study the layouts of Power system and its components.						
2. To familiarize power system elements, devices, equipments and applications.						
3. To study different type of transmission line model and their applications.						
4. To familiarize with the safety rules for power system laboratory.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Impart the conceptual knowledge of basic layouts of power system and its components.					
CO2	Ability to analyze the performance as well as handling of electrical elements and equipments like line conductors, cables, insulators etc.					
CO3	Acknowledge the principles of operation and the main features of transmission line.					
CO4	Develop skills to use power system elements and devices in different technological field.					

Expt. No	**COURSE SYLLABUS**	**COs**
	CONTENTS OF MODULE	
1	To study and draw the layout of 33KV substation.	**CO1 CO2 CO3 CO4**
2	To study and draw the layout of 110/220 KV substation.	
3	To study distribution network with measurement of distribution voltage and current in distributors.	
4	To study different types of Line insulators and obtain breakdown characteristics of any one type of insulator.	
5	To study and designing of Earthing / Grounding.	
6	To measure Potential distribution across different units of a string insulators: with guard ring and without guard ring and also determine the string efficiency.	
7	To plot equi-potential curve and voltage gradient in i. Two/three core cable ii. Single-core cable.	

8	To study the different parts of a power cable and measurement of insulation resistance of a cable.	
9	To study the core to core & core to sheath capacitance of a three phase cable.	
10	To study and obtain A B C D parameter of a transmission line (model).	
11	To study Ferranti Effect of transmission line model.	
12	To obtain Voltage Regulation of a long transmission line with resistive, inductive and capacitive loads	
13	To obtain Voltage Profile of a long transmission line when: i. Open circuited ii. Using shunt/series capacitive compensation iii. Using shunt inductive compensation.	
14	To study filtration and treatment of transformer oil.	
15	To study and determine dielectric strength of transformer oil.	

Reference books:

1. Power System Engg: I.J.Nagrath and D.P.Kothari (TMH)
2. A Course in Electrical Power: Gupta, Soni & Bhatnagar (Dhanpat Rai & Sons).
3. Electric Power System: B.M.Weedy, John Wiley & Sons.
4. Transmission & Distribution of Electrical Engineering: Westing House & Oxford Univ. Press, New Delhi.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-202	**Course Name:** Power Electronics-I		**L**	**T**	**P**	**C**
			3	**1**	**0**	**4**
Year and Semester	**2nd Year (IVth Semester)**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Brief knowledge of in the following topics: Basic Electrical and Electronics engineering, Semiconductor devices, Digital Electronics, rectifiers.	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To introduce, study the Constructional features & characteristics of power devices.						
2. To study the various Triggering & switching techniques and devices.						
3. To study the series parallel operation and thyristors protection						
4. To study the single phase and three phase thyristors at different types of loadings.						
5. To study the principle and different types of cycloconverters.						
6. To study the various modes of cycloconverter under continuous and discontinuous conduction, effect of source inductance on the performance of cycloconverter.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To Familiarize with construction and characteristics of power devices.					
CO2	To understand and analyze the various triggering techniques and devices..					
CO3	To understand series parallel operation and protection of thyristor.					
CO4	To understand the output response of rectifiers at different loading.					
CO5	To understand and analyze the operation of cycloconverters under different modes.					
CO6	To understand the effect of source impedance on performance of cycloconverters.					

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Introduction to power devices: Constructional features & characteristics of thyristors, MOSFET, IGBT, MCT. Triggering & switching: Various triggering devices used for thyristor.	**7**	**I & II**
2	Thyristor Analogy: Two transistor analogy, series and parallel operation of thyristors. Protection: Protection of SCR against over current, over voltage, high dv/dt, and high di/dt.	**8**	**III**
3	Classification of Rectifiers, Phase Controlled Rectifiers: Single phase half wave controlled, Fully wave and half controlled rectifiers with Resistive, Inductive and e.m.f. loading and their performance parameters. Three phase half wave, full wave and half controlled rectifiers with resistive and inductive and emf loading and their performance.	**11**	**IV**
4	Cycloconverter: Introduction & principle of working cycloconverter; types of cycloconverter; enveloped type & phase controlled type , features of cycloconverter; voltage wave form, circulating mode of operation, circulating current free modes, cycloconverter under discontinuous conduction, effect of source inductance on the performance of cycloconverter, network reaction, Advantages and disadvantages of cycloconverter .	**10**	**V & VI**

Text Books:

1. Modern Power Devices by B.Jayant Balica, New Age Inter.
2. Power Electronics by P.C. Sen (TMH)
3. An Introduction to Thyristors and Their Applications by M. Ramamurthy (EWP)
4. Power electronics by Ned Mohan and Robins, John Wiley and Sons
5. Power Electronics by M. Rashid (PHI)
6. Thyristor Phase Controlled converters and Cyclo-converters by B.R.Pelly
7. Power Electronics by Vendem Subrahmanyam, New Age International

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-204	**Course Name:** Electrical Measurements & Instrumentation	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Year and Semester	**2^{nd} Year (IV^{th} Semester)**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)	
Pre-requisite of course	Physics, Mathematics, Basic Electrical Engineering, Basic Electronics Engineering, basic Instrumentation.	**Evaluation**	
		CIE: 40	**SEE: 60**

Course Objectives:
1. To introduce electrical & electronics measurement techniques. To study the varioustypes of instruments and different types of measurements in AC/DC.
2. To study the low and high resistance measurements.
3. To study the principle and performance equations of galvanometers.
4. To study the principle and operation of wattmeters and energy meters.
5. To study the Construction, operation, and principle of power factor & frequency meters**.**
6. To study the AC bridges and CROs.

Course Outcomes: On completion of the course, student would be able to:	
CO1	To learn different types of Instruments used in AC & DC supplies and Electrical & Electronics measurement techniques.
CO2	To understand and analyze the how to calculate low & high resistances.
CO3	To learn various types of Galvanometers.
CO4	To understand various types of wattmeters & energy meters and its applications.
CO5	To understand and analyze the Construction, operation, and principle of power factor & frequency meters**.**
CO6	To understand the AC bridges and CROs.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Fundamentals of Electrical & Electronics measurements:** Principle, Construction, Features, Analysis & Performance of moving coil instruments, Moving iron instruments, Electrodynamic instruments, electrostatic instruments and Induction Instruments. Instrument cases (Covers).Construction, operating principle, Torque equation, Shape of scale. **MEASURING INSTRUMENTS (AC/DC):** use as Ammeter or as Voltmeter (Extension of Range), Use on AC/DC or both, Advantages & disadvantages, Errors (Both on AC/DC) of PMMC types, Electrodynamics Type, Moving iron type (attraction, repulsion & combined types), Induction type.	**6**	**CO1**
2	**LOW & HIGH RESISTANCE MEASUREMENTS:** Measurement of resistance (low, medium, high). Limitations of Wheatstone bridge; Kelvin's double bridge method, bridge controlled circuits, Sensitivity-Null indicators Difficulties in high resistance measurements, Measurement of high resistance by direct deflection, loss of charge method, Megaohm bridge. **GALVANOMETERS:** General principle and performance equations of D'Arsonval Galvanometers, Vibration Galvanometer and Ballistic Galvanometer.	**8**	**CO2, CO3**

3	**WATTMETERS & ENEGRY METERS:** Construction, operating principle, Torque equation, Shape of scale, Errors, Advantages & Disadvantages of Electrodynamic & Induction type Wattmeters; construction, theory, operation, Two element energy meter, average demand indicator. Single Phase Induction Type Energy meter, Compensation & creep in energy meter. **POWER FACTOR & FREQUENCY METERS:** Construction, operation, principle, Torque equation, Advantages & disadvantages of Single phase power factor meters (Electrodynamic & Moving Iron types) & Frequency meters (Electrical Resonance Type, Ferrodynamic & Electrodynamic types).	**12**	**CO4, CO5**
4	**A.C. BRIDGES:** General balance equation, Ckt. diagram, Phasor diagram, Advantages, disadvantages, applications of Maxwell's, inductance-capacitance, Hays, Owens, Schering & Wein's bridges, Shielding & earthing, wagner's device. **CRO:** Block diagram, Sweep generation, vertical amplifiers, use of CRG in measurement of frequency, phase, Amplitude and rise time of a pulse.	**10**	**CO6**

TEXT BOOK:

1. A Course in Elect. & Electronic Measurement & Instrumentation by A. K. Sawhney; Khanna Pub.

REFERENCE BOOKS:

1. Electrical Measurments by E.W. Golding
2. Electronic & Elect. Measurment&Instrumention by J.B.Gupta; Kataria& Sons.
3. Electronic Instrumentation &Measurment Technique, W.D. Cooper & A.D. Helfrick.
4. Measuring Systems by E.O. Doeblin; TMH.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-206	**Course Name: Program Elective- I** (ii) Electrical Energy Conservation and Auditing		**L**	**T**	**P**	**C**
			2	**1**	**0**	**3**
Year and Semester	**2nd Year (IVth Semester)**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)				

Pre-requisite of course	Basic Science, Basic Electrical Engineering, Basic Instrumentation Engineering	**Evaluation**	
		CIE: 40	**SEE: 60**

Course Objectives:	
1.	To study the present Energy Scenario and Basics of various forms of Energy
2.	To introduce the concept of Energy Management, Action Planning, Financial Management and Audit.
3.	To study the Energy Monitoring and Targeting system, the Power Supply System and electric motors.
4.	To introduce the concept of Lighting System, Energy Efficient Technologies.
Course Outcomes: On completion of the course, student would be able to:	
CO1	To familiarized with the present Energy Scenario and Basics concept of various forms of Energy.
CO2	To impart conceptual knowledge and analysis of Energy Management, Action Planning, Financial Management and Audit.
CO3	To understand the concept of Energy Monitoring and Targeting system, the Power Supply System and electric motors, Lighting System, Energy Efficient Technologies.
CO4	Ability to use and learn the conventional techniques and skills ofengineering in the field of electrical and instrumentation engineering.
CO5	To impart technical education to learn and engage in the related fields. Ability to handle administrative responsibilities and manage projects and their related issues.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Energy Scenario and Basics of Energy:** Energy scenario in world and India, Energy Conservation and its Importance, Energy Strategy for the Future, The Energy Conservation Act, 2001 and its Features, Various Forms of Energy, Electrical Energy Basics **Energy Management and Audit:** Definition & Objectives of Energy Management, Energy Audit: Types and Methodology, Energy Audit Reporting Format, Understanding Energy Costs, Benchmarking and Energy Performance, Matching Energy Usage to Requirement, Maximizing System Efficiency, Fuel and Energy Substitution, Energy Audit Instruments.	**7**	**CO1, CO2**
2	**Energy Action Planning and Financial Management:** Introduction, Energy Management System, Introduction, Investment Need, Appraisal and Criteria, Financial Analysis, Financial Analysis Techniques, Sensitivity and Risk Analysis, Financing Options. Introduction and steps in Project Management. **Energy Monitoring and Targeting:** Definition, Elements of Monitoring & Targeting System, A Rationale for Monitoring, Targeting and Reporting, Data and Information Analysis, Relating Energy Consumption and Production, CUSUM, Case Study.	**7**	**CO3, CO4, CO5**
3	**Electrical System and Motors :**Electrical Load Management and Maximum Demand Control, Power Factor Improvement and Benefits, Harmonics, Analysis of Electrical Power Systems Motor Selection, Energy Efficient Motors, Factors Affecting Energy Efficiency and Minimizing Motor Losses in Operation, Rewinding Effects on Energy Efficiency, Speed Control of AC Induction Motors, Motor Load	**7**	**CO3, CO4, CO5**

	Survey: Methodology.		
4	**Lighting System:** Introduction, Basic Terms in Lighting System and Features, Lamp Types and their Features, Recommended Illuminance Levels for Various Tasks/Activities/Locations, Methodology of Lighting System, Energy Efficiency Study, Case Examples, Some Good Practices in Lighting. **Energy Efficient Technologies in Electrical Systems:** Maximum Demand Controllers, Automatic Power Factor Controllers, Energy Efficient Motors, Soft Starter, Variable Speed Drives, Energy Efficient Transformers, Electronic Ballasts, Energy Efficient Lighting Controls.	**7**	**CO3, CO4, CO5**

Text/References:

1. B.R.Gupta, "Generation of Electrical Energy", Eurasia Publishing House, New Delhi.
2. A Ter-Gazarian,"Energy Storage for Power Systems", Peter Peragrinus Ltd.
3. Quarterly journals on Energy Managements, Energy Management Centre, Govt. of India, Ministry of Power, New Delhi.
4. Anthony J. Pansini, Kenneth D. Smalling, "Guide to Electric Load Management", Pennwell Pub; 1998
5. Howard E. Jordan, "Energy-Efficient Electric Motors and Their Applications", Plenum Pub Corp; 2ndedition, 1994.
6. Giovanni Petrecca, "Industrial Energy Management: Principles and Applications", The Kluwerinternational series -207, 1999.
7. Y P Abbi and Shashank Jain,"Handbook on Energy Audit and Environment Management", TERI,2006
8. Albert Thumannand William J. Younger,, "Handbook of Energy Audits", Terry Niehus, 2009.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-206	**Course Name: Program Elective- I** (i) Control System Components		**L** / **2**	**T** / **1**	**P** / **0**	**C** / **3**
Year and Semester	**2nd Year (IVth Semester)**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Mathematics, Physics, basic electrical and electronic engineering	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
1. Introduction, concept of Open loop & closed loop operation and to study the components for Mechanical, pneumatic, hydraulic and electrical systems	
2. Study of Mathematical Modeling of Dynamic system and find out the Transfer function of system by block diagram, reduction technique, signal flow graphs techniques	
3. To study the Basic control action & Industrial pneumatic automatic controllers and their mathematical Modeling and analysis	
4. To study Hydraulic control system and their mathematical Modeling and analysis	
5. To study Electronic control system and their mathematical Modeling and analysis	
6. Introduction the concept of control valve, their sizing and applications	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Student understands the concept of Open loop & closed loop control system and familiarized with the Mechanical, pneumatic, hydraulic and electrical systems components.
CO2	Ability to derive Mathematical Modeling of various dynamical systems and able to find out the Transfer function of system by block diagram, reduction technique, signal flow graphs techniques.
CO3	Ability to identify, formulate and solve a problem using pneumaticsystem in instrumentation control engineering
CO4	Ability to identify, formulate and solve a problem using hydraulic system in instrumentation and control engineering
CO5	Ability to identify, formulate and solve a problem using electronic system in instrumentation and control engineering
CO6	Ability to understand and use the concept of control valve, their sizing and applications

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	Control System: Open loop & closed loop operation, Introduction to control system components, Representation of control components: Mechanical, Electrical, hydraulic and pneumatic. Transfer function of control system, Mathematical Modeling of Dynamic system: Mechanical, Electrical, Analogous system, Electromechanical system, hydraulic and pneumatic transfer function by block diagram, reduction technique, signal flow graphs techniques, Meson's gain formula for signal flow graph.	**8**	**CO1** **CO2**
2	Basic control action & Industrial automatic controller: On/Off or two position, proportional, integral, proportional-Integral, proportional-derivative and proportional-integral-derivative control action. Pneumatic controller: Pneumatic amplifiers, pneumatic proportional controller, pneumatic derivative and integral control action, PID controller, PI controller action.	**7**	**CO3**
3	Hydraulic controller: Advantage and disadvantage of Hydraulic controllers, Hydraulic integral controller, proportional controller, Hydraulic PI controller, hydraulic PD controller. Comparison between pneumatic and hydraulic systems Electronic controller: On/Off or two position, proportional, integral, proportional-integral, proportional-derivative and proportional-integral-derivative, design and consideration.	**7**	**CO4** **CO5**
4	Control valve: Type and characteristics, control valve sizing, selection	**6**	**CO6**

	criteria concept. Calculation of control valve size, positioner, necessity type & effects on performance of control valve. Pneumatic control valve characteristics, Auxiliary process components: Hydraulic pumps & power supply, Hydraulic servomotor, Hydraulic integrator, Amplidyne.		

Reference Books:

1. Process Control and Instrument Technology by C.D.Jhonson.
2. Instrumentation for Process Measurement and Control By N.A.Anderson
3. Automatic Control Engineering by Raven
4. Automatic Control System by C.Kuo
5. Modern Control Engineering by Katsuhiko & Ogata
6 Control System by Nagrath & Gopal

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-208	**Course Name:** Electrical Machines - I		**L** 3	**T** 1	**P** 0	**C** 4
Year and Semester	**IInd Year IVth Semester**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**Basic Electrical Engg**	**Evaluation**				
		CIE: 40		**SEE: 60**		

Course Objectives:	
1. To introduce students with the fundamentals of energy conversion.	
2. To familiarize and gain knowledge about DC generators and DC motors construction, working, staring and performance.	
3. To have good understanding of single phase transformers based on working and operation under different loading conditions.	
4. To introduce open circuit, short circuit, transmission, hybrid parameters and their interrelationship.	
5. To gain analytical skills based on operation of three phase transformers.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Acquire knowledge about the fundamental principles and electromagnetic energy conversion.
CO2	Acquire knowledge about the constructional details and principle of operation of dc

	machines, starting and speed control, including numerical problems.
CO3	Acquire knowledge about testing and applications of dc machines
CO4	Acquire knowledge about the constructional details, principle of operation, testing and applications of transformers.
CO5	Acquire knowledge about the constructional details, operation, testing, Analytical capability, and applications of single and 3 phase transformers.
CO6	Operate single phase and three phase transformers in parallel sharing the load. And Numerical analysis of this operation.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	Cos
1	**Principles of Electro-mechanical Energy Conversion:** Introduction, Review of magnetic system, Force and torque in magnetic field system, Energy balance equation, Energy conversion via electrical field, Determination of the Force and Torque from energy and co-energy, Generation of EMF in Machines.	**5**	**CO1, CO2**
2	**DC Machines-I:** Principle, Construction, and Classification of DC generators, EMF equation of generator, Armature winding, Armature reaction, Commutation, Performance characteristics of DC generators, and applications.	8	**CO2**
3	**DC Machines-II:** Principle, Construction, and Classification of DC motor, back emf, power equation, condition for maximum efficiency, armature torque and shaft torque, losses and efficiency, power stages, Performance characteristics of DC motors, Starting of DC motors; 3 point and 4 point starters, Speed control of DC motors; Field control, Armature control and Voltage control (Ward Leonard method); Efficiency and Testing of DC machines (Hopkinson's and Swinburne's Test).	**9**	**CO2, CO3.**
4	**Single Phase Transformer:** Construction & Principle, Ideal and practical transformer, shifting impedances, exact and approximate equivalent circuit, resistive, inductive and capacitive loading with phasor diagrams, losses in transformers. Efficiency and condition for maximum efficiency, voltage regulation, Testing of Transformers- O.C. and S.C. tests, Polarity test, Sumpner's test, parallel operation and load sharing, Auto Transformer- Single phase autotransformers, merits and de-merits and applications.	**10**	**CO4,**
5	**Three Phase Transformers:** Construction, Three phase transformer, phasor groups and their connections, open delta connection, three phase to 2 phase conversion, Three winding transformers from three single phase transformers. Parallel operation of three phase transformers.	**6**	**CO5, CO6**

Text Books:

1. Electrical Machines", I J Nagrath& D.P. Kothari, Tata McGraw Hill
2. Electrical Machines", Rajendra Prasad , PHI
3. Electrical Machines", S K Sahadev, Cambridge University Press.
4. Electrical Machinery", P S Bimbhra, Khanna Publisher.

Reference Books:

1. Electric Machinery, AE Fitggerald, C. Kingsley Jr and Umans, McGraw Hill, International.

2. Electrical Technology, H. Cotton, CBS Publication.
3. The Performance and Design of AC machines, M G Say, Pit man& Sons.
4. Generalized Theory, P S Bimbhra,Khanna Publishers

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-OE-210</td><td colspan="2">Course Name: Open Elective- II
(i) Digital Techniques</td><td>L
2</td><td>T
1</td><td>P
0</td><td>C
3</td></tr>
<tr><td>Year and Semester</td><td>2nd Year
(IVth Semester)</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">EI-ES-108: Basic Electronics Engineering IInd Semester</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To impart the basic concepts of Digital Electronics.</td></tr>
<tr><td colspan="7">2. To design and study various logic circuits.</td></tr>
<tr><td colspan="7">3. To study various switching applications.</td></tr>
<tr><td colspan="7">4. To lay the foundation for the courses in electronics related to microprocessors and microcomputers.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Understand the basic concepts of Boolean theory and concepts of logic gates in digital electronics.</td></tr>
<tr><td>CO2</td><td colspan="6">Understand the concept of sequential and combinational logical circuit.</td></tr>
<tr><td>CO3</td><td colspan="6">Develop design capability in synchronous and asynchronous sequential circuits.</td></tr>
<tr><td>CO4</td><td colspan="6">Design of memory cells and different memory circuits. Classify different semiconductor memories.</td></tr>
</table>

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	Number system and codes, Boolean relations, sum of products method, algebraic simplification, k-Maps, Karnaugh simplifications, binary addition, binary subtraction, Gates: OR, AND, inverter, the inhibit (enable) operation, XOR circuits, NAND & NOR gates. DeMorgan's Laws, Logic Hardware: DTL, TTL, PMOS, NMOS, CMOS Logic and their characteristics, Dynamic MOS circuits.	7	**CO1**
2	Binary Adders (Half Adder, Full adder,). Arithmetic functions	7	**CO2**

	(True/Complement, Zero/One Element, Binary Subtraction, Digital Comparator), Tristate logic and its uses in computers, Flip flops: RS Latches, Level clocking (Clocked SR flip flop), D latch, Edge triggered JK Flip Flop, JK Master Slave flip flop, T type Flip Flop.		
3	Decoder, Encoders, Multiplexers, Demultiplexures Registers, parallel and Shift Registers, MOS Shift registers, synchronous & Asynchronous counters, up/down counters, Applications of Counters.	**5**	**CO2 CO3**
4	A/D & D/A converters and their design. Digital storage devices: ROM, RAM, EPROM, EEPROM, MOS ROM, ROM Applications	**5**	**CO4**

Reference Books:

1. Digital Electronics by Gothman, Prentice-Hall
2. Digital Principals & Applications by Malvino& Leach, TMH
3. System Design by Sonde, TMH
4. Digital Computer Electronics by A.P.Malvino, TMH
5. Integrated Electronics by Millman&Halkias, McGraw Hill

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-OE-210	**Course Name: Open Elective – II** (ii) Computer Organization		**L** 2	**T** 1	**P** 0	**C** 3
Year and Semester	**2nd Year (IVth Semester)**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Brief knowledge in the following: Logic Circuit Design, Sequential Circuits, Fundamental programming skills	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1.	Understand the basics of computer organization: structure and operation of computers and their peripherals.					
2.	Understand the concepts of programs as sequences or machine instructions.					
3.	Expose different ways of communicating with I/O devices and standard I/O interfaces.					
4.	Describe hierarchical memory systems including cache memories and virtual memory.					
5.	Describe arithmetic and logical operations with integer and floating-point operands.					
6.	Understand basic processing unit and organization of simple processor, concept of					

pipelining and other large computing systems.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	The basic structure of computers & machine instructions and programs, Addressing Modes, Assembly Language, Stacks, Queues and Subroutines. Input/output Organization such as accessing I/O Devices, Interrupts and Memory system
CO2	Some Fundamental Concepts of Basic Processing Unit organization and execution of instruction, buses, buses peripheral devices etc.
CO3	Apply the knowledge gained in the design of Computer.
CO4	Analyse and design arithmetic and logical units
CO5	Design and evaluate performance of memory systems
CO6	Understand the importance of life-long learning

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Basic Structure of Computers**: Basic Operational Concepts, Bus Structures, Performance – Processor Clock, Basic Performance Equation and Measurement.**Machine Instructions and Programs:** Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Basic Input and Output Operations, Stacks and Queues, Subroutines, Additional Instructions, Encoding of Machine Instructions.	**7**	**CO1, CO2**
2	**Input/Output Organization:**Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access, Buses, Interface Circuits,	**6**	**CO2, CO3**
3	**Memory System**: Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, Cache Memories – Mapping Functions, Replacement Algorithms, Performance Considerations, Virtual Memories, and Secondary Storage.	**7**	**CO2, CO3, CO5**
4	**Basic Processing Unit**: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hard-wired Control, Micro programmed Control.	**6**	**CO3, CO4, CO6**

Text Books:

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: Computer Organization, 5th Edition, Tata McGraw Hill, 2002.

Reference Books:

1. William Stallings: Computer Organization & Architecture, 9th Edition, Pearson, 2015.
2. Patterson and Hennessy: Computer Organization & Design: The Hardware/Software Interface, Fourth Edition, Morgan Kaufmann Publishers, 2012.
3. J.P. Hayes: Computer Architecture and Organization, TMH
4. Microprocessor and Interfacing –Douglas V. Hall, TMGH 2nd edition

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-HSM-212	**Course Name:** Project Planning Estimation and Assessment			**L** 2	**T** 0	**P** 0	**C** 2
Year and Semester	**2nd Year (IVth Semester)**	**Contact hours per week:** (2Hrs) Exam: (3 Hrs)					
Pre-requisite of course	**Nil**	**Evaluation**					
		CIE: 40	**SEE: 60**				
Course Objectives:							
1. How to prepare project proposal and appraisal							
2. How to make market survey and demand analysis							
3. How to make technical analysis							
4. How to make finance planning							
5. Hoe to achieve project objectives and policies							
Course Outcomes: On completion of the course, student would be able to:							
CO1	Project appraisal documentation						
CO2	Based on make market survey and demand analysis, to give demand forecast						
CO3	Choice of Technology						
CO4	Cost of the project and means of finance						
CO5	To develop tools to arrive at project objectives						

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	Cos
1	**Project Development Cycle:** Pre-investment phase, implementation phase, operational phase. Aspects of Appraisal: Market Appraisal, Technical Appraisal, Financial Appraisal, Economic Appraisal. Objectives of investment decision making. Scouting for project ideas; Preliminary Screening, compatibility with the promoter, consistency with governmental prioritize, availability of inputs, Adequacy of the market, Reasonableness of cost, Acceptability of Risk Level.	**6**	**CO1**
2	**Market and Demand Analysis:** Information required for Market and Demand Analysis, Secondary sources of information, Market Survey - Steps in sample survey, Demand Forecasting, Uncertainty in Demand forecasting, Method of Forecasting, Environmental Changes, coping with uncertainties. **Technical Analysis:** Material and inputs; Product Technology; Choice of Technology, Acquiring Technology, Appropriateness, of Technology, Product Mix, Plant Capacity, Location of site.	**6**	**CO2**
3	**Financial Estimates:** Cost of Project, Main Components, Means	**6**	**CO3**

	of financing, Planning the Capital structure of a new company, Norms of the Controller of Capital issue, Norms and requirements of All India Financial Institutions, Stock Exchange stipulation, Difficulty in raising External Finance, Designing the capital structure.		**CO4**
4	**Project Planning & Control:** Functions of Planning, Areas of planning, Project objectives and policies, life cycle of a project, Tools of Planning, Hierarchy of plans; Project Control- Reasons for ineffective control, variance Analysis Approach, Performance Analysis, Modern Approach to Control.	**6**	**CO5**
5			

Reference Books:

1. Project Preparation, Appraisal, Budgeting Implementation by Prasanna Chandra, Tata Mc-Graw Hill. (2017)
2. O.P. Khanna – Industrial Engineering and Management – Dhanpat Rai and Sons, 2001
3. S. Elion – Elements of Production planning and control – Macmillan Co. 2007
4. I.M. Pandey – Financial Management – Vikas Publishing Co.
5. E.S. Baffa – Modern production management – John Wiley and Sons. 2008
6. I.W.Burr – Engineering Statistics and Quality Control – McGraw Hill, 2011
7. A.J. Ducan – Quality control and industrial statistics – Richard.D.Irwing Inc.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRPC-10</td><td colspan="2" rowspan="2">Course Name: Power Electronics-I Lab.</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Year and Semester</td><td>2nd Year
IVth Semester</td><td colspan="5">Contact hours per week: (2Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Brief knowledge of in the following topics: Basic Electrical and Electronics engineering, Semiconductor devices, Digital Electronics, rectifiers.</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 20</td><td colspan="4">SEE: 30</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Understand the Construction, principles and Characteristics of Power Devices Such as SCR, IGBT, MosFET etc .</td></tr>
</table>

2. Understand the concepts of SCR triggering circuits and its firing techniques.	
3. Understand different types of supplies used for turning on of SCRs.	
4. Understand the output characteristics of converters at different firing angles and different types of loadings.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the Construction, principles and Characteristics of Power Devices.
CO2	To understand the various types of SCR triggering circuits and its firing techniques.
CO3	To understand different methods of turning on of SCRs.
CO4	To understand the output characteristics of converters at different firing angles and different types of loadings.

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
	LIST OF EXPERIMENTS STUDY EXPERIMENTS :	**CO1, CO2, CO3, CO4**
1.	To Study the characteristics of SCR. find out the holding and latching current.	
2.	To plot the output characteristics of MOSFET	
3.	To plot the output characteristics of IGBT.	
4.	To trigger the SCR with DC triggering	
5.	To trigger the SCR with μ- controller based firing circuit.	
6.	To synchronize UJT firing circuit.	
7.	To perform the time delay with the help of UJT.	
8. t	To trigger single phase converter at different firing angles.	
9.	To study the resistance R and resistance-capacitance RC triggering of SCR.	
10.	To trigger SCR with digital circuit.	
11.	To turn on SCR using different methods.	
	SIMULATION EXPERIMENTS :	
1.	Single Phase Half wave controlled converter with R,RL&RLE Load (for firing angles 30,60,90)with/without FD	
2.	Single Phase Half controlled converter with R,RL&RLE Load (for firing angles 30,60,90)with/without FD	
3.	Single Phase Full controlled converter with R,RL&RLE Load (for firing angles 30,60,90)with/without FD	
4.	Three Phase semi controlled converter with R,RL&RLE Load	
5.	Three Phase full controlled converter with R,RL&RLE Load	
6.	Single phase AC Voltage Controller with R&RL Loads	
7.	Boost converter and buck converter with open loop and closed loop operations	
8.	Single Phase cyclo converter	
	HARDWARE EXPERIMENTS :	
1.	Thyristorised drive for PMDC motor with speed measurement and Single Phase Half controlled rectifier and full controlled rectifier	
2.	Three Phase input Thyristorised drive for Dc Motor with closed loop control	
3.	Single Phase Series Inverter	
4.	Single Phase Parallel Inverter	

REFERENCE BOOKS:

1. Modern Power Devices by B.Jayant Balica, New Age Inter.
2. Power Electronics by P.C. Sen (TMH)
3. An Introduction to Thyristors and Their Applications by M. Ramamurthy (EWP)
4. Power electronics by Ned Mohan and Robins, John Wiley and Sons

5. Thyristor Phase Controlled converters and Cyclo-converters by B.R.Pelly
6. Power Electronics by Vendem Subrahmanyam, New Age International

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRPC-12</td><td colspan="2" rowspan="2">Course Name: Electrical Measurements & Instrumentation Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Year and Semester</td><td>2nd Year
IVth Semester</td><td colspan="5">Contact hours per week: (2Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Brief knowledge of in the following topics: Basic Electrical and Electronics engineering, Semiconductor devices, Digital Electronics, rectifiers.</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 20</td><td colspan="4">SEE: 30</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Understand the Construction and principles of Construction and working principles of wattmeter and energy meters..</td></tr>
<tr><td colspan="7">2. Understand the concepts of measurements of high and low resistances.</td></tr>
<tr><td colspan="7">3. Understand the null deflection and implement it in CT & PT.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">To understand the Construction and working principles of wattmeter and energy meters.</td></tr>
<tr><td>CO2</td><td colspan="6">To understand the methods to measure high and low resistances..</td></tr>
<tr><td>CO3</td><td colspan="6">To understand how to implement null deflection and in CT & PT.</td></tr>
<tr><td>CO4</td><td colspan="6">To understand the displacement measurements in LVDT.</td></tr>
</table>

<table>
<tr><td rowspan="2">Expt. No</td><td>COURSE SYLLABUS</td><td rowspan="2">COs</td></tr>
<tr><td>CONTENTS OF MODULE</td></tr>
<tr><td></td><td>LIST OF EXPERIMENTS STUDY EXPERIMENTS :</td><td rowspan="15">CO1, CO2, CO3, CO4</td></tr>
<tr><td>1.</td><td>To calibrate D.C. Energy Meter at different loads.</td></tr>
<tr><td>2.</td><td>To study the error in wattmeter at various p.f,s (power factors)</td></tr>
<tr><td>3.</td><td>To measure resistance of the order of 5/10 ohm using (a) Ammeter, Voltmeter method. (b) Method of substitution (c) Carrey foster bridge.</td></tr>
<tr><td>4.</td><td>To measure the inductance and resistance of given inductor at different audio frequencies 200 Hz to 10Kz, using Maxwell’s inductance, capacitance bridge, Hays Bridge.</td></tr>
<tr><td>5.</td><td>To measure low resistance using Kelvin’s Double Bridge.</td></tr>
<tr><td>6.</td><td>To determine the current ratio and phase angle of the given current transformer at different nominal current ratio using direct deflection method.</td></tr>
<tr><td>7.</td><td>To study Lloyd fisher square and separate hysterises and eddy current losses of the specimen in the square.</td></tr>
<tr><td></td><td>Calibration of D.C. Voltmeter 0-300 V and Ammeter 0-10 mA using Crompton potentiometer.</td></tr>
<tr><td>8.</td><td>Measurement of displacement with the help of LVDT.</td></tr>
<tr><td>9.</td><td>Dielectric oil testing using H.T. testing Kit.</td></tr>
<tr><td>10.</td><td>Calibration and Testing of single phase energy Meter.</td></tr>
<tr><td>11.</td><td>Measurement of 3 - Phase reactive power with single-phase wattmeter.</td></tr>
<tr><td>12.</td><td>Measure the capacitance using Schering bridge and find out the balance equation.</td></tr>
<tr><td>13.</td><td>Measure the self-inductance using Anderson bridge and find out the balance equation.</td></tr>
</table>

14.	Resistance strain gauge – strain measurements and Calibration.	
15.	C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method.	
16.	PT testing by comparison – V. G. as Null detector – Measurement of % ratio error and phase angle of the given PT.	

REFERENCE BOOKS:

1. A Course in Elect. & Electronic Measurement & Instrumentation by A. K. Sawhney; Khanna Pub.

REFERENCE BOOKS:

1. Electrical Measurments by E.W. Golding
2. Electronic & Elect. Measurment&Instrumention by J.B.Gupta; Kataria& Sons.
3. Electronic Instrumentation &Measurment Technique, W.D. Cooper & A.D. Helfrick.
4. Measuring Systems by E.O. Doeblin; TMH.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PROE-14	**Course Name:** Open Elective-II Lab. (i) Digital Techniques		**L** 0	**T** 0	**P** 2	**C** 1
Year and Semester	**2nd Year IVth Semester**	**Contact hours per week:** (2 Hrs) **Exam:** (3 hrs.)				
Pre-requisite of course	**Basic Electronics**	**Evaluation**				
		CIE: 20	**SEE: 30**			
Course Objectives:						
1. To impart the basic practical aspects of Digital Electronics.						
2. To make a differentiation between the Analog Electronics and Digital electronics through practical modes.						
3. To lay the foundation for the courses in electronics related to microprocessors, microcomputers and computers which are more advanced courses based on digital electronics and the revolution in electronics						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Well verse with the fundamentals and the parameters of digital components related to their fabrication and internal circuitry.					
CO2	To design and study various logic circuits.					
CO3	Develop design capability in synchronous and asynchronous sequential circuits.					

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	Design and study Diode logic circuit AND and OR gate and verify the truth table.	**CO1, CO2, CO3**
2	Design and study DTL circuit NAND and NOR gate and verify the truth table.	
3	Design and study TTL NAND gate Circuit and verify the truth table.	
4	Draw EX-OR and EX-NOR logic circuit with the help of 7400 and verify its truth table.	
5	Draw the circuit of half adder and full adder and verify its truth table.	
6	Draw the SR and D flip flop and verify the truth table with the help of 7400.	
7	Draw the JK Flip flop and JK Master slave flip flop with 7400 and verify the truth table.	
8	Draw the Parallel in Parallel out registers with 7476 and verify its operation	

9	Draw the shift registers with 7476 and verify its operation.	
10	Draw the circuit of synchronous counter with 7476 and perform the up counting.	
11	Draw the circuit of asynchronous counter with 7476 and perform the up counting.	
12	Draw the circuit of asynchronous counter with 7476 and perform the down counting.	
13	Draw the mode 10 asynchronous up counter with 7476.	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PROE-14	**Course Name:** Open Elective-II Lab. (ii) Computer Organization		**L** / **0**	**T** / **0**	**P** / **2**	**C** / **1**
Year and Semester	**2nd Year IVth Semester**	**Contact hours per week:** (2Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	Brief knowledge of in the following topics: Logic Circuit Design, Sequential Circuits, Fundamental programming skills	**Evaluation** — **CIE: 20**	**SEE: 30**			

Course Objectives:	
1.	Understand the basics of computer organization: structure and operation of computers and their peripherals.
2.	Understand the concepts of programs as sequences or machine instructions.
3.	Expose different ways of communicating with I/O devices and standard I/O interfaces.
4.	Describe hierarchical memory systems including cache memories and virtual memory.
5.	Describe arithmetic and logical operations with integer and floating-point operands.
6.	Understand basic processing unit and organization of simple processor, concept of pipelining and other large computing systems.
Course Outcomes: On completion of the course, student would be able to:	
CO1	The basic structure of computers & machine instructions and programs, Addressing Modes, Assembly Language, Stacks, Queues and Subroutines. Input/output Organization such as accessing I/O Devices, Interrupts and Memory system
CO2	Some Fundamental Concepts of Basic Processing Unit organization and execution of instruction, buses, buses peripheral devices etc.
CO3	Apply the knowledge gained in the design of Computer.
CO4	Analyse and design arithmetic and logical units
CO5	Design and evaluate performance of memory systems
CO6	Understand the importance of life-long learning

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
	Exercises in Micro Processor programming:	
1	Write the working of 8085 simulator GNUsim8085 and basic architecture of 8085 along with small introduction.	**CO1, CO2, CO3, CO4**
2	Study the complete instruction set of 8085 and write the instructions in the instruction set of 8085 along with examples.	
3	Write an assembly language code in GNUsim8085 to implement data transfer instruction.	

4	Write an assembly language code in GNUsim8085 to store numbers in reverse order in memory location.	
5	Write an assembly language code in GNUsim8085 to implement arithmetic instruction.	
6	Write an assembly language code in GNUsim8085 to add two numbers using lxi instruction.	
7	Write an assembly language code in GNUsim8085 to add two 8 bit numbers stored in memory and also storing the carry.	
8	Write an assembly language code in GNUsim8085 to find the factorial of a number.	
9	Write an assembly language code in GNUsim8085 to implement logical instructions.	
10	Write an assembly language code in GNUsim8085 to implement stack and branch instructions.	
	Write assembly language programs for the following using GNU Assembler.	
11	Write assembly language programs to evaluate the expressions: i) a = b + c – d * e ii) z = x * y + w – v +u / k a. Considering 8-bit, 16 bit and 32 bit binary numbers as b, c, d, e. b. Considering 2 digit, 4 digit and 8 digit BCD numbers. Take the input in consecutive memory locations and also Display the results by using “int xx” of 8086. Validate program for the boundary conditions.	
12	Write an ALP of 8086 to take N numbers as input. And do the following operations on them. a. Arrange in ascending and descending order.	
13	Write an ALP of 8086 to take N numbers as input. And do the following operations on them. a. Find max and minimum b. Find average Considering 8-bit, 16 bit binary numbers and 2 digit, 4digit and 8 digit BCD numbers. Display the results by using “int xx” of 8086. Validate program for the boundary conditions.	
14	Write an ALP of 8086 to take a string of as input (in ‘C’ format) and do the following Operations on it. a. Find the length b. Find it is Palindrome or n. Considering 8-bit, 16 bit binary numbers and 2 digit, 4digit and 8 digit BCD numbers. Display the results by using “int xx” of 8086. Validate program for the boundary conditions.	
15	Write an ALP of 8086 to take a string of as input (in ‘C’ format) and do the following Operations on it. a. Find whether given string substring or not.	
16	Write an ALP of 8086 to take a string of as input (in ‘C’ format) and do the following Operations on it a. Find the Armstrong number b. Find the Fibonacci series for n numbers Display the results by using “int xx” of 8086.	
17	Write the ALP to implement the above operations as procedures and call from	

	the main procedure.	
18	Write an ALP of 8086 to find the factorial of a given number as a Procedure and call from the main program which display the result.	

REFERENCE BOOKS:

1. Switching theory and logic design –A. Anand Kumar PHI, 2013
2. Advanced microprocessor & Peripherals-A. K. Ray and K. M. Bherchandavi, TMH, 2nd edition.
3. Switching and Finite Automatic theory-Zvi Kohavi, Niraj K.Jha Cambridge, 3rd edition
4. Digital Design –Morris Mano, PHI, 3rd edition
5. Microprocessor and Interfacing –Douglas V. Hall, TMGH 2nd edition

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-16	**Course Name:** ELECTRICAL MACHINES-I LAB	**L** 0	**T** 0	**P** 3	**C** 1.5
Year and Semester	**IInd Year IV th Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Basic Electrical Engg**	**Evaluation**			
		CIE: 30		**SEE: 45**	
Course Objectives:					
1. To have practical knowledge about working of DC machines.					
2. To be able to test DC machines for their performance.					
3. To have practical knowledge of working of single and three phase transformers.					
4. To be able to conduct experimentation on single and three phase transformers.					
Course Outcomes: On completion of the course, student would be able to:					
CO1	have sound practical understanding of DC generators and DC motors.				
CO2	conduct experimentation on DC machines under different operating conditions.				
CO3	have practical understanding of single phase and three phase transformers.				
CO4	conduct various tests on single and three phase transformers.				

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	Cos
1	Measurement of induced emf and magnetising current under open circuit condition in D.C. generators.	**CO1, CO2, CO3, CO4**
2	Determination of the relationship between terminal voltage and load current keeping speed constant for(a) Separately excited generator keeping excitation constant (b) D.C. shunt generator.	
3	To measure the variation in no load speed of a separately excited d.c. motor for the variation in (a) Armature circuit resistance(b) Field circuit resistance.	
4.	To study the working of DC motor starters.	
5	Speed control of DC shunt motor using (a) armature control (b) field control.	
6	To conduct brake test on dc shunt motor.	
7	To Perform Load test on a single phase transformer.	
8	To perform Open circuit and short circuit tests on a single phase transformer and hence find Equivalent circuit, voltage regulation and efficiency.	
9	To find the efficiency and voltage regulation of single phase transformer under different loading Conditions	
10	To perform parallel operation of two single phase transformers.	
11	Polarity test and 3-phase connections of single phase transformers.	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-OE-301	**Course Name: Open Elective-III** **(i)** Environment Monitoring Instrumentation		**L** 3	**T** 1	**P** 0
Year and Semester	**3rd Year** **Vth Semester**	**Contact hours per week:** (4Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**NIL**	**Evaluation**			
		CIE: 40	**CIE: 60**		

C: 4

Course Objectives:	
1.	To understand the concept of pollution monitoring
2.	To Understand the concepts of Air pollution
3.	To study the various air pollution monitoring instruments and methods
4.	To study water pollution and its monitoring equipment

Course Outcomes: On completion of the course, student would be able to:	
CO1	Identify sources of air and water pollution and their effects
CO2	Sample and analyze air pollutants
CO3	Understand the air quality monitoring instruments
CO4	Sample and analyze water borne pollutants
CO5	Understand the water quality monitoring instruments

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Air and water Pollution: Sources & Effects:** Definition and concentrations, classification, emission sources, Air pollution standards, sources of pollutions, effects of Air pollution, Sources of contamination of surface and ground water.	9	CO1
2	**Air Pollution Sampling and Measurements:** Ambient air sampling, Collection of gaseous air pollutants, Collection of particulate pollutants, stack sampling, Analysis of Air pollutants.	9	CO1, CO2
3	**Air Pollution Monitoring Instruments:** Photometry, Mass spectrometry, NMR, X-ray Fluorescence, Infra-red spectrometry, Flame photometry, Atomic absorption spectroscopy, chromatography, Coulometry etc. for measurement of SO2, Nitrogen oxides, carbon monoxide, hydrocarbons and particulate matter.	9	CO2, CO3
4	**Water Pollution sampling and Measurements and Monitoring Instruments:** Sampling and Analysis, Samplers-Bailers, Heavy metal and trace metal analyzers, pH meters, Resistivity meters, Induced Polarization (IP) Meter for monitoring of industrial contamination. Waste water management and recycling equipment.	9	CO1, CO4, CO5

Recommended Books:

1. A Text Book in Environmental Pollution and control, Bhatia H.S., Galgotia Publication (1998)
2. Environmental Engineering and Management, Dhameja S.K., S.K Kataria (2000)
3. Air Pollution, Rao M.N. and Rao H.V., Tata McGraw Hill (2004)
4. Environmental Pollution Control, Rao. C.S., New Age International (P) Limited, Publishers (2006) 2nd ed.
5. Environmental Pollution Analysis, S M Khopkar, New Age International.
6. Industrial Pollution, V P Kudesa, PragatiPrakashan
7. Ground Water Hydrology, David Keith Todd, Wiley Publications

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-OE-301</td><td colspan="3">Course Name: Open Elective-III
(ii) Electromagnetic Filed Theory</td><td>L
3</td><td>T
1</td><td>P
-</td><td>C
4</td></tr>
<tr><td>Year and Semester</td><td>3rd Yr.
5th Semester</td><td colspan="6">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="6">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="4">SEE: 60</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td colspan="8">1. To introduce the basic mathematical concepts related to electromagnetic vector fields.</td></tr>
<tr><td colspan="8">2. To impart knowledge on the concepts of electrostatics, electrical potential, energy density and their applications.</td></tr>
<tr><td colspan="8">3. To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications</td></tr>
<tr><td colspan="8">4. To impart knowledge on the concepts of Faraday’s law, induced emf and Maxwell’s equations.</td></tr>
<tr><td colspan="8">5. To impart knowledge on the concepts of Concepts of electromagnetic waves and Pointing vector.</td></tr>
<tr><td colspan="8">6. To acquaint mathematically with transmission lines circuits and their characteristics.</td></tr>
<tr><td colspan="8">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="7">Have a good understanding of various principles and phenomenon of electrostatics through analytical illustrations.</td></tr>
<tr><td>CO2</td><td colspan="7">Gain sound knowledge of magnetostatics in terms of magnetic field, flux density,</td></tr>
</table>

	current density, and time varying equations (Maxwell's equations).
CO3	Understand and apply Maxwell's equations for time varying fields.
CO4	Understand and explain the characteristics, propagation of EM waves under different media and conditions.
CO5	Have knowledge of transmission times in terms of Characteristics Impedance, Propagation Constant, Phase and Group Velocities, Input Impedance Relations through illustrations.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Electrostatics:** Coulomb's Law, Electric Field Intensity - Fields due to Different Charge Distributions, Electric Flux Density, Gauss Law and Applications, Electric Potential, Relations Between E and V, Maxwell's Two Equations for Electrostatic Fields, Energy Density, Illustrative Problems, Convection and Conduction Current, Dielectric Constant, Isotropic and Homogeneous Dielectrics, Continuity Equation, Relaxation Time.	**8**	**CO1**
2	**Magnetostatics:** Biot - Savart's Law , Ampere's Circuital Law and Applications, Magnetic Flux Density, Maxwell's Two Equations for Magnetostatic Fields, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Ampere's Force Law, Inductance and Magnetic Energy, Illustrative Problem.	**6**	**CO2**
3	**Time Varying Fields (Maxwell's equations):**Ampere's Law and Displacement Current Density, Maxwell's Equations in Different Forms and Word Statements, Conditions at a Boundary Surface: Dielectric - Dielectric and Dielectric - Conductor Interfaces, Illustrative Problems	**6**	**CO3**
4	**EM Wave Characteristics** Wave Equations for Conducting and Perfect Dielectric Media, Uniform Plane Waves - Definition, All Relations Between E & H, Sinusoidal Variations, Wave Propagation in Lossless and Conducting Media, Conductors & Dielectrics - Characterization, Wave Propagation in Good Conductors and Good Dielectrics, Polarization, Illustrative Problems. **Reflection and Refraction of Plane Waves** - Normal and Oblique Incidence for both perfect Conductor and perfect Dielectrics, Brewster Angle, Critical Angle and Total Internal Reflection, Surface Impedance, Poynting Vector and Poynting Theorem - Applications, Power Loss in a Plane Conductor., Illustrative Problems.	**10**	**CO4**
5	**Transmission Lines** Types, Parameters, Transmission Line Equations, Primary & Secondary Constants, Expressions for Characteristics Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line Concepts, Losslessness/Low Loss Characterization, Input Impedance Relations, SC and OC Lines, Reflection Coefficient,Illustrative Problems.	**6**	**CO5**

Text Books:

1. Electromagnetism – Theory and Applications, Ashutosh Pramanik, , PHI Learning Private Limited, New Delhi, Second Edition-2009.

2. Engineering Electro-magnetics : E. C. Jordan.
3. Electromagnetic Field Theory (including Antennaes and wave propagation,K.A. Gangadhar, P.M. Ramanthan 16th Edition, Khanna Publications, 2007.

Reference Books:

1. Field & Wave Electromagnetic: Cheng, Pearson Education
2. Principles of Electromagnetics', Mathew N. O. Sadiku, 4th Edition ,Oxford University Press Inc. First India edition, 2009.
3. Electromagnetics: Edminister, Schaum series, 2nd Ed.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-OE-301</td><td colspan="2" rowspan="2">Course Name: Open Elective-III
(iii) Mathematics– III</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>3rdYear
<b>5th Semester</td><td colspan="5">Contact hours per week: (4 Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">The course assume prior knowledge of Infinite series, Trigonometric relations, Partial Differentiation, Probability concepts</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 40</td><td colspan="4">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">9. To understand power series and possible application for solving differential equation</td></tr>
<tr><td colspan="7">10. To know and understand the Fourier series expansions and its utilities.</td></tr>
<tr><td colspan="7">11. To gain knowledge on complex domains and evaluate residues of series expansions in complex domains.</td></tr>
<tr><td colspan="7">12. To explore and analyze Probability distributions and probe its utilities in various situations.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Understand the fundamental of series expansions.</td></tr>
<tr><td>CO2</td><td colspan="6">Apply the series expansions to solve various Mathematical problem situations.</td></tr>
<tr><td>CO3</td><td colspan="6">Understand and analyze complex functions handling and its applications to solve various problems.</td></tr>
</table>

CO4	Students should be able to use his knowledge of probability to analyze and apply to communicate in technical ways.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Bessel functions:** series solution of Bessel differential equation, Bessel function of first kind Jn(x), recurrence relations. **Legendre Polynomials:** Legendre differential equation, Legendre polynomials $P_n(x)$ as solution of Legendre differential equation for (n>0), recurrence relations.	**10**	**CO1, CO2**
2	**Fourier Series:** Euler's formulae, conditions for Fourier expansions, Fourier expansion of functions having points of discontinuity, change of interval, odd & even functions, half range series. **Fourier Transforms:** Fourier Integrals, Fourier transforms, Fourier cosine and sine transforms, **Properties of Fourier Transforms**: convolution theorem, Parseval's identity, relation between Fourier and Laplace transforms	**8**	**CO1, CO2**
3	**Function of a complex variables:** Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, harmonic functions, Taylor and Laurent series, singular points, residues, evaluation of residues at poles, and poles of m^{th} order, Cauchy's residue theorem, the Cauchy's principle value, evaluation of definite integrals.	**10**	**CO1, CO2, CO3**
4	**Probability Distributions:** Probability, Bayes theorem, Discrete & Continuous probability distributions, discrete random variable, probability function, distribution function, Mathematical expectation, expectation of a sum of random variables, expectation of product of independent variables, covariance, Moment generating function, probability generating function.	**8**	**CO1, CO2, CO4**

TEXT BOOKS:

1. Advanced Engineering Mathematics by E. Kreyszig. 10th Edition, John Wiley
2. Higher Engineering Mathematics by B.S. Grewal. 43rd Edition, Khanna Publications
3. Schaum's Outline of Complex Variables by Murray R. Spiegel, 2nd Edition, McGraw-Hill Education
4. Probability and Statistics for Engineers by J. Ravichandran, Wiley India Publication.

REFERENCE BOOKS:

1. Engineering Mathematics Part-I: S.S. Sastry, 4th Edition, PHI.
2. Advanced Engineering Mathematics: R.K. Jain, S.R.K. Iyengar, 3rd Edition, Narosa Publications
3. Probability and Statistics for Engineers by Richard A Johnson, 9th Edition, PHI

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-OE-301	**Course Name: Open Elective-III** (iv) Energy Efficient Systems	**L** 3	**T** 1	**P** 0	**C** 4
Year and Semester	**3rd Year (Vth Semester)**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)			
Pre-requisite of course	Brief knowledge of in the following topics: Electrical Machines, Electrical Power System and Generation.	**Evaluation** — **CIE: 40**	**SEE: 60**		

Course Objectives:

1. To introduce the concept of single phase and three phase motors.
2. To introduce the concept of Energy efficient machines and Economics of Power factor improvements.
3. To study the concept of Energy efficient lighting and Economics of Energy power generation.
4. To study the concept of economics of electrical energy distribution and electrical drives.

Course Outcomes: On completion of the course, student would be able to:

CO1	To Familiarize withthe concept of single phase and three phase motors.
CO2	To understand the concept of Energy efficient machines and Economics of Power factor improvements.
CO3	To Familiarize with the concept of Energy efficient lighting and Economics of Energy power generation.
CO4	To understand the concept of economics of electrical energy distribution and electrical drives.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**THREE PHASE INDUCTION MOTROS:** Cage motors-equivalent circuit-speed-torque characteristics-performance characteristics voltage unbalance-over motoring-slip ring induction motor characteristics multi speed motors. **SINGLE PHASE INDUCTION MOTORS:** Starting & running performance-split phase-capacitor type motor-characteristics reluctance motor.	**7**	**CO1**
2	**ENERGY EFFICIENT MOTORS:** Constructional details-factors affecting	**8**	**CO2**

	efficiency-losses distribution-characteristics calculation of pay back period. **ECONOMICS OF POWER FACTOR IMPROVEMENT:** Simple pay back method-return on investment-life cycle analysis.		
3	**ENERGY EFFICIENT LIGHTING:** Terminology-cosine law of illumination-types of lamps-characteristics-design of illumination systems-good lighting practice-lighting control-steps for lighting energy conservation. **ECONOMICS OF ELECTRICAL ENERGY GENERATION:**Definitions-connected load, maximum demand-demand factor-curve-base load and peck load.	**11**	**CO3**
4	**ECONOMICS OF ELECTRICAL ENERGY DISTRIBUTION:** Electrical load analysis-type of consumers& tariffs-line losses-corner losses-types of distribution systems- Kevin's law-loss load factor. **ECONOMICS OF ELECTRICAL DRIVES:** Selection of motors-types of loads-energy consumption during starting of ac and dc motors braking of motors-plugging-regenerative braking.	**10**	**CO4**

Text Books:

1. Electrical Machinery: Fitzerland, Kingsley, Kusko-MC Graw Hill Ltd.
2. Energy-Efficient Electrical motors: John C.Andreas-Marcel Decker Inc.
3. Electrical Technology: Edward Hughes-ElLBS. Energy Management and good lighting practice: Fuel Efficiency Booklet 12-eeo.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PC-303</td><td rowspan="2" colspan="2">Course Name: Power Electronics-II</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>3rd Year
(Vth Semester)</td><td colspan="5">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Brief knowledge of in the following topics: Power Electronics I, Basic Electrical and Electronics engineering, Semiconductor devices, Digital Electronics, rectifiers.</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 40</td><td colspan="4">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
</table>

1. To introduce the concept of Choppers.	
2. To introduce the concept of Inverters and types of inverters.	
3. To study the modulation & harmonics and techniques to remove harmonics.	
4. To study various types of chopper drives and its applications.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To Familiarize with control strategies of choppers, types of choppers.
CO2	To understand the working of Inverters.
CO3	To Familiarize with inverters, types of choppers and their mode of angles of operations.
CO4	To understand the applications of choppers and at different stages.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Choppers:** Principle of choppers, Control strategies; Constant frequency system and Variable frequency system. Step-up choppers, Types of chopper Circuits; First Quadrant or Type-A choppers, Second-Quadrant or Type-b choppers, Two-Quadrant Type-a Chopper or Type-C chopper, Two-Quadrant Type-b Chopper or Type-D chopper, Four-Quadrant Type-a Chopper or Type-E chopper.	**7**	**CO1**
2	**Inverters:** operating Principle of Single Phase Voltage source inverter; Single –Phase bridge inverter, Force-commutated thyristor inverter; Modified Mcmurray-Bedford Half-bridge Inverter, Modified Mcmurray-Bedford Full-bridge Inverter, Three Phase Bridge Inverter; Three –Phase 180^0 Mode VSI and Three –Phase 120^0 Mode VSI.	**8**	**CO2**
3	**Modulation and Harmonics;** Pulse Width Modulated Inverter; Single-Phase Modulation, Multiple Phase Modulation, Sinusoidal Pulse Modulation (Sin M), Reduction Of Harmonics in the inverter output Voltage; Harmonics Reduction by PWM, Harmonics Reduction by Transformer connection, Harmonics Reduction by Stepped wave Inverter.	**11**	**CO3**
4	**Chopper Drives and Applications:** Thyristor Chopper Circuits; Voltage commutated choppers, Current-commutated choppers and Load commutated choppers. Chopper Drives; Power Control or Motoring Control. Regenerative-Breaking control, Two Quadrant chopper control and Four Quadrant Chopper control, Static Kramer Drives, Static Scherbius Drive. (No quantitative analysis)	**10**	**CO4**

Text Books:

1. Modern Power Devices by B.Jayant Balica, New Age Inter.
2. Power Electronics by P.C. Sen (TMH)
3. An Introduction to Thyristors and Their Applications by M. Ramamurthy (EWP)
4. Power electronics by Ned Mohan and Robins, John Wiley and Sons
5. Power Electronics by M. Rashid (PHI)
6. Thyristor Phase Controlled converters and Cyclo-converters by B.R.Pelly
7. Power Electronics by Vendem Subrahmanyam, New Age International

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-PE-305</td><td colspan="2">Course Name: Program Elective-II
(i) Microprocessors</td><td>L
3</td><td>T
1</td><td>P
-</td><td>C
4</td></tr>
<tr><td>Year and Semester</td><td>3rd Yr.
5th Semester</td><td colspan="5">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">EI-OE-210 DIGITAL TECHNIQUES IVth Semester</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To equip the students with architecture and working of basic microprocessors.</td></tr>
<tr><td colspan="7">2. To make the students understand the instructions sets of basic microprocessors and various assembly language programs.</td></tr>
<tr><td colspan="7">3. To impart the knowledge of various programmable interfacing chips.</td></tr>
<tr><td colspan="7">4. To design and study the various instrumentation systems with programmable chips.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Understand the basic of the internal organisation of 8086 Microprocessor.</td></tr>
<tr><td>CO2</td><td colspan="6">Understand different addressing modes and instructions of 8086, design and develop assembly language programs using software interrupts, subroutines, macros.</td></tr>
<tr><td>CO3</td><td colspan="6">Understand to interface memory and I/O devices with 8086 through programmable interface chips</td></tr>
<tr><td>CO4</td><td colspan="6">Understand interrupt structure in 8086 and few case studies using interfacing chips useful in instrumentation systems.</td></tr>
</table>

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Introduction and Evolution of microprocessors, Introduction to Microcomputer systems, 8086 Microprocessor - Architecture and signals, Pin diagram, Memory organisation,, Minimum mode 8086 system and Timing diagrams, Maximum Mode 8086 system and Timing diagrams.	**8**	**CO1**
2	8086 Addressing Modes, 8086 Instruction set and Assembler Directives - Assembly Language Programming, Basic interfacing concepts in a microprocessor, Peripheral and Memory mapped I/O, PPI 8255, Modes of operation – Mode-0 and BSR Mode	**8**	**CO2**

3	Block diagram, Control word format and modes of operation of Keyboard displace interface 8279 , DMA controller 8257 and Programmable interval timer 8253, Basic concepts of Serial Communication interface chip (e.g.8251)	**8**	**CO2** **CO3**
4	Interrupts study - Types of Interrupts and Interrupt Service Routine. Handling Interrupts in 8086, Interrupt programming, Programmable Interrupt Controller - 8259 – Architecture only. Programming and applications Case studies using interface chips: Traffic Light control, Interfacing Keyboard display and and temperature Controller using 8255.	**8**	**CO2** **CO3** **CO4**

Reference Books:

1. Microprocessor Architecture Programming and Applications by Gaonkar, Penram International
2. Microprocessor system: The 8086/8088 family IInd ed. By Yu.Cheng & Gibson
3. Microprocessors and interfacing by D.V.Hall
4. Bhurchandi and Ray, Advanced Microprocessors and Peripherals, Third Edition McGraw Hill.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-305	**Course Name: Program Elective-II** (ii) Analog and Digital Communication		**L** / **3**	**T** / **1**	**P** / **-**	**C** / **4**
Year and Semester	**3rd Yr.** **5th Semester**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**NIL**	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To introduce students with the need for electronic communication.						
2. To familiarize with analog modulation and its formats.						
3. To have understanding of angle modulation and its types.						
4. To have knowledge of pulse modulation and digital modulation.						
5. To gain analytical skills based information theory.						

6. To have basic knowledge about source coding and error controlling codes.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Acquire knowledge about the analog modulation and its different formats including power and current relations in and AM wave.
CO2	Have good understanding of angle modulation including frequency modulation and phase modulation and respective demodulation techniques.
CO3	Acquire knowledge about pulse analog modulation and digital modulation and respective demodulation techniques.
CO4	To have acquaint about the basics of information theory and associated codes.
CO5	Acquire basic knowledge about source coding and error control coding techniques together with solving simple numerical problems.
CO6	

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Amplitude Modulation:** Need for modulation, Amplitude Modulation - Time and frequency domain description, single tone modulation, power relations in AM waves, Generation of AM waves, Detection of AM Waves - Envelope detector, DSBSC modulation, Generation of DSBSC Waves - Balanced Modulators, SSB modulation and demodulation.	**7**	**CO1**
2	**Angle Modulation:**Basic concepts of Phase Modulation, Frequency Modulation: Single tonefrequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM and Wide band FM, Transmission bandwidth of FM Wave, Generation of FM Signal, Demodulation of FM, Comparison of FM and AM.,	**7**	**CO2**
3	**Pulse Modulation:** PCM Generation and Reconstruction, Differential Pulse code modulation, Delta Modulation and Adaptive Delta Modulation. **Digital Modulation Techniques:** ASK- Modulator, Coherent ASK Detector, FSK- Modulator, Non- Coherent FSK Detector, BPSK- Modulator, Coherent BPSK Detection. Principles of QPSK, Differential PSK.	**10**	**CO3**
4	**Information Theory:** Information, Average Information, Mutual Information, Entropy, Information Sources, Communication Channels, Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, Channel Capacity.	**7**	**CO4**
5	**Source Coding:** Source coding theorem, Prefix Codes, Krafts inequality, Shannon's Encoding Algorithm Shannon Fano Encoding Algorithm, Huffman codes. **Basics of Error Control coding:**Longitudinal Redundancy Check (LRC), Vertical Redundancy Check (VRC), linear block codes, cyclic codes.	**7**	**CO5**

Text Books:

1. Communication systems, Sanjay Sharma, Katson, Publications
2. Modern Digital and Analog Communication Systems, B P Lathi, Zhi Ding, H M Gupta, Oxford publishers.

3. Electronics & Communication System, George Kennedy and Bernard Davis, TMH 2004

Reference Books:

1. Principles of Communication Systems" - Herbert Taub, Donald L Schilling, Goutam Saha, 3rd Edition, McGraw-Hill, 2008.
2. Electronic Communications" – Dennis Roddy and John Coolean , 4th Edition , PEA, 2004.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-305	**Course Name: Program Elective-II** (iii) Switchgear and Protection		**L** 3	**T** 1	**P** 0	**C** 4
Year and Semester	**3rd Year (Vth Semester)**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Brief knowledge of in the following topics: Electrical Machines, Power Electronics.	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To introduce the concept of Electric Protection.						
2. To Familiarize with Circuits Breakers and Lightning Arresters.						
3. To understand the Protective relays.						
4. To study the protection schemes.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To Familiarize with Switches and Fuses.					
CO2	To understand the Circuits Breakers and Lightning Arresters.					
CO3	To understand the Protective relays.					
CO4	To understand the protection schemes.					

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**SWITCHES AND FUSES:** Introduction, energy management of power system, definition of switchgear, switches - isolating, load	**7**	**CO1**

	breaking and earthing. Introduction to fuse, fuse law, cut -off characteristics,: Time current characteristics, fuse material, HRC fuse, liquid fuse, Application of fuse **PRINCIPLES OF CIRCUIT BREAKERS:**Introduction, requirement of a circuit breakers, difference between an isolator and circuit breaker, basic principle of operation of a circuit breaker, phenomena of arc, properties of arc, initiation and maintenance of arc, arc interruption theories - slepian's theory and energy balance theory, Restriking voltage, recovery voltage, Rate of rise of Restriking voltage, DC circuit breaking, AC circuit breaking, current chopping, capacitance switching, resistance switching, Rating of Circuit breakers.		
2	**CIRCUITS BREAKERS LIGHTNING ARRESTERS:**CIRCUITS BREAKERS: Air Circuit breakers – Air break and Air blast Circuit breakers, oil Circuit breakers - Single break, double break, minimum OCB, SF6 breaker - Preparation of SF6 gas, Puffer and non-Puffer type of SF6 breakers. Vacuum circuit breakers - principle of operation and constructional details. Advantages and disadvantages of different types of Circuit breakers, Testing of Circuit breakers, Unit testing, synthetic testing, substitution test, compensation test and capacitance test. LIGHTNING ARRESTERS: Causes of over voltages – internal and external, lightning, working principle of different types of lightning arresters. Shield wires.	**7**	**CO2**
3	**PROTECTIVE RELAYING:**Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, Classification of Protective Relays. **INDUCTION TYPE RELAY:**Non-directional and directional over current relays, IDMT and Directional characteristics. Differential relay – Principle of operation, percentage differential relay, bias characteristics, distance relay – Three stepped distance protection, Impedance relay, Reactance relay, Mho relay, Buchholz relay, Negative Sequence relay, Microprocessor based over current relay – block diagram approach.	**10**	**CO3**
4	**PROTECTION SCHEMES:**Generator Protection - Merz price protection, prime mover faults, stator and rotor faults, protection against abnormal conditions – unbalanced loading, loss of excitation, over speeding. Transformer Protection - Differential protection, differential relay with harmonic restraint, Inter turn faults Induction motor protection - protection against electrical faults such as phase fault, ground fault, and abnormal operating conditions such as single phasing, phase reversal, over load.	**12**	**CO4**

REFERENCE BOOKS:

1. Chakraborti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., a Text Book on Power System Engineering, DhanpatRai and Co. (P) Ltd. (2008).
2. Pathinkar, Y.G. and Bhide, S.R., Fundamentals of Power System Protection, PHI Learning Pvt. Limited (2008).
3. Rao, S.S., Switchgear and Protection, Khanna Publishers (2007).

4. Deshpande, M.V., Switchgear and Protection, Tata McGraw–Hill (2005).
5. Elmore, W.A., Protective Relaying Theory and Applications, ABB Power T and D Company Inc. (2003).

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-307	**Course Name:** Power System - II		**L** 3	**T** 1	**P** -	**C** 4
Year and Semester	**3rd year 5th Semester**	**Contact hours per week:** (4Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Basic Electrical Engineering, Power System-I**	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
1. To study the concept of corona and its impact in transmission line.	
2. To study the construction, features and types of underground cables.	
3. To introduce the concept of per unit system to study different faults in power system.	
4. To study the behavior of travelling waves on transmission lines.	
5. To study the concept of power system stability and methods to improve stability.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the concept of corona and its impact in transmission line.
CO2	To understand the construction, features and types of underground cables.
CO3	Understand and implement the per-unit system and utilize it for fault analysis purpose.
CO4	To analyse the impact of travelling waves on transmission lines.
CO5	Understand the problem of power system stability and its impact on the system. The methods to improve stability.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Corona:** Phenomenon of corona, disruptive critical voltage, visual critical voltage, corona loss, radio interference.	9	CO1, CO2

	Underground Cables: Classification and construction, insulation resistance, capacitance, capacitance determination, power factor in cables, capacitance grading, use of inter-sheaths, losses, heat dissipation and temperature rise in cables, current rating, comparison with overhead lines.		
2	**Per Unit System**: Change of base, per unit quantities in three phase system, selection of base values, base quantities in terms of KV and MVA, per unit load impendence, advantages of per unit representation, one-line diagrams, preparation of impendence and reactance diagrams. **Fault Analysis:** Transients on a transmission line, short circuit of synchronous machine at no load and on full load, Symmetrical component transformation, phase shift in star-delta transformation, sequence impedances, Single line to ground fault, line to line fault, double line to ground fault, open conductor fault.	8	CO3
3	**Travelling Waves on Transmission Line**: Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behaviour of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion – Multi-conductor system and Velocity wave. **Transients of Transmission lines:** Transmission-line transients, Transient Analysis: Travelling Waves, reflections and refraction of waves.	9	CO4
4	**Power Systems Stability:** Definitions: angular stability- steady state stability, dynamic stability, transient stability, mechanics of angular momentum, swing equation, equal area criteria, critical clearing angle, solution of swing equation, stability study in multi-machine system, Technique of improving transient stability, Voltage stability, Voltage collapse, V-P and V-Q curves.	8	CO5

Suggested Text / Reference Books:

1. John J. Grainger, William D. Stevenson,"Power System Analysis", McGraw-Hill
2. B.Ram, D.N.Vishvakarma,"Power System protection and switchgear", TMH.
3. B. M. Weedy, B. J. Cory, "Electric Power Systems", John Wiley& Sons.
4. I.J. Nagrath and D.P. Kothari,"Power System Engg", TMH.
5. Soni, Gupta and Bhatnagar,"A course in Electrical Power", DhanpatRai& Sons.
6. K.R. Padiyar, " Power System Dynamics, Stability and Control", B. S. Publications,2002.
7. P. Kundur, " Power System Stability and Control", McGraw Hill,1995.
8. P. Sauer and M. A. Pai, " Power System Dynamics and Stability" , Prentice Hall,1997..

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code: EI-PC-309</td><td rowspan="2" colspan="2">Course Name: Linear Automatic Control System</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>3rd Year
(Vth Semester)</td><td colspan="5">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Control system components</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Study the time response of various types (0, 1, 2, 3, etc.) of system Execute time response analysis of a second order control system using MATLAB/ simulation software</td></tr>
<tr><td colspan="7">2. Study the Stability analysis of Linear system, Analyze and interpret stability of the system through Root Locus, Bode plot and Nyquist plot.</td></tr>
<tr><td colspan="7">3. Study Lag, Lead, Lead-Lag compensators and verify experimental results using MATLAB.</td></tr>
<tr><td colspan="7">4. Study the concept of state, state variables and various state models techniques and concept of controllability and observability, pole placement by state feedback</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Ability to derive Mathematical Modeling various types (0, 1, 2, 3, etc.) of system and anayze their time responses</td></tr>
<tr><td>CO2</td><td colspan="6">Able to Analyze the effect of P, PI, PD and PID controllers on a control system and design suitable controller for a typical process</td></tr>
<tr><td>CO3</td><td colspan="6">Ability to Analyze and interpret stability of the systemthroughRoot Locus, Bode plot and Nyquist plot.</td></tr>
<tr><td>CO4</td><td colspan="6">Able to design lead, lag, lead-lag compensators using time domain and frequency domain analysis techniques.</td></tr>
<tr><td>CO5</td><td colspan="6">An ability to understand concept of state, state variables and the design output feedback controller in state space.</td></tr>
</table>

<table>
<tr><td rowspan="2">Module No</td><td>COURSE SYLLABUS</td><td rowspan="2">Hrs</td><td rowspan="2">COs</td></tr>
<tr><td>CONTENTS OF MODULE</td></tr>
<tr><td>1</td><td>TIME DOMAIN ANALYSIS: Standard test signal (step, ramp, impulse, parabolic) time response of various types (0, 1, 2, 3, etc.) of system. Steady state error analysis, Design consideration of 2ndorder system, design of higher order system, performance indices.</td><td>9</td><td>CO1
CO2</td></tr>
<tr><td>2</td><td>STABILITY OF A CONTROL SYSTEM : Concept of stability, necessary conditions of stability, Hurwitz Stability criterion, Routh stability criterion, relative stability analysis, more on the Routh stability criterion, The Root locus technique: The root locus concept construction of root loci, root contours, system with transportation Lag.</td><td>9</td><td>CO3
CO4</td></tr>
<tr><td>3</td><td>FREQUENCY DOMAIN ANALYSIS: Correlation between time and frequency response, polar plots, bode plots, all- pass and minimum-</td><td>10</td><td>CO3
CO4</td></tr>
</table>

	phase system, experimental determination of transfer functions, log magnitudeversus phase plots. Stability in frequency domain: Nyquist stability criterion, assessment of relativestability using Nyquist criterion, closed-loop frequency response.		
4	STATE VARIABLE ANALYSIS AND DESIGN: Concept of state, state variables and state models, state models for linear continuous time system, diagonization, solution of state equations, concept of controllability and observability, pole placement by state feedback.	**10**	**CO5**

Reference Books:

1. Automatic Control System By Kuo
2. Feedback Control System By D'Azzo and Houpis
3. Modern Control Engineering By Oagata
4. Control Systems Engineering By Nagrath & Gopal.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-PRPC-17</td><td colspan="2">Course Name: Power Electronics Lab. - II</td><td colspan="2">L T P C
0 0 3 1.5</td></tr>
<tr><td>Year and Semester</td><td>3rd Year
Vth Semester</td><td colspan="3">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Brief knowledge of in the following topics: Basic Electrical and Electronics engineering, Semiconductor devices, Digital Electronics, rectifiers.</td><td colspan="3">Evaluation</td></tr>
<tr><td>CIE: 30</td><td colspan="2">SEE: 45</td></tr>
<tr><td colspan="5">Course Objectives:</td></tr>
<tr><td colspan="5">1. Understand operation of different types of choppers.</td></tr>
<tr><td colspan="5">2. Understand the operation of series and parallel inverters.</td></tr>
<tr><td colspan="5">3. Understand half & full wave Single phase and three phase converters.</td></tr>
<tr><td colspan="5">4. Understand the concept of Dual Converter.</td></tr>
<tr><td colspan="5">5. Understand the motor control</td></tr>
<tr><td colspan="5">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="4">To understand the operation of John’s and Morgon’s of choppers.</td></tr>
</table>

CO2	To understand the operation of series and parallel inverters.
CO3	To understand the output characteristics of half & full wave Single phase and three phase converters.
CO4	To understand the significance and operation of Dual Converter.
CO5	To understand the motor control.

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
	LIST OF EXPERIMENTS STUDY EXPERIMENTS :	**CO1, CO2, CO3, CO4**
1.	To Study the parallel inverter.	
2.	To study John's Chopper	
3.	To study the three phase full controlled converter.	
4.	To study the Morgon.s Chopper.	
5.	To study the three phase half controlled converter.	
6.	To Study the series inverter.	
7.	To study dual converter.	
8.	To study the single phase half and full controlled converter.	
9.	To study speed control of DC motor.	
10.	To study half controlled bridge converter under reactive load.	
	SIMULATION EXPERIMENTS :	
11.	Single Phase Half wave controlled converter with R,RL&RLE Load (for firing angles 30,60,90)with/without FD	
12.	Single Phase Half controlled converter with R,RL&RLE Load (for firing angles 30,60,90)with/without FD	
13.	Single Phase Full controlled converter with R,RL&RLE Load (for firing angles 30,60,90)with/without FD	
14.	Three Phase semi controlled converter with R,RL&RLE Load	
15.	Three Phase full controlled converter with R,RL&RLE Load	
16.	Single phase AC Voltage Controller with R&RL Loads	
17.	John's Chopper	
18.	Morgon.s Chopper	
	HARDWARE EXPERIMENTS :	
19.	Thyristorised drive for PMDC motor with speed measurement and Single Phase Half controlled rectifier and full controlled rectifier	
20.	Three Phase input Thyristorised drive for Dc Motor with closed loop control	
21.	Single Phase Series Inverter	
22.	Single Phase Parallel Inverter	

REFERENCE BOOKS:

1. Modern Power Devices by B.Jayant Balica, New Age Inter.
2. Power Electronics by P.C. Sen (TMH)
3. An Introduction to Thyristors and Their Applications by M. Ramamurthy (EWP)
4. Power electronics by Ned Mohan and Robins, John Wiley and Sons
5. Thyristor Phase Controlled converters and Cyclo-converters by B.R.Pelly
6. Power Electronics by Vendem Subrahmanyam, New Age International

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-19	**Course Name:** Power System-II LAB	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
Year and Semester	**3rdYear 5th Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Basic Electrical Engineering Lab, Power System-I Lab**	**Evaluation**			
		CIE: 30	**SEE: 45**		

Course Objectives:

- To study the working operation of relays and its main components.
- To familiarize with the power system elements, devices, equipments and applications.
- To study different type of transmission cables and their applications.
- To Familiarize with the safety rules for power system laboratory.

Course Outcomes: On completion of the course, student would be able to:

CO1	Impart the practical knowledge of basic of equipments of power system and its operation.
CO2	Ability to analyze the performance as well as handling of electrical elements and equipments like underground cables, insulators etc.
CO3	Acknowledge the operation and main features of protective relays
CO4	Develop skills to use power system elements and devices in different technological field.

Expt. No	**COURSE SYLLABUS CONTENTS OF MODULE**	**COs**
1	Single line diagram of electrical power flow of generalized power substation.	**CO1 CO2 CO3 CO4**
2	To study and designing of Earthing / Grounding	
3	To plot equi-potential curve and voltage gradient in iii. Two/three core cable iv. Single-core cable.	
4	To study the different parts of a power cable and measurement of insulation resistance of a cable.	
5	To study the core to core & core to sheath capacitance of a three phase cable.	
6	To draw the operating characteristics of IDMT over Voltage relay.	
7	To draw the operating characteristics of Differential current relay.	
8	To draw the operating characteristics of negative sequence relay.	
9	To draw the operating characteristics of IDMT over current relay.	
10	Study the burden effect on the performance of CT and measure ratio error.	
11	Find out the sequence components of currents in three 1-Phase transformers and 3- Phase transformer and compare their results.	
12	To determine the earth resistance using Megger.	

Reference books:

1. Power System Engg: I.J.Nagrath and D.P.Kothari (TMH)
2. A Course in Electrical Power: Gupta, Soni & Bhatnagar (Dhanpat Rai & Sons).
3. Electric Power System: B.M.Weedy, John Wiley & Sons.
4. Transmission & Distribution of Electrical Engineering: Westing House & Oxford Univ. Press, New Delhi.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPE-21	Course Name: Program Elective- II Lab (i) Microprocessors lab.		L	T	P	C
			0	0	3	1.5
Year and Semester	**3rd Year Vth Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	EI-PROE-14, Digital Techniques Lab.	**Evaluation**				
		CIE: 30	**SEE: 45**			
Course Objectives:						
1. Understand the basics of microprocessors, architecture and operation of microprocessors and their peripherals.						
2. Understand the concepts of machine instructions, assembly language and programs.						
3. Expose different ways of communicating with I/O devices and standard I/O interfaces.						
4. Analyze and design microprocessor based instrumentation system.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Get familiarized with the microprocessor based system.					
CO2	Create and develop ALPs with arithmetic and logical Instructions, Loop instructions, use of directives and others.					
CO3	Work on the ALPs involving the peripheral chips interface.					
CO4	Design and develop programs for microprocessor based instrumentation system.					

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	Write the working of 8086 and basic architecture of 8086 along with small introduction	**CO1, CO2, CO3, CO4**
2	Study the complete instruction set of 8086 and write the instructions with examples.	
3	Write the note on assembly directives in 8086 with few examples.	
4	Write an ALP for 16 bit arithmetic operations for 8086 (using various addressing modes)	
5	Write an ALP of 8086 to take N numbers as input and arrange in ascending and descending order.	
6	Write an ALP of 8086 to take N numbers as input and find max and minimum number.	
7	Write an ALP of 8086 to take N numbers as input and find average.	
8	Program for searching for a number or character in a string for 8086.	
9	Program for digital clock design using 8086	
10	Interfacing ADC and DAC to 8086.	
11	Parallel communication between two microprocessors using 8255.	
12	Serial communication between two microprocessor kits using 8251.	
13	Interfacing and programming of 8086 and to control stepper motor	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPE-21	Course Name: Program Elective –II LAB **(ii)** Analog and Digital Communication Lab	L	T	P	C
		0	0	3	1.5

Year and Semester	**III^{ed} Year VthSemester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)	
Pre-requisite of course	**Basic Electronics Engg**	**Evaluation**	
		CIE: 30	**SEE: 45**
Course Objectives:			
1. To familiarize the students practically about different types of communication systems.			
2. To make students able to work on electronic circuits used in communication engineering.			
3. To have knowledge about the analog and digital communication systems and also be able to perform experimentation on various techniques.			

Course Outcomes: On completion of the course, student would be able to:

CO1	Able to perform experimentation on analog communication techniques and able to analyze the results.
CO2	Able to perform experimentation on pulse and digital communication, modulation and demodulation techniques.
CO3	To have practical knowledge about delta modulation and demodulation.

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	Cos
1	Analog Communication Concepts and Circuit Board Familiarization	**CO1, CO2, CO3,**
2	To study the function of Amplitude Modulation & Demodulation (under modulation, perfect modulation & over modulation) and also to calculate the modulation index.	
3	To study the working of the Balanced Modulator and demodulator.	
4.	To study frequency modulation and demodulation techniques.	
5	Study of 4 Channel Analog Multiplexing and De multiplexing Techniques.	
6	To study the frequency division multiplexing and De multiplexing Techniques.	
7	To study the Pulse amplitude modulation & demodulation Techniques.	
8	To study the Pulse Width Modulation (PWM) and Demodulation Techniques	
9	To study the generation Pulse Position Modulation (PPM) and Demodulation.	
10	To study ASK Signal Generation and Asynchronous Detection.	
11	To study FSK Signal Generation, Asynchronous Detection, Synchronous Detection.	
12	To study PSK Signal Generation and Synchronous Detection.	
13	To study pulse code modulation and demodulation.	
14.	To study Delta modulation and demodulation.	
15.	To different gain pattern on antenna training system kit.	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPE-21	**Course Name: Program Elective-II Lab** (Switch Gear and Protection)	**L**	**T**	**P**	**C**
		-	-	3	1.5
Year and Semester	**3rd Yr. 5th Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	Brief knowledge of in the following topics: Basic Electrical and Electronics engineering, Semiconductor devices, Digital	**Evaluation**			
		CIE: 30		**SEE: 45**	

	Electronics, rectifiers.		

Course Objectives:	
	4. Understand the Construction and principles of Construction and working principles of various types of relays
	5. Understand the concepts of fuses.
	6. Understand the null deflection and implement it in CT & PT.
Course Outcomes: On completion of the course, student would be able to:	
CO1	Identify various types of faults in Power system
CO2	Explain working of different types of circuit breakers in power system.
CO3	Explain working of different types of relays in power system.
CO4	Maintain the protection of transmission line and feeder from various faults
CO5	Protect transformer, alternator, motor and bus bar
CO6	Protect power system against over voltages

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
	LIST OF EXPERIMENTS STUDY EXPERIMENTS :	**CO1, CO2, CO3, CO4**
17.	Check the Polarity of Current Transformer and Potential	
18.	Transformer and connect it with the relay.	
19.	Principle of working, construction and operation of electromagnetic induction (shaded pole, watt-hour meter and induction cup),Thermal relay.	
20.	Principle of working, construction and operation of Distance relay	
21.	Principle of working, construction and operation of Directional relay	
22. t	Find the fusing factor of a given fusing material.	
23.	Dismantle a Vacuum circuit breaker.	
24.	Identify the various components of SF6 circuit breaker.	
25.	Working principle of arc quenching in HVDC circuit breaker	
26.	Test overload relay and plot Time-Current characteristic	
27.	C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method.	
28.	PT testing by comparison – V. G. as Null detector – Measurement of % ratio error and phase angle of the given PT.	

REFERENCE BOOKS:

2. A Course in Elect. & Electronic Measurement & Instrumentation by A. K. Sawhney; Khanna Pub.

REFERENCE BOOKS:

1. Electrical Measurments by E.W. Golding
2. Electronic & Elect. Measurment&Instrumention by J.B.Gupta; Kataria& Sons.
3. Electronic Instrumentation &Measurment Technique, W.D. Cooper & A.D. Helfrick.
4. Measuring Systems by E.O. Doeblin; TMH.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-23	Course Name: Control System Lab.		L	T	P	C
			0	**0**	**3**	**1.5**
Year and Semester	**3rd Year V th Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Control components engineering**	**Evaluation**				
		CIE: 30	**SEE: 45**			

Course Objectives:

1. Study the time response of various types (0, 1, 2, 3, etc.) of system Execute time response analysis of a various order control system.
2. To study and tuned the different modes of Linear controller(PID)
3. To study the performance characteristics of a D.C. Motor Speed and angular position Control System.
4. To Relay control system
5. To Compensation Design study and designing controller for different physics variables control
6. To Study Digital control System with programming skill

Course Outcomes: On completion of the course, student would be able to:

CO1	Ability to derive the response of a variety of simulated linear systems and to correlate the studies with theoretical results.
CO2	Ability to analyze and tuned the different modes of Linear controller(PID) and able to design controller for different Linear process
CO3	Ability to understand DC, AC, stepper motors and implements their application in control system
CO4	Ability to Design and develop digital control system of a simulated system using an 8-bit microcomputer with development of programming skill

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	To Study Potentiometric Error Detector :- To study the performance characteristics of an angular position error detector using potentiometers	**CO1, CO2, CO3, CO4**
2	To Study PID control Trainer: To study the performance characteristics of an analog PID controller using simulated systems.	
3	To Study Linear Systems Simulator: - To study the response of a variety of simulated linear systems and to correlate the studies with theoretical results.	
4	To Study DC Motor speed Control: - To study the performance characteristics of a D.C. Motor Speed Control System.	
5	To Study DC Position Control: - To study the performance characteristics of a d.c. motor angular position control system.	
6	To Study Stepper Motor Trainer: - To study the operation of a Stepper Motor.	
7	To Study Digital control System: to study of digital control system of a simulated system using an 8-bit microcomputer	
8	Relay control system: study of relay control system and to observe the effect of dead zone and hysteresis on stability	
9	Compensation Design: To design, implement and study the effect of different cascade compensation network for a given system	
10	To Study PID Temperature Control Trainer	
11	To Study Synchro Devices	

12	To Study AC Motor Study Trainer	
13	To Study DC Motor study Trainer	
14	To Study Light Intensity Control	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-302	**Course Name: Program Elective-III** (i) Electrical Machine Design		**L** 2	**T** 1	**P** -	**C** 3
Year and Semester	**3rd Yr. 6th Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	EI-PC-208:Electrical Machines-I EI-PC-304: Electrical Machines-II	**Evaluation** **CIE: 40**	**SEE: 60**			
Course Objectives:						
1. To familiarize the students about design and materials used in electrical machines.						
2. To design the DC machines and its parts as per given data.						
3. To design single phase and three phase transformer based on given parameters.						
4. To design induction motor as per given parameters and loading conditions						
5. To design synchronous machines as per given parameters.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Identify and list, limitations, modern trends in design, manufacturing of electrical machines and properties of materials used in the electrical machines.					
CO2	Derive the output equation of DC machine, discuss selection of specific loadings and magnetic circuits of DC machines, design the field windings of DC machine, and design the stator and armature circuits of a DC machine.					
CO3	Derive the output equations of transformer, discuss selection of specific loadings, and design of transformer based on given parameters.					
CO4	Develop the output equation of induction motor, discuss selection of specific loadings and magnetic circuits of induction motor, and designthe stator and rotor circuits of an induction motor.					
CO5	Formulate the output equation of alternator and design the slots and windings of Synchronous machine.					

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**Cos**
1	**Fundamental Aspects of Electrical Machine Design:** Design of Machines, Design Factors,Limitations in design, Modern Trends in design, **Electrical Engineering Materials:** Desirability of Conducting Materials, Comparison of aluminum and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials, Classification of Insulating materials based on Thermal Consideration.	**3**	**CO1**
2	**Design of DC Machines:** Output Equation, Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap, Design of Shunt	**5**	**CO2**

	and Series Field Windings.		
3	**Design of Transformers:** Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.	**8**	**CO3**
4	**Design of Three Phase Induction Motors:** Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance.	**5**	**CO4**
5	**Design of Three Phase Synchronous Machines:** Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non-salient Pole Rotors. Magnetic Circuit and Field Winding.	**5**	**CO5**

Text Books:

1. A course in Electrical Machine design A.K.Sawhney DhanpatRai 6th Edition, 2013.
2. Performance and Design of Alternating Current Machines M.G. Say CBS Publisher 3rd Edition, 2002
3. Design Data Handbook A. Sanmugasundaram Et al New Age International 1st Edition,

Reference Books:

1. Electric Machinery, AE Fitggerald, C. Kingsley Jr and Umans, McGraw Hill, International.
2. Electrical Technology", H. Cotton, CBS Publication.
3. The Performance and Design of AC machines", M G Say, Pitman& Sons.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI –PE-302</td><td colspan="2">Course Name: Program Elective-III</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">(ii) Mechanical Measurements in Instrumentation</td><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>3rd Year
VIth Semester</td><td colspan="5">Contact hours per week: (3 Hrs.)
Exam: (3 Hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To introduce techniques and instrumentation used in mechanical measurement</td></tr>
<tr><td colspan="7">2. Imparting the principles of measurement which include the working mechanism of various sensors and devices</td></tr>
<tr><td colspan="7">3. To highlight the importance of measurement of non-electric quantities in instrumentation</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Apply methods of measurement for various physical quantities</td></tr>
<tr><td>CO2</td><td colspan="6">Select appropriate device for the measurement of physical parameters</td></tr>
<tr><td>CO3</td><td colspan="6">Justify the use of particular device through characteristics and performance</td></tr>
<tr><td>CO4</td><td colspan="6">Design a measurement system using acquired knowledge base</td></tr>
</table>

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	Introduction, Significance of mechanical measurements. Pressure measurement – pressure measurement terminology, Manometers – U tube manometer, bell type manometer, inclined tube manometer, Ring Balance manometer, Micromanometer. Bell gauges – balanced lever gauge, beam bell gauge, spring balanced bell gauge. Bourdon tube and its types, bellows and diaphragms	**9**	**CO1, CO2, CO3**
2	Measurement of torque – torque reaction method, strain gauge torque meter, stroboscopic method, inductance torque meter, Digital torque meter, magneto-strictive torque meter. Measurement of Angular velocity – Mechanical tachometers, Electrical tachometers, digital tachometers, stroboscopic tachometers. Measurement of Vibration.	**9**	**CO1, CO2, CO3**
3	Temperature measurements – liquid in glass thermometer, pressure gauge thermometer, liquid filled systems, gas filled systems and liquid vapor filled systems thermometer, static errors in filled systems thermometers, speed of response of filled systems. Bimetallic thermometers, Thermocouples – working principle, thermoelectric laws, series and parallel connection of thermocouples.	**9**	**CO1, CO2, CO3**

Text Books:

1. A course in mechanical measurements and instrumentation, A. K. Swahney, Dhanpatrai and Company, 2017
2. Mechanical Measurements and control, D.S. Kumar, Metropolitan Book Co. Pvt. Ltd., 2015
3. Measurement Systems, E. O. Doeblin, McGraw Hill, 2020

Note for Examiner(s):

Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-302	**Course Name: Program Elective- III** (iii) Electric and Hybrid Vehicles		**L** 2	**T** 1	**P** -	**C** 3
Year and Semester	**3rd year 6th Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	Electrical Machines, Power Electronics, Basic Science Engineering	**Evaluation** CIE: 40	**SEE: 60**			
Course Objectives:						
1. To introduce the upcoming technology of electric and hybrid system						
2. To study the basics theory, operation and modeling of electric Hybrid system.						
3. To study different topologies of electric Hybrid system						
4. To study electric propulsion system in electric hybrid system						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To familiarize with upcoming technology of electric and hybrid system					
CO2	To understand the basics theory, operation and modeling of electric Hybrid system.					
CO3	To understand and analyze different drive train topologies electric of Hybrid system.					
CO4	To learn the role of electric propulsion system in electric hybrid system andits application.					
CO5	To impart basic technical knowledge of electric hybrid vehicle system and apply it to technological fields.					

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction:** Introduction to hybrid electric vehicles: history of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional vehicles: basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical	7	CO1, CO2

	models to describe vehicle performance.		
2	**Hybrid Electric Drive:** Hybrid electric drive-trains: basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	7	CO3
3	**Electric Propulsion Unit:** Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC motor drives, configuration and control of induction motor drives, configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.	7	CO4
4	**Case Studies:** Design of a hybrid electric vehicle (HEV), design of a battery electric vehicle (BEV).	5	CO5

Suggested Text / Reference Books:

1. Iqbal Hussein, "*Electric and Hybrid Vehicles, Design Fundamentals*", CRC Press, 2003.
2. MehrdadEhsani, YimiGao, E Sebastian Gay, Ali Emadi, "*Modern Electric, Hybrid Electric and Fuel Cell VehiclesFundamentals", Theory and Design*, CRC Press, 2004.
3. James Larminie, John Lowry, "*Electric Vehicle Technology Explained*", Wiley, 2003.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PC-304</td><td colspan="2" rowspan="2">Course Name: Electrical Machines-II</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>3rdYr.
6thSemester</td><td colspan="5">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 40</td><td colspan="4">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To study three phase induction motors and its associated numerical problems and applications.</td></tr>
<tr><td colspan="7">2. To study single phase and factional horse power motors.</td></tr>
<tr><td colspan="7">3. To have knowledge of three phase synchronous generators.</td></tr>
</table>

4. To gain knowledge about three phase synchronous motors	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Have theoretical as well as analytical knowledge of three phase synchronous motors in terms of working, testing and operation.
CO2	Understand single phase induction motors and special (FHP) motors and their applications.
CO3	Explain the working and operation of three phase alternator under different loading conditions, synchronization, parallel operation and load sharing and related phasor diagrams.
CO4	Acquire knowledge about the constructional details and principle of operation of synchronous motors, excitations (under, normal and over), effect of variation of excitation under constant load and V curves, inverted V curves, associated numerical problems.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Three Phase Induction Machines:** Constructional details, Types of rotors, Principle of operation, Slip, cogging and crawling, Equivalent circuit, Torque-Slip characteristics, Condition for maximum torque, Losses and efficiency, Load test, No load and blocked rotor tests, Separation of losses, Double cage induction motors, Induction generators, Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star delta starters, Speed control, Voltage control, Frequency control and pole changing Cascaded connection-V/f control.	**12**	**CO1**
2	**Single Phase Induction Motors:** Constructional details of single phase induction motor, Double field revolving theory and operation – Equivalent circuit, Starting methods of single-phase induction motors, Capacitor-start capacitor run Induction motor, Shaded pole induction motor, Repulsion motor, Hysteresis motor, AC series motor.	**6**	**CO2**
3	**Synchronous Generators:** Constructional details – Types of rotors – winding factors- emf equation – Synchronous reactance – Armature reaction, Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input- Voltage regulation – EMF, MMF, ZPF, steady state power- angle characteristics– Two reaction theory –slip test -short circuit transients.	**10**	**CO3**
4	**Synchronous Motors:** Principle of operation, Torque equation, Operation on infinite bus bars, V and Inverted V curves, Power input and power developed equations, Starting methods, Current loci for constant power input, constant excitation and constant power developed-Hunting, natural frequency of oscillations, damper windings- synchronous condenser.	**10**	**CO4**

Text Books:

1. A course in Electrical Machine design A.K.Sawhney DhanpatRai 6th Edition, 2013.
2. Performance and Design of Alternating Current Machines M.G. Say CBS Publisher 3rd Edition, 2002

3. Design Data Handbook A. Sanmugasundaram Et al New Age International 1st Edition,

Reference Books:

1. Electric Machinery", AE Fitggerald, C. Kingsley Jr and Umans, McGraw Hill, International.
2. Electrical Technology", H. Cotton, CBS Publication.
3. The Performance and Design of AC machines", M G Say, Pitman& Sons.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PC-306</td><td colspan="2" rowspan="2">Course Name: Power Plant Engineering.</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>3rd Year
(VIth Semester)</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Brief knowledge of in the following topics: Electrical Machines, Electrical Power System and Generation, Power System Engineering.</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To introduce the concept of trends in power Generation.</td></tr>
<tr><td colspan="7">2. To introduce the Techniques of load forecasting and Generation planning.</td></tr>
<tr><td colspan="7">3. To study the concept types of energy sources.</td></tr>
<tr><td colspan="7">4. To study the concept of Energy Conservation and Management.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">To Familiarize with available Energy sources and trends in power Generation.</td></tr>
<tr><td>CO2</td><td colspan="6">To understand different types of loads, load forecasting and Generation planning.</td></tr>
<tr><td>CO3</td><td colspan="6">To Familiarize with the Conventional and Non-Conventional types of energy sources.</td></tr>
<tr><td>CO4</td><td colspan="6">To understand the concept of Energy management, Energy Auditing etc.</td></tr>
</table>

Module	COURSE SYLLABUS	Hrs	COs

No	CONTENTS OF MODULE		
1	**INTRODUCTION**: Energy sources, their availability, Recent trends in Power Generation, Interconnected Generation of Power Plants.	**7**	**I**
2	**POWER GENERATION PLANNING**: Load forecasting, load curves, load duration curve, Base load and Peak load Power Plants, connected Load, maximum demand, demand factor, Group diversity factor, load factor, significance of load factor, plant factor, capacity factor, selection of unit size, No. of Units, reserves, cost of power generation, Depreciation, tariff.	**7**	**II**
3	**CONVENTIONAL ENERGY SOURCES**: Selection of site, capacity calculations, classification, Schematic diagram and working of Thermal Power Stations, Hydro Electric Plant, Nuclear Power Plant and Diesel Power Stations. **NON-CONVENTIONAL ENERGY SOURCES**: Wind, Solar, Tidal, Ocean, and Geothermal sources of Energy, fuel cell, Magneto Hydro Dynamic (MHD) system.	**7**	**III**
4	**ELECTRIC ENERGY CONSERVATION & MANAGEMENT**:Energy management, Energy Audit, Energy Efficient Motors, Co-generation.	**7**	**IV**

TEXT BOOKS:

1. Electric Power Generation, B.R.Gupta
2. Power Generation, Operation and Control, Wood and Wollenberg, John Wiley & Sons, 1984.

REFERENCE BOOKS:

1. A Course in Electric Power System, Soni, Gupta, Bhatnagar, Dhanpat Rai & Sons
2. Power System Engineering, Nagrath & Kothari, Tata Mc-Graw Hill, New Delhi
3. Power Plant Engg: G.D. Rai
4. Electric Power: S.L. Uppal (Khanna Publishing)

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-308	**Course Name:** Digital Signal Processing		**L**	**T**	**P**	**C**
			3	**1**	**-**	**4**
Year and Semester	**3rd year 6th Semester**	**Contact hours per week:** (4Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Mathematics**	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:

1. To study the basic of Z transform and its application in LTI discrete-time systems.
2. To study the Discrete linear Time Invariant systems in Z domain and in frequency domain.
3. To study different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
4. To study the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its application.
5. To study the digital filters for filtering applications.

Course Outcomes: On completion of the course, student would be able to:

CO1	To learn the basic of Z transform and its application in LTI discrete-time systems.
CO2	To analyze the Discrete linear Time Invariant systems in Z domain and in frequency domain.
CO3	To understand the different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
CO4	To learn the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its applications.
CO5	To Design digital filters for filtering applications.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Discrete Time Systems &Analysis of LTI System:** Discrete system and its types, Z-transform and its properties, inverse Z-transform, region of convergence and its properties, Z-Domain analysis of Linear Time Invariant systems: transient and steady-state response, causality and stability. Frequency domain analysis of Linear Time Invariant systems: Frequency domain characteristics of LTI systems and frequency response of LTI systems.	9	CO1, CO2
2	**Structure Realization of Discrete Time Systems:** Introduction to structure realization and factor influencing structure realization, Structure realization of Finite Impulse Response (FIR) system: Direct form, transposed form, cascade form, frequency selective form and lattice form. Structure realization of Infinite Impulse Response (IIR) system: Direct form-I, Direct form-II, cascade form, parallel form and lattice form.	9	CO3
3	**Discrete and Fast Fourier Transform (DFT & FFT):**Discrete Fourier Transform (DFT), Inverse Discrete Fourier Transform (IDFT), relationship between DFT and Z-transform, Fast Fourier Transform: Decimation-in-time (DIT) FFT algorithm, decimation-in-frequency (DIF) FFT algorithm, Radix-2 FFT algorithms, linear filtering approach: Goertzel algorithm and Chirp z-transform algorithm, Quantization effect	9	CO4

	in computations, Effect of word length in digital filter.		
4	**Digital Filter Design:** Characteristics and properties of digital filter, FIR digital filter design by using Fourier series method, Use of window functions method, frequency sampling method. Design of IIR filter from analog filter: Approximations of derivatives method, Impulse Invariant method, Bilinear - transformation method.	9	CO5

Suggested Text / Reference Books:

1. John G. ProakisandDimitris G. Manolakis,"Digital Signal Processing", PHI Pub.
2. Allan Y. Oppenhein& Ronald W. Schater, "Digital Signal Processing", PHI, 2004.
3. J. R. Jhohnson, "Introduction to Digital Signal Processing", PHI, 2000.
4. B. Somanthan Nair, "Digital Signal Processing: Theory, Analysis & Digital Filter Design", PHI, 2004
5. Sanjit K. Mitra, "DSP a Computer based approach" , TMH, 2nd Ed., 2001.
6. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", PHI, Second Edition, 2008.
7. S. Salivahanan, C. Gnanapriya, "Digital Signal Processing", McGraw Hill.
8. S. Sridhar, "Digital Image Processing", Oxford, 2011.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-310	**Course Name:** Microcontroller & Embedded System		**L**	**T**	**P**	**C**
			3	**1**	**0**	**4**
Year and Semester	**3rd Year** **VIth Semester**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Digital logic Circuits, microprocessors	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. In depth study of 8051 Architectures and programming of microcontrollers: embedded system applications.						
2. Use of assembler directives and programming in assembly language using Assembler						

3. This course concerns with Embedded systems basic knowledge: embedded architectures:	
4. To analyze and design the RTOS and applications.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the fundamental concepts of Microcontroller Organization and Architecture (Intel 8051), Data Representation and Memory Usage
CO2	Apply the basic programming skills of microcontrollers for Problem Solving and Algorithm Development, Assembling/Compiling and Execution
CO3	Understand the basic of Embedded system, Understand the Embedded Product Development Life Cycle, Design embedded system in RTOS
CO4	Illustrate and design the hardware using Embedded System.
CO5	Apply various algorithms in solving sorting problems.
CO6	After study of this course it is expected that students will be able to develop interface for real time industrial process and write programs for different applications, Further it is expected that students will be able to do of their own for higher processors and microcontrollers.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	Microcontrollers:- Introduction; comparison of microprocessors & microcontrollers; A survey of microcontrollers, Architecture of 8051: Input/Output Pins; Ports and Circuits; External memory; counter & timers; serial data input/output; & Interrupts. Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction	**9**	**CO1, CO2**
2	8051 software and programming memory interfacing and address decoding, programming Input/ Output port/ timer/ ADC/DAC, Serial data communication controller and interrupts controller for different application with respect to instrumentation & control.	**9**	**CO2, CO3**
3	Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Memory Devices, Processor and Memory Selection, Memory Map and Applications, Memory Blocks for Different Structures.	**9**	**CO2, CO3, CO5**
4	Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.Embedded Networking – Introduction – I/O Device Ports & Buses – Serial Bus communication protocols – RS232 standard – RS422 – RS485 – CAN Bus -Serial Peripheral Interface (SPI) –Inter Integrated Circuits (I2C) – need for device drivers	**9**	**CO3, CO4, CO6**

Text Books:

1. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
2. The 8051 Microcontroller Architecture Programming & Application by Kenneth J. Ayala, Penram Inter.
3. The 8051 Microcontroller and Embedded Systems- Muhammad Ali Mazidi; Pearson Education India

4. Programming and Customizing the 8051 Microcontroller by Fredko Mike, TMH
5. Embedded Systems Architecture, Programming, and Design by Raj Kamal, TMH

REFERENCE BOOKS:

1. Microcontroller Architecture, Programming, Interfacing and System Design by Raj Kamal, Pearson Education India
2. Design with Micro-controllers by John. B. Pitman, Mc-Graw Hill
3. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRPC-18</td><td rowspan="2" colspan="2">Course Name: Electrical Machines Lab-II</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>-</td><td>-</td><td>3</td><td>1.5</td></tr>
<tr><td>Year and Semester</td><td>3rd Yr.
6th Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">NIL</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 30</td><td colspan="4">SEE: 45</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To familiarize the students practically about working and operation of three phase induction motors</td></tr>
<tr><td colspan="7">2. To provide hands on experimentation on single phase induction motors.</td></tr>
<tr><td colspan="7">3. To explain practically the operation of three phase alternator along with performing standard test on it.</td></tr>
<tr><td colspan="7">4. To know the working and starting of three phase synchronous motors.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Work practically on three phase and single phase induction motors</td></tr>
<tr><td>CO2</td><td colspan="6">Operate and test three phase synchronous generators (alternators).</td></tr>
<tr><td>CO3</td><td colspan="6">Operate and test three phase synchronous motors.</td></tr>
</table>

Expt. No.	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	To perform load test on three-phase squirrel cage induction motor	**CO1,**

2	To perform load test on three-phase slip ring induction motor	**CO2, CO3,**
3	To perform No-load & blocked rotor test on three-phase induction motor	
4.	To perform load test on single-phase induction motor	
5	To perform No-load & Blocked rotor test on single-phase induction motor	
6	To study and implement Starting methods on single-phase induction motor	
7	To Study and Measure Synchronous Impedance and Short circuit ratio of Synchronous Generator.	
8	To perform O.C. test on synchronous generator and determine the full load regulation of a three phase synchronous generator by synchronous impedance method	
9	To conduct the process of synchronization of two Three Phase Alternators, by a) Synchroscope Method b) Three dark lamp Method c) Two bright one dark lamp Method	
10	To study Load sharing between two Three Phase alternators in parallel operation condition.	
10	To plot and analyse V- Curve of synchronous motor.	
11	To plot and analyse inverted V curves of synchronous motor.	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-20	**Course Name:** Micro-controller Lab		**L** 0	**T** 0	**P** 3	**C** 1.5
Year and Semester	**3rd Year VIth Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	Digital logic Circuits, microprocessors	**Evaluation**				
		CIE: 30	**SEE: 45**			
Course Objectives:						
1. To provide in depth knowledge of 8051 and assembly language programming						
2. To learn how to interface devices with different modules on a microcontroller.						
3. To expertise working with Keil compiler and embedded C programming.						
4. To impart the I/O interfacing concepts for developing real time embedded systems.						
5. To encourage the students in building real time applications.						
Course Outcomes: On completion of the course, student would be able to						
CO1	Familiarize with the assembly level programming using lob kits.					
CO2	Familiarize with the Keil and Embedded Workbench tools.					
CO3	Design circuits for various applications using microcontrollers.					
CO4	Apply the concepts on real- project design and development					

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
	Programming	
1	Data Transfer - Block move, Exchange, Sorting, Finding largest element in an array.	**CO1, CO2, CO3, CO4**
2	Arithmetic Instructions - Addition/subtraction, multiplication and division, square, Cube(16 bits Arithmetic operations – bit addressable).	
3	Timers/Counters.	

4	Boolean & Logical Instructions (Bit manipulations).	
5	Conditional CALL & RETURN.	
6	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII;	
7	HEX - Decimal and Decimal - HEX.	
8	Programs to generate delay, Programs using serial port and on-Chip timer /Counter.	
	Interfacing	
9	Simple Calculator using 6 digit seven segment displays and Hex Keyboard interface to 8051.	
10	Alphanumeric LCD panel and Hex keypad input interface to 8051.	
11	External ADC and Temperature control interface to 8051.	
12	Generate different waveforms Sine, Square, Triangular, Ramp etc. using DAC interface to 8051; change the frequency and amplitude.	
13	Stepper and DC motor control interface to 8051.	
14	Elevator interface design and testing using 8051.	

Note:

1. **For Programming** exercise is to be done on both 8051 & simulator.
2. **For interfacing** Write C and ALP programs to interface 8051 chip to Interfacing modules to develop single chip solutions.

Text Books:

1. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
2. The 8051 Microcontroller Architecture Programming & Application by Kenneth J. Ayala, Penram Inter.
3. The 8051 Microcontroller and Embedded Systems- Muhammad Ali Mazidi; Pearson Education India
4. Programming and Customizing the 8051 Microcontroller by Fredko Mike, TMH
5. Embedded Systems Architecture, Programming, and Design by Raj Kamal, TMH

REFERENCE BOOKS:

1. Microcontroller Architecture, Programming, Interfacing and System Design by Raj Kamal, Pearson Education India
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3. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRPC-22</td><td colspan="2" rowspan="2">Course Name: Digital Signal Processing Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td>Year and Semester</td><td>3rd Year
5th Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Knowledge of programming and Mathematics</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 30</td><td colspan="3">SEE: 45</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To study the fundamentals of MATLAB programming in digital signal processing.</td></tr>
<tr><td colspan="7">2. To study the mathematical concept of discrete system and implement it in MATLAB programming.</td></tr>
</table>

3. To utilize MATLAB programming for the analysis of discrete systems.	
4. To utilize MATLAB programming for the design digital filters.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To introduce the MATLAB programming in discrete signal and system.
CO2	Ability to use MATLAB programming to get solutions of mathematical of discrete system.
CO3	To develop a skill to do the analysis of discrete systems by MATLAB programming.
CO4	To develop a skill to do the design digital filters by MATLAB programming.

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	Develop a program to represents basic elementary discrete signals.	**CO1 CO2 CO3 CO4**
2	Develop a program P to calculate the convolution and correlation of two discrete signals.	
3	Develop a program to determine Z-transform and inverse z-transformof given discrete signal.	
4	Develop a program to determine Fast Fourier transform of given discrete signal.	
5	Develop a program to describe discrete LTI system in Z-domain and draw its plot pole-zero.	
6	Develop a program to determine the impulse response and step response of given LTI discrete system.	
7	Develop a program to determine the Frequency response of Discrete LTI system.	
8	Develop a program to describe a digital filter and determine its output response.	
9	Develop a program to design a FIR filter by using window techniques.	
10	To design analog filter (low-pass, high pass, band-pass, band-stop)	
11	Develop a program to design a Butterworth IIR filter.	
12	To develop a program for computing direct forms realization values of IIR digital filter	
13	To develop a program for computing parallel realization values of IIR digital filter	
14	To develop a program for computing direct form realization values of FIR digital filter	

B. Tech Electrical and Instrumentation Engineering
SYLLABI for EXAMINATIONS
B. Tech. 4th YEAR

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-OE-401	**Course Name: Open Elective IV** (i) Computer Graphics and CAD/CAM		**L** 3	**T** 1	**P** 0	**C** 4
Year and Semester	**4th Year** **VIIth Semester**	**Contact hours per week:** (4Hrs) **Exam:** (3 Hrs)				
Pre-requisite of course	Programing in C, General Math	**Evaluation** **CIE: 40**	**SEE: 60**			

Course Objectives:	
1. To learn and understand Graphics fundamentals.	
2. To develop the algorithm design capability for creating different 2-D and 3-D graphical objects To learn creation of animated scenes for virtual objects creations	
3. To further the acquired knowledge to utilize it in different research works on Pattern Recognition and Image Processing.	
4. To learn and understand Graphics fundamentals.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand how to write algorithms for generating different 2-D and 3-D graphical objects.
CO2	Apply the knowledge to create and filling polygon (solid area fill),
CO3	Implement the different techniques of 2-D
CO4	Implement different line and polygon clipping algorithms,
CO5	Draw different types of projections in 3-D vector algebra, different 3-D transformation techniques, curves and surfaces and rendering methods
CO6	Animate scenes entertainment and apply the knowledge to research work.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	Introduction of computer Graphics and its applications, Overview of Graphics systems, Video display devices, Raster scan display, Raster scan systems, video controller, Raster scan display processor, Random scan display, random scan systems, color CRT monitor, Flat panel display, Interactive input devices, Logical classification of input devices, Keyboard, mouse, Trackball and spaceball, Joysticks, Image scanner, Light pens, Graphics software, Coordinates representations, Graphics primitives and functions.	**9**	**CO1, CO2**
2	Points and lines, Line drawing algorithms, midpoint circle and ellipse algorithms. Filled area primitives: scan line polygon fill algorithm, boundary-fill and flood fill algorithms. Translation, scaling, rotation, reflection and shear transformations, matrix representations and homogeneous coordinates, composite transforms, transformation between coordinate systems. 2-D Viewing: The viewing pipeline, viewing coordinate reference frame, window to viewport coordinate transformation, viewing functions, Cohen-Sutherland and Cyrus beck line clipping algorithms	**9**	**CO2, CO3, CO5**
3	Polygon surfaces, quadric surfaces, spline representation, Hermite	**9**	**CO3,**

	Curve, Bezier Curve and BSpline curves, Bezier and B-Spline surfaces, sweep representations, 3-D Geometric Transformations: Translation, Rotation, Scaling, Reflection and Shear transformations, composite transformations, 3-D viewing, viewing pipeline, viewing coordinates, view volume and general projection transforms and clipping.		**CO4**
4	Classification, back-face detection, depth-buffer, scan line, depth sorting, BSP- tree methods, are subdivision and octree methods Illumination models and surface rendering methods: Basic illumination models, polygon rendering methods. Design of animation sequence general computer animation functions, raster animation, computer animation languages, key frame systems, motion specifications.	**9**	**CO4, CO6**

TEXT BOOKS

1. COMPUTER GRAPHICS C VERSION by Donald Hearn and M. Pauline Baker, Pearsosn Education.
2. Principles of Interactive Graphics, Neuman and Sproul, TMH
3. Computer Graphics second edition "Zhigand Xiang, Roy Plastock, Schaum's outlines Tata McGraw Hill Edition.

REFERENCE BOOKS

1. Computer Graphics Principles & Practice", Second Edition in C, Foley, VanDam, Feiner and Hughes, Pearson Education.
2. Procedural Elements for Computer Graphics, David F Rogers, Tata McGraw Hill, 2nd edition.
3. An Integrated Introduction to Computer Graphics and Geometric Modelling, R. Goldman, CRC Press, Taylor & Francis Group.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-OE-401</td><td colspan="2">Course Name: Open Elective-IV
(ii) IoT and It's Applications</td><td>L
3</td><td>T
1</td><td>P
0</td><td>C
4</td></tr>
<tr><td>Year and Semester</td><td>4th Year
VIIth Semester</td><td colspan="5">Contact hours per week: (4 Hrs.)
Exam: (3 Hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Microprocessor, Microcontrollers and Embedded Systems</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
</table>

Course Objectives:	
1. To understand what Internet of Things is.	
2. In this course, student will explore various components of Internet of things such as Sensors, internetworking and cyber space.	
3. In the end they will also be able to design and implement IoT circuits and solutions.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Identify the main components of Internet of Things.
CO2	Program the sensors and controller as part of IOT.
CO3	Assess different Internet of Things technologies and their applications.
CO4	Design a component or a product applying all the relevant standards and within realistic constraints.
CO5	Identify a suitable hardware and software solution for the given electrical and instrumentation problems.
CO6	Execute their electrical and instrumentation product ideas into a real-time working model.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**INTRODUCTION TO INTERNET OF THINGS**: Definition & Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security. **COMPONENTS IN INTERNET OF THINGS:** Control Units – Communication modules –Bluetooth – Zigbee –Wifi – GPS- IOT Protocols (IPv6, 6LoWPAN, RPL, CoAP), MQTT, Wired Communication, Power Sources. Current trends in IoT.	**9**	**CO1, CO2**
2	**PROGRAMMING THE MICROCONTROLLER FOR IOT:** Introduction of Raspberry Pi 3 B+ - About Raspberry version and processor, specification, pin details, features. Raspberry OS, IP configuration, Wi-Fi configuration, supporting package installation. Basic Linux commands, basic python programming, web server installation, Basic HTML and PHP, connecting My SQL data base. Different type of IoT Gate way	**9**	**CO2, CO3**
3	**HARDWARE INTERFACING:** Working principles of sensors – IOT deployment for Raspberry Pi – Reading from Sensors, Communication: Connecting microcontroller with mobile devices – communication through Bluetooth, Wi-Fi and USB - Contiki OS. Camera interface, Think speck IoT platform, Android interface with IoT.	**9**	**CO2, CO3**
4	**RESOURCE MANAGEMENT IN IOT:** Clustering, Clustering for Scalability, Clustering Protocols for IoT - From the internet of things to the web of things - The Future Web of Things – Set up cloud environment – Cloud access from sensors– Data Analytics for IOT- Case studies- Open Source 'e-Health sensor platform' – 'Be Close Elderly monitoring' – Other recent projects. **IOT APPLICATIONS:** Business models for the internet of things, Home energy management, home automation etc.	**10**	**CO2, CO3, CO4, CO5, CO6**

Text Books:

1. Architecting the Internet of Things, Dieter Uckelmann et.al Springer, 2011

2. Internet of Things – A Hand-on Approach, ArshdeepBahga and Vijay Madisetti, Universities press, 2015

Reference Books:

1. Building Internet of Things with the Arduino, CharalamposDoukas, Create space, April 2002.
2. Internet of Things: From research and innovation to market deployment, Dr.OvidiuVermesan and Dr. Peter Friess, River Publishers 2014.
3. 8051 Microcontroller: An Application Based Introduction, David Calcutt, Fred Hassan, Newness, 2008.
4. Contiki: The open source for IOT, www.contiki-os.org
5. Vijay Madisetti and ArshdeepBahga, **“Internet of Things (A Hands-on-Approach)”,** 1st Edition, VPT, 2014
6. Francis daCosta, **“Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”,** 1st Edition, Apress Publications, 2013
7. CunoPfister, Getting Started with the Internet of Things, O‟Reilly Media, 2011, ISBN: 978-1-4493- 9357-1

List of Open Source Software/learning website:

1. https://github.com/connectIOT/iottoolkit
2. https://www.arduino.cc/
3. Contiki (Open source IoT operating system)
4. https://www.ubuntupit.com/best-iot-operating-system-for-your-iot-devices/
5. Arduino (open source IoT project)
6. IoT Toolkit (smart object API gateway service reference implementation)
7. Zetta (Based on Node.js, Zetta can create IoT servers that link to various devices and sensors)

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PE-403</td><td colspan="2" rowspan="2">Course Name: Program Elective-IV
(i) Bio Medical Instrumentation</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>4th Year
(VIIth Semester)</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Brief knowledge of in the following topics: Physics, Basic Electrical Engg.</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 40</td><td colspan="4">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To introduce the concept of Bio Medical Instrumentation.</td></tr>
</table>

2. To introduce Bio Potential Electrodes and Biomedical Recorders.	
3. To introduce the Heart Sound and Ultrasound.	
4. To study the Imaging System.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To Familiarize with Bio Medical Instrumentation.
CO2	To understand with Bio Potential Electrodes and Biomedical Recorders.
CO3	To understand the Heart Sound and Ultrasound.
CO4	To understand the Imaging System.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction;** Bio-electric potential and electrode: Instrumentation system, Living Instrumentation system, Bio-metric, the anatomy of nervous system, origin of bio-potentials, resting and action potentials, propagation of action potentials, the Bio-electric potentials.	**5**	**I**
2	**Bio-potential electrode and Biomedical recorders:** Bio-potential electrode: Microelectrodes, skin surface electrode, Needle electrodes. EEG: Electrode for EEG, Block diagram of EEG Machine, EMG Recording, pre amplifier for EMG, EMG recording method.	**7**	**II**
3	**Heart Sound Monitoring and Ultrasonic Imaging system:** Basic functioning of heart, Electrocardiograph Block diagram of ECG, ISOLATION AMPLIFIER, the ECG leads, Microprocessor based ECG Machine, PCG, Microphones for PCG, amplifier for PCG, Physics of ultrasonic waves, Biological effect of ultrasound.	**6**	**III**
4	**Imaging System:** X-ray Machine and Computed Tomography: X-ray machine, X-ray image Intensifier T.V. system, X-ray computed Tomography (CT Scanner). NMR imaging system: Imager system. Application of NMR Imaging, Advantage & disadvantage of NMR Imaging system	**6**	**IV**

REFERENCE BOOKS:

1. Introduction to Biomedical Equipment Technology By Carr & Brown.
2. Biomedical Instrumentation and Measurement by Cromwell, PHI.
3. Handbook of Biomedical Instrumentation by R.S.Khandpur, TMH.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-403	**Course Name: Program Elective- IV** **(ii)** Reliability Engineering	**L** 2	**T** 1	**P** -	**C** 3
Year and Semester	**4th year** **7th Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	Basic Engineering Mathematics	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:

1. To study the basic concept of reliability, maintainability and availability engineering.
2. To study the evaluation techniques of engineering models and reliability improvement methods.
3. To study the concept of fault tree analysis and optimization techniques.
4. To study evaluation modesl for reliability, maintainability, availability testing.
5. To study the applications of fuzzy theory and neural networks to reliability engineering,

Course Outcomes: On completion of the course, student would be able to:

CO1	To understand the basic concept of reliability, maintainability and availability engineering.
CO2	To understand the evaluation techniques of engineering models and reliability improvement methods.
CO3	To learn the fault tree analysis and optimization techniques.
CO4	Ability to do testing and evaluate the reliability, maintainability, availability of engineering models.
CO5	To study the applications of fuzzy theory and neural networks to reliability engineering,

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	COs
1	Review of basic concepts in reliability engineering, reliability function, different reliability models etc., and reliability evaluation techniques for complex system: Non path set and cutest approaches, path set and cut set approaches, different reliability measures and performance indices, modeling and reliability evaluation of system subjected to common cause failures.	7	CO1
2	Reliability improvement, Reliability allocation/apportionment and redundancy optimization techniques, Fault tree analysis.	7	CO2, CO3
3	Maintainability Analysis: measure of system performance, types of maintenance, reliability centered maintenance, reliability and availability evaluation of engineering systems using Markov models. Reliability testing, Design for reliability and maintainability.	7	CO1, CO4
4	Applications of fuzzy theory and neural networks to reliability engineering, Typical reliability case studies.	7	CO5

Suggested Text / Reference Books:

1. M.L Shooman, "Probabilistic reliability- an engineering approach" RE Krieger Pub, 1990.
2. K.K Aggarwal, "Reliability Engineering" Springer Pub, 1993.
3. E. Balaguruswamy, "Reliability Engineering" McGraw hill, 2002.
4. R. Ramakumar, "Engineering Reliability" Prentice, NJ, 1993.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-403	**Course Name: Program Elective – IV** **(iii)** Wind and Solar Energy Systems		**L** 2	**T** 1	**P** -	**C** 3
Year and Semester	**4th year 7th Semester**	**Contact hours per week: (3Hrs) Exam: (3hrs.)**				
Pre-requisite of course	Electrical Machines, Power Electronics, Basic Science Engineering	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To familiarize the energy scenario and the consequent growth of the power generation from renewable wind and solar energy sources.						
2. To study the basic science of wind and solar energies.						
3. To study the wind and solar energy conversion systems for electrical power system.						
4. To studyintegration issues of the wind and solar generation.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Understand the energy scenario and the consequent growth of the power generation from renewable wind and solar energy sources.					
CO2	Understand the basic science of wind and solar energies.					
CO3	Understand the wind and solar energy conversion systems for electrical power system.					
CO4	Understand the power electronic interfaces for wind and solar generation.					
CO5	Understand the issues related to the grid-integration of solar and wind energy systems.					

Module No.	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Wind Energy Systems:** Historical developments of Wind Energy, energy and power in wind, wind energy dynamics, power extracted, axial thrust on turbines, torque, maximum power and Beltz coefficient, wind turbine operational characteristic, site selection. Wind energy conversion system, basic integration issues related to wind power, status of Wind power in India.	7	CO1, CO2
2	**Wind Energy Conversion Systems:** HAWT and VAWT constructions, basic rotor differences, relative merits and operational difficulties, lift and drag turbines, upwind and down wind machines. Basic components, fixed and variable speeds systems, type of generators used-D.C.,	7	CO3, CO4, CO5

	induction and synchronous machines; grid, standalone, and hybrid schemes.		
3	**Solar Energy Systems:** Fundamentals of solar cell, semiconductors as basis for solar cells materials and properties, P-N junction, sources of losses and prevention, estimating power and energy demand, site selection, land requirements, choice of modules, economic comparison, balance of systems. Overview of different types of solar cells/panels. Photovoltaic industries in India and world.	7	CO1, CO2
4	**Solar PV Power Plants System:**Array design, inverter types and characteristics, power conditioning system: working algorithms, performance analysis; design of stand alone, hybrid and grid interactive plants, commissioning of solar PV plant.	7	CO3, CO4, CO5

Suggested Text / Reference Books:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.
7. V. Yaramasu and B.Wu, "Model Predictive Control of Wind Energy Conversion Systems",Wiley- IEEE Press, 2016.
8. L. L. Freris, "Wind Energy Conversion System", Prentice Hall, (U.K.) 1990.
9. Thomas Ackermann, "Wind Power in Power System", John Wiley & Sons Ltd., 2005.
10. SuneelDeambi,"Photovoltaic System Design: Procedures, Tools and Applications", CRC Press 2016.
11. A. Freundlich, P. Verlinden, WvanSark, "Photovoltaic Solar Energy: From Fundamentals to Applications", John Wiley & Sons Ltd. 2017.
12. Md. Rabiul Islam, FazRahman, Wei Xu, "Advances in Solar Photovoltaic Power Plants", Springer-Verlag Berlin Heidelberg, 2016.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-403	**Course Name: Program Elective – IV** **(iv)** POWER QUALITY AND FACTS	**L** 2	**T** 1	**P** 0	**C** 3
Year and Semester	**IVth Year** **VIIth Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**EI-PC-202** POWER ELECTRONICS-I **EI-PC-303** POWER ELECTRONICS-II **EI-PC-307** POWER SYSTEM-II	**Evaluation** **CIE: 40**	**SEE: 60**		

Course Objectives:

To introduce students about the power quality and its classification.
To learn the students about voltage profile under different types of events.
To give brief idea of integration of distributed generation.
To introduce the students about FACTS and FACTS based controllers.
To give a brief knowledge about series and shunt compensation.

Course Outcomes: On completion of the course, student would be able to:

CO1	To understand the term power quality and its related issues like voltage unbalance, voltage sag/swell, harmonics etc.
CO2	To learn about different voltage profiles under the events of voltage sag/swell, transients, harmonic distortion, intra-harmonics etc.
CO3	To have a brief idea of distributed generation and its impact on power quality.
CO4	Learn about the FACTS and basics of FACTS controllers.
CO5	Know about the need of compensation and achieving it through static compensation; static series and shunt compensation.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**Cos**
1	**Introduction:** Power quality-voltage quality, power quality terms, power quality evaluation procedures term and definitions, general classes of power quality problems, transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion.	**5**	**CO1, CO2**
2	**Voltage sags and interruptions:** Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags. **Transient over voltages:** Fundamentals of harmonics, Harmonic distortion, voltage harmonic indexes, harmonic sources from commercial loads, harmonic sources from Industrial loads, effects of harmonic distortion, intra harmonics. **Distributed generation and power quality**: DG technologies, interface to utility system, power quality issues.	**7**	**CO2, CO2**
3	**FACTS Concept and General System Considerations:** Transmission Interconnections, Flow of Power in an AC System, Power Flow and Dynamic Stability	**8**	**CO4, CO5**

	Basic Types of FACTS Controllers, Brief Description and Definitions of FACTS Controllers, **Static Shunt Compensators:** Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability Thyristor Controlled Reactor.		
4	**Static Series Compensators:** Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static synchronous Series Compensator.	**6**	**CO5**

Text Books:

1. Narain G. Hingorani& Laszlo Gyugyi Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems Wiley
2. Arinthom Ghosh & Gerard Ledwich, Power Quality Enhancement Using Custom Power Devices Kluwer Academic Publishers
3. C. Sankaran, Power Quality CRC Press
4. S. Sivanagaraju& S. Satyanarayana, Electric Power Transmission and Distribution, Pearson Education

Reference Books:

1. Roger C Dugan, McGrahan, Santoso&Beaty, Electrical Power System Quality McGraw Hill
2. Power quality in power systems and electrical machines Ewald F Fuchs, Mohammad, A.S., Masoum Academic Press, Elsevier 2009.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-405	**Course Name:** Electric Drives		**L**	**T**	**P**	**C**
			3	**1**	**0**	**4**
Year and Semester	**4^{TH} Year (VIIth Semester)**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Brief knowledge of in the following topics: Electrical Machines, Power Electronics.	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
1. To introduce the concept of types of Electric Drives.	
2. To introduce the DC Motor Drives.	
3. To introduce the AC Motor Drives.	
4. To study the Motor power rating.	
5. To implement Traction Drives.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To Familiarize with Dynamics and Control of Electric Drives.
CO2	To understand efficient speed control techniques in DC Motor Drives.
CO3	To understand efficient speed control techniques in AC Motor Drives.
CO4	To understand the significance and selection of power rating.
CO5	To familiarization of Load and choice of traction for suitable load.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Electrical Drives:** Introduction, advantages, choice of electrical drives, status of ac and dc drives. **Dynamics of Electrical Drives:** Fundamental torque equations, multi-quadrant operation, equivalent values of drive parameters, load torque components, types of loads, steady state stability, load equalization. **Control of Electrical Drives:** Modes of operation, closed loop control of drives, sensing of current and speed**.**	**7**	**CO1**
2	**DC Motor Drives:** Speed-torque characteristics of different types of dc motors, starting, types of braking, transient analysis, speed control methods, static control of dc motors. Converter fed dc drive & chopper fed dc drive.	**7**	**CO2**
3	**Induction motor Drives:** Characteristics, analysis and performance, starting methods, braking methods, transient analysis, methods of speed control, vector control. Static control techniques- stator frequency control, stator voltage control, rotor resistance control. Static Scherbius system & static Kramer system.	**10**	**CO3**
4	**Selection of motor power rating:** Heating and cooling, determination of motor rating, continuous, short time and intermittent duties, determination of moment of inertia of the flywheel. **Traction Drives:** Nature of traction load, important features of traction drives, static control of traction drives; comparison between ac and dc tractions.	**12**	**CO4**

TEXT BOOKS:

1. Fundamentals of Electrical Drives, G.K.Dubey, Narosa Publishing House

REFERENCE BOOKS:

1. Power Semiconductor controlled drives, G.K.Dubey, Prentice Hall.
2. Electric Drives: V.Subrahmaniyam TMH
3. Electric Drives: Leonard, Narosa Pub.
4. Electric Drives: Diwan

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-407	**Course Name:** Advance Process Dynamics and Control		**L** 3	**T** 1	**P** 0	**C** 4
Year and Semester	**4th year VIIIth Semester**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)				
Pre-requisite of course	EI-PC-309 Linear Automatic Control System	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
5.	Acquire knowledge Process dynamics and various forms of mathematical models to express them
6.	To understand the multiloop systems
7.	To develop knowledge about controller tuning
8.	To develop understanding about PI diagrams
9.	To analyze samples data control systems
Course Outcomes: On completion of the course, student would be able to:	
CO1	Formulate mathematical model of various systems
CO2	Design and develop multiloop control systems
CO3	Compute the tuning parameters of controllers
CO4	Construct PI diagrams
CO5	Develop the sample data control systems

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs.**	**COs**
1	Need of mathematical modelling, lumped and distributed parameters, state variables and state equations of chemical processes, mathematical modelling of CSTR, interacting system and non-interacting system. Control of jacketed kettle systems, dynamic response of gas absorber, heat conduction into solids, heat exchanger.	**10**	**CO1**
2	Review and limitation of single loop control, need of multi loops, cascade, selective override, auctioneering, split range, feed forward, feed forward feedback, adaptive, inferential, ratio control, Self-adaptive control: MRAC, TR.	**8**	**CO1, CO2**
3	Tuning of PID controller, Zeigler – Nichols methods, Process reaction curve, Ultimate gain and period method, quarter decay ratio advance method of tuning, IAE, ISE, IATE tuning of controllers. Effect of measurement and transportation lag on process response, Effect of	**8**	**CO1, CO3**

	disturbances.		
4	Standard Instrumentation Symbols for Devices, Signal Types, Representation of a Process Control Loop using PI diagram. Sampling, open loop and closed loop response, Stability, sampled data control of first order process with transport lag, Design of sampled data controllers.	**10**	**CO4, CO5**

Text books:

1. Stephanopoulos, G., Chemical Process Control, Prentice–Hall of India Private Limited (1983).
2. Johnson, C.D., Process Control Instrumentation Technology, Prentice–Hall of India Private Limited (1992).
3. Process Systems Analysis and Control, D. R. Coughanour, McGrawHill

Reference books:

1. Liptak, B.G., Instrument Engineers Handbook, Butterworth, Heinemann (2002)
2. Seborg, D.E. and Edgar, T., Process Dynamics and Control, John Wiley and Sons (1989).

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRPC-27</td><td colspan="2" rowspan="2">Course Name: Electric Drives Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td>Year and Semester</td><td colspan="2">4th Year
VIIth Semester</td><td colspan="4">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td colspan="2" rowspan="2">Brief knowledge of in the following topics: Basic Electrical and Electronics engineering, Semiconductor devices, Digital Electronics, rectifiers.</td><td colspan="4">Evaluation</td></tr>
<tr><td>CIE: 30</td><td colspan="3">SEE: 45</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Understand the Chopper Control Drives</td></tr>
<tr><td colspan="7">2. Understand the concepts of Cyclocontroller based control.</td></tr>
<tr><td colspan="7">3. Understand the concept of Electric Breaking.</td></tr>
<tr><td colspan="7">4. Understand Current Source Inverter.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">To understand the concept of chopper control DC motors.</td></tr>
<tr><td>CO2</td><td colspan="6">To understand the cyclocontroller bases Induction Motor Control</td></tr>
<tr><td>CO3</td><td colspan="6">To understand how to implement electric Breaking using Induction Motor.</td></tr>
</table>

CO4	To understand the current Source Inverter and Voltage Source Inverters for Induction motor Control.

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
	LIST OF EXPERIMENTS STUDY EXPERIMENTS :	**CO1, CO2, CO3, CO4**
1.	Study of Chopper controller of DC Series motor	
2.	Study of Chopper controller of SE DC Series motor trainer	
3.	Study of half wave cycloconverter with IM	
4.	Study of DC dynamic breaking 3-phase slippering IM	
5.	VSI Controlled IM chopper trainer	
6.	Study of Self-controlled synchronous motor	
7.	To Study Current Source Inverter controlled IM	
8.	To study Voltage Source Inverter Controlled IM	

TEXT BOOKS:

1. Fundamentals of Electrical Drives, G.K. Dubey, Narosa Publishing House

REFERENCE BOOKS:

1. Power Semiconductor controlled drives, G.K. Dubey, Prentice Hall.
2. Electric Drives: V. Subrahmaniyam TMH
3. Electric Drives: Leonard, Narosa Pub.
4. Electric Drives: Diwan

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PROE-29	**Course Name: Open Elective IV Lab.** (i) Computer Graphics and CAD/CAM	**L** 0	**T** 0	**P** 3	**C** 1.5
Year and Semester	**4th Year VIIth Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	Programing in C, General Math	**Evaluation** — **CIE: 30**	**SEE: 45**		

Course Objectives:

5. To learn and understand fundamentals of Graphics programming
6. How to design and develop the algorithm for creating different 2-D and 3-D graphical objects and procedure to create animated scenes for virtual objects.
7. To further the acquired knowledge to utilize it in different research works on Pattern Recognition and Image Processing.

Course Outcomes: On completion of the course, student would be able to

CO1	Write algorithms for generating different 2-D and 3-D graphical objects.
CO2	Implement various 2D and 3D transformations
CO3	Design various types of graphical animation and complex designs
CO4	Apply the concepts on real- project design and development

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	Study of Fundamental Graphics Functions.	**CO1, CO2, CO3, CO4**
2	Implementation of Line drawing algorithms: DDA Algorithm, Bresenham's Algorithm	
3	Implementation of Circle drawing algorithms: Bresenham's Algorithm, Mid-	

	Point Algorithm.	
4	Ellipse Generation Algorithm	
5	Creating various types of texts and fonts	
6	Creating two dimensional objects	
7	Programs using 2-D transformations in C.	
8	Programs to study 3-D transformations in C.	
9	Implement Polygon filling algorithms [Flood-Fill Algorithm] in C.	
10	Programs to study window to viewport transformations in C.	
11	Program for Cohen Sutherland Line clipping algorithm in C.	
12	Write a program to implement Cohen Sutherland line clipping algorithm	
13	Write a program to draw Bezier curve.	
14	Key Frame Animation	

Text Books:

1. Procedural Elements for Computer Graphics, David F Rogers, Tata McGraw Hill, 2nd edition.
2. An Integrated Introduction to Computer Graphics and Geometric Modelling, R. Goldman, CRC Press, Taylor & Francis Group.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PROE-29	**Course Name:Open Elective- IV lab.** (ii) IoTand Its Application Lab		**L** 0	**T** 0	**P** 3	**C** 1.5
Year and Semester	**4th Year VIIth Semester**	**Contact hours per week:** (3 Hrs.) Exam: (3 hrs.)				
Pre-requisite of course	Microprocessor, Microcontrollers and Embedded Systems	**Evaluation**				
		CIE: 30		**SEE: 45**		
1. **Course Objectives:**						
2. To understand what Internet of Things is.						
3. In this course, student will explore various components of Internet of things such as Sensors, internetworking and cyber space.						
4. In the end they will also be able to design and implement IoT circuits and solutions.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Understand general concepts of Internet of Things (IoT)					
CO2	Recognize various devices, sensors and applications					
CO3	Apply, Analyze and Evaluate various design concept to IoT solutions					
CO4	Create IoT solutions using sensors, actuators and Devices					

Expt. No	**COURSE SYLLABUS CONTENTS OF MODULE**	**COs**
1	Introduction to various sensors and various actuators & its Application (Students have to prepare Report for the same). Perform Experiment using Arduino Uno to measure the distance of any object using Ultrasonic Sensor. a) PIR Motion Sensor. b) Rain Drop Sensor. c) Moisture Sensor. d) Temperature Sensor. e) Touch Sensor.	**CO1, CO2, CO3, CO4**

	f) Infrared Sensor. g) Servo Moto. h) RFID Sensor. i) Bluetooth Module. j) Wi-Fi Module.	
2	Demonstrate NodeMCU and its working	
3	Getting Started with (ESP8266 Wi-Fi SoC	
4	Hands-on with on-board peripherals of ESP8266	
5	Demonstrate Arduino and its pins.	
6	Perform Experiment using Arduino Uno to measure the distance of any object using Ultrasonic Sensor.	
7	Create a circuit using Arduino and sensors. Perform experiment using Arduino Uno to Learn Working of Servo Motor	
8	Creating a webpage and display the values available through Arduino.	
9	Demonstration of Setup & Working of Raspberry Pi. (Students have to prepare the Report for the same.).	
10	OPEN Ended problem: Students are required to submit an IOT based project using the Microcontroller or a Raspberry Pi and connecting various sensors and actuators. The data for the same should be displayed via a webpage or a web app.	

Supplementary Resources: Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

References: Web

a) https://www.udemy.com/course/internet-of-things-iot-for-beginners-getting-started/
b) https://playground.arduino.cc/Projects/Ideas/
c) https://runtimeprojects.com/
d) https://www.megunolink.com/articles/arduino-garage-door-opener/
e) https://www.willward1.com/arduino-wifi-tutorial/
f) https://www.makeuseof.com/tag/pi-overdose-heres-5-raspberry-pi-alternatives/
g) https://www.electronicshub.org/arduino-project-ideas/
h) http://homeautomationserver.com/
i) http://toptechboy.com/arduino-lessons/
j) https://www.eprolabs.com/

YouTube

a) https://www.youtube.com/watch?v=dC2GdEWHRxQ&list=PLy6JR9IR8VKOZBpDcETs
b) https://www.youtube.com/watch?v=kLd_JyvKV4Y
c) https://www.youtube.com/watch?v=TkA2LJctU1c

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-OE-402	**Course Name: Open Elective-V** (i) Artificial Intelligence	**L** 2	**T** 1	**P** 0	**C** 3
Year and Semester	**4th Year VIIIth Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	The course assume prior knowledge of basic programming, management skills.	**Evaluation**			
		CIE: 40	**SEE: 60**		
Course Objectives:					

1. To explore the basics of Artificial Intelligence.	
2. To introduce the concepts of a Rational Intelligent Agent and that can be designed to solve problems.	
3. To gain knowledge on blind and heuristic search in AI.	
4. To create an understanding of the basic issues of knowledge representation and Logic.	
5. To be able to design expert systems with intelligence.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Recognize the role of AI to solve real world problems
CO2	Explain and implement representation of knowledge, problem solving methods in AI.
CO3	Know how to build simple knowledge-based systems.
CO4	Solve complex engineering and real-world problems using AI.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction:** History, the turning test, overview of AI applications, problem & problem spaces, problems characteristics.	**7**	**CO1, CO2**
2	**Knowledge Representation Logic**: Proportional & first order prediction logic, inference rules, resolution limitation of logic. **Production system:** Definition & history, examples of search in production system, advantages.	**9**	**CO1, CO2, CO3**
3	**Search:** Informal and informal, algorithms of depth 1st, breadth 1st, hill climbing, best 1st search; **Game playing:** minimax search, alpha and beta pruning, forward and backward reasoning.	**9**	**CO2, CO3, CO4**
4	**Expert system:** Introduction & examples, architecture (rule based system), development, knowledge engineering process, limitations.	**7**	**CO3, CO4**

TEXT BOOKS

1. A.I by Elaine Tich, Kevin Knoght, Shiv Sankar B Nair, 3rd Edition, McGraw Hill Education
2. Artificial Intelligence: A Modern approach by Stuart J Russel, Peter Norvig, 3rd edition, Pearson
3. Introduction to Artificial Intelligence & Expert systems by Dass W. Patterson, PHI Publications.
4. PROLOG Programming for Artificial Intelligence, Ivan Bratko, 4th Edition, Addison-Wesley Educational Publishers Inc

REFERENCE BOOKS

1 A.I: an engineering approach by Robert J. Schlkoff, McGraw Hill.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-OE-402	**Course Name: Open Elective-V** (ii) Robotics		**L** 2	**T** 1	**P** 0	**C** 3
Year and Semester	**4th Year VIIIth Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	General Mathematics, Computer Graphics	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
1.	To develop the student's knowledge in various robot structures and their workspace.
2.	To develop student's skills in performing spatial transformations associated with rigid body motions.
3.	To develop student's skills in perform kinematics analysis of robot systems.
4.	To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
5.	To provide the student with some knowledge and analysis skills associated with trajectory planning.
6.	To provide the student with some knowledge and skills associated with robot control

Course Outcomes: On completion of the course, student would be able to:	
CO1	Outline the structure of a typical robotic system, understand its link and joint parameters, and perform robot kinematics.
CO2	Identify the geometric parameters of a robot by applying the knowledge of robot kinematics and generalized differential model of the robot.
CO3	Analyse planar and spatial parallel robots in context to its forward and inverse kinematics, and evaluate its singularity, condition number and maneuverability.
CO4	Identify the dynamic parameters of a robot by applying the knowledge of general form of dynamic equation of motion.
CO5	Identify the independent joint control and torque
CO6	Design a robotic manipulator and evaluate its primary and secondary workspace. Evaluate the performance of a robot.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction to Robotics**, terminology and definitions, Classification: Cylindrical, Spherical, Revolute, Rectangular; Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeatability. **End effectors** – Tools and grippers Components of Robotic Systems: Actuators, Sensors, Controllers, and Manipulators.	**7**	**CO1, CO2, CO3**
2	**Position and Orientation**: Description & frames, Rotation, Homogeneous transform, Translations, Transformation matrix. Robot Arm Kinematics: Introduction to Robot Arm Kinematics, Homogeneous Coordinate transformations, Direct & Inverse Kinematics, Composite Homogeneous transformation matrix.	**7**	**CO2, CO3**

3	**Link, joint and parameters:** DenavitHarten Berg Notation, D-H Matrix, Kinematic equations. Exercises on Direct & Inverse Kinematics up to six degree of freedom Robots.	**7**	**CO2, CO3, CO5**
4	**Manipulator Dynamics**: Euler-Lagrange Equation, KE and PE Expressions, Equations of motion, Newton-Euler transformation, some examples; Independent Joint control: Actuator Dynamics, set point tracking, Trajectory Interpolation	**7**	**CO3, CO4**

Text Book:

1. **Robotics control sensing Vision and Intelligence**- K.S.Fu, R.C.Gonzalez, C.S.G. Lee, McGraw Hill, 1987.
2. **Robot Technology Fundamentals -** James G.Keramas, Cengage learning
3. Robot and Controls By Mittal and Nagarath, Tata McGraw-Hill, 2003
4. Introduction to Robotics: Mechanics and control By J. J. Craig, AddisionWeslay Pub. Co.
5. Robot Dynamics and Control, By W. Sponge & M. Vidyasagar, John Wiley and Sons, New York, 1989.

Reference Books:

1. Bruno Siciliano and OussamaKhatib, Handbook of Robotics, Springer, 2016.
2. S. K. Saha, Introduction to Robotics, McGraw Hill Education, 2008.
3. P. Marlett, Parallel Robots, Springer, 2006.
4. Harry Asada &Slottine "Robot Analysis& Control" , Wiley Publications, 2014

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-OE-402</td><td rowspan="2" colspan="2">Course Name: Open Elective-V
(iii) High Voltage Engineering</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>-</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>4th year
8th Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Power System Engineering, Basic Science Engineering</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To introduce the concepts of high voltage engineering and methods of generation.</td></tr>
<tr><td colspan="7">2. To study with different high voltage measurements and required necessary instruments.</td></tr>
<tr><td colspan="7">3. To study the basics theories of lightening phenomenon, voltage surges and their</td></tr>
</table>

	characteristics.
4.	To introduce the protection methods and measurement methods for lightening and voltage surges.
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the concepts of high voltage engineering and methods of generation.
CO2	To familiarize with different high voltage measurements and required necessary instruments.
CO3	To understand the basics theories of lightening phenomenon, voltage surges and their characteristics.
CO4	To learn the protection methods of against lightening and surges.
CO5	To learn about the measuring instruments of lightening surges and its measurement methods.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**CONDUCTION AND BREAKDOWN:** Recent trends in high voltage transmission Conduction & breakdown in gases, liquids and solid dielectrics, insulator breakdown, insulation characteristics of long air gaps.	7	CO1
2	**METHODS OF HIGN VOLTAGE GENERATION:** Methods of generation of power frequency high voltage: cascaded transformers and resonance transformers Generation of high voltage DC, voltage multiplier circuits. Electrostatic Generation:Van de Graff machine and its voltage stabilization. Impulse voltage Generation: Basic impulse circuit, single stage impulse generator, multistage impulse generator (Marx circuit).	7	CO1, CO2
3	**PROTECTION OF SYSTEM AGAINST SURGES:**Ground wires, protective angle,tower footing resistance,surge diverters, Gap type and gapless lightning arresters, Insulation coordination, basic insulation levels, Voltage-time curve, impulse ratio.	7	CO3, CO4
4	**LIGHTENING:** Lightening phenomenon, lightning stroke mechanism, principle of lightning protection, tower foot resistance, insulator flash over and withstand voltage, lightning arresters and their characteristics, testing, generation of direct voltage, measurement of high voltage, general layout of H.V. Laboratory.	7	CO4, CO5

Suggested Text / Reference Books:

1. R.D. Begamudre,“E.H.V. AC Transmission”, Wiley Eastern Ltd.
2. V. Kamaraju and M.S. Naidu, “H.V. Engg”’,T.M.H., N.Delhi.
3. M.S. Naidu and V. Kamaraju,“High Voltage Engineering”,TMH Publication
4. C.L Wadhwa,“High Voltage Engineering”, Pub.: New Age International Ltd.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PE-404</td><td rowspan="2" colspan="2">Course Name: Program Elective-V
(i) Utilization of Electrical Energy</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>4th Year
(VIIIth Semester)</td><td colspan="5">Contact hours per week: (4Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Brief knowledge of in the following topics: Electrical Machines, Electrical Power System and Generation, Energy efficient System.</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 40</td><td colspan="4">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To introduce the concept of Illumination.</td></tr>
<tr><td colspan="7">2. To introduce the concept of Electric Heating and Welding.</td></tr>
<tr><td colspan="7">3. To study the concept of Electrolytic Process.</td></tr>
<tr><td colspan="7">4. To study the concept of Electric Traction.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">To Familiarize with the concept of Illumination.</td></tr>
<tr><td>CO2</td><td colspan="6">To understand the concept of Electric Heating and Welding.</td></tr>
<tr><td>CO3</td><td colspan="6">To Familiarize with the concept of Electrolytic process.</td></tr>
<tr><td>CO4</td><td colspan="6">To understand the concept of economics of Electric Traction.</td></tr>
</table>

<table>
<tr><td rowspan="2">Module No</td><td>COURSE SYLLABUS</td><td rowspan="2">Hrs</td><td rowspan="2">COs</td></tr>
<tr><td>CONTENTS OF MODULE</td></tr>
<tr><td>1</td><td>ILLUMINATION: Basic laws of illumination, light sources and their characteristics, sources of light, design of lighting schemes, incandescent lamp, sodium lamp, mercury lamp and fluorescent lamp, comparison of various lamps, LED,CFL Lamp.</td><td>7</td><td>I</td></tr>
<tr><td>2</td><td>ELECTRIC HEATING & WELDING:Principle and application of resistance, induction and dielectric heating.,Resistance welding, arc welding, welding generator and welding transformer, properties of arcing electrode.</td><td>8</td><td>II</td></tr>
<tr><td>3</td><td>ELECTROLYTIC PROCESS: Principles and applications of electrolysis. Faraday's law of electrolysis, electroplating, charging and discharging. Capacity and efficiency of battery, defects in battery, maintenance of battery.</td><td>11</td><td>III</td></tr>
<tr><td>4</td><td>ELECTRIC TRACTION: Systems of electric traction, traction motors, traction motor control, multiunit control, braking of electric motors, thyristor control of electric traction., Types of services, speed</td><td>10</td><td>IV</td></tr>
</table>

	time and speed distance curves, average and schedule speed, Estimation of power and energy requirements: specific energy consumption. Mechanics of train movement coefficient of adhesion, Adhesive weight, effective weight.		

REFERENCE BOOKS:

1. Utilization of Electrical Energy: Open Shaw Taylor; ELBS
2. Art and Science of Utilization of Electrical Energy: H. Pratab ;DhanpatRai& Sons, Delhi.
3. Generation, Distribution and Utilization of Electrical Power: C.L. Wadhwa; Khanna Pub.
4. H. Pratab,"Electric Traction", Dhanpat Rai & Sons.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PE-404</td><td colspan="2" rowspan="2">Course Name: Program Elective- V
(ii) Instrumentation and System Design</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>4th Year
VIIIth Semester</td><td colspan="5">Contact hours per week: (4 Hrs)
Exam: (3 hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">EI-ES-108 Basic Electronics Engineering</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">CIE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">5. To provide a coherent knowledge about concepts of instrument system design</td></tr>
<tr><td colspan="7">6. to develop knowledge about system characteristics and performance attributes</td></tr>
<tr><td colspan="7">7. To elaborate relevant issues of physical, architecture design at printed circuits board level of complex electronic systems</td></tr>
<tr><td colspan="7">8. To understand the fundamentals circuit layout</td></tr>
<tr><td colspan="7">9. To develop concept of power distributions systems</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Apply basic principles and guidelines of physical architecture design for complex electronic systems</td></tr>
<tr><td>CO2</td><td colspan="6">Analyze the various system attributes and their impact on system performance</td></tr>
<tr><td>CO3</td><td colspan="6">Analyze the influence of interconnects at different levels on electronic system performance</td></tr>
<tr><td>CO4</td><td colspan="6">Develop system model on the basis of learned concepts</td></tr>
</table>

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction** - overview of system engineering, system perspective, documentation, concept development, requirements, design development, rapid prototyping and field testing, validation, verification and integration, maintenance and life-cycle costs, failure, iteration and judgment. **Packaging and Enclosures:** Packaging influence, packaging design, wiring, temperature, vibration and shock, component packaging, mechanical issues	**8**	**CO1**
2	**Grounding and Shielding:** Safety, Noise, principle of energy coupling, Grounding, filtering, shielding, electrostatic discharge and it protection, general rules for design; Case study-EMC design of an oscilloscope.	**8**	**CO1, CO2**
3	Fundamentals of circuit design, high speed design, low power design, noise and error limitation, standard data buses and networks **Circuit Design:**, reset and power failure detection, input/output interfaces.	**8**	**CO2, CO3**
4	**Circuit layout and Power:** Circuit boards, component placement, routing of signals and traces, grounds, returns and shields, connectors and cables, design for manufacture, testing and maintenance; Power: Power requirements, sources of power, power conversion, definitions and specifications, power distribution and conditioning, electromagnetic interfaces.	**8**	**CO1, CO4**

Recommended Books:

1. Noise reduction techniques in electronic systems, 2nd ed. New York: Wiley By H.W.Ott
2. Electronic Instrument Design, Oxford Univ. Press, By Kim R. Fowler
3. Intuitive Operational Amplifiers, MeGraw-Hill, By T.M.Frederiksen
4. Printed Circuit Boards, CEDT Series TMH By Walter C. Bosshart

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-404	**Course Name: Program Elective- V** **(iii)** Fuzzy Logic Control		**L** / **3**	**T** / **1**	**P** / **-**	**C** / **4**
Year and Semester	**4th year** **8th Semester**	**Contact hours per week:** (4Hrs) **Exam:** (3hrs.)				

Pre-requisite of course	Basic Engineering Mathematics, Control system	Evaluation	
		CIE: 40	SEE: 60

Course Objectives:
To study and acquire the basic knowledge of fuzzy logic.
To study the basic architecture of FKBC and its design parameters
To study nonlinear & adaptive fuzzy controllers.
To identify, formulate and solve the neuro fuzzy logic based problems.

Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand working of basic fuzzy system and its architecture.
CO2	Able to fuzzy techniques in different field, which involve perception, reasoning and learning.
CO3	Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
CO4	Assess the results obtained by FKBC and Neuro fuzzy systems.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**FUZZY CONTROL & ITS MATHEMATICS :** Fuzzy control from an industrial perspective, knowledge representation in KBC's,Vagueness, fuzzy logic versus probability theory, fuzzy sets; their properties & operations on fuzzy sets, fuzzy relations & operations on fuzzy relations, the Extension Principle, Fuzzy propositions, The Compositional Rule of Inference, Different implications, Representing a set of rules.	8	CO1
2	**FKBC DESIGN PARAMETERS:** The FKBC architecture, choice of variables & content of rules, Derivation of rules, choice of membership functions, choice of scaling factors, choice of fuzzification procedure, choice of defuzzification procedure, comparison and evaluation of defuzzification methods.	8	CO1, CO2
3	**NONLINEAR & ADAPTIVE FUZZY CONTROL:** The Control Problem, The FKBC as a Non-Linear Transfer Element, Types of FKBC such as PID-like FKBC, Sliding Mode FKBC, Sugeno FKBC, Adaptation mechanism for FKBC Design & Performance Evaluation, Approaches to Design such as membership function tuning using gradient descent, membership function tuning using performance criteria, the self-organizing controller, model based controller.	8	CO2, CO3, CO4
4	**STABILITY OF FKBC & INTRODUCTION TO NEURO FUZZY CONTROLLERS:** The State space approach, Stability and robustness indices , input-output stability, circle criterion, Application of the Circle Criterion to Design, Conicity criterion, Neural networks based Fuzzy controllers & their applications.	8	CO3, CO4

Suggested Text / Reference Books:

1. D. Driankov, H.Hellendoorn and M.Reinfrank,"An Introduction to Fuzzy Control",Narosa Publications.
2. G.J. Klir andB Yuan, "Fuzzy sets and Fuzzy logic, theory and applications", Prentice Hall India Private Limited.
3. Abraham Kandel and Gideon Imngholz,"Fuzzy Control Systems",Narosa Publications.
4. Bart Kosko, "Neural Network & Fuzzy System", PHI

Note for Examiner(s): Question paper will comprise three sections,
1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:
1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-404	**Course Name: Program Elective- V** (iv) Optical Instrumentation		**L** 3	**T** 1	**P** -	**C** 4
Year and Semester	**4th year** **8th Semester**	**Contact hours per week:** (4Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	Optics, EM theory, digital communication, workshop	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To expose the basic concepts of optical fibers and their industrial applications.						
2. To provide adequate knowledge about Industrial application of optical fibres.						
3. To provide basic concepts of lasers.						
4. To provide knowledge about Industrial application of lasers						
5. To provide knowledge about Industrial application of Holography and Medical applications of Lasers.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Student will be able to Understand the working of optical fiber as a sensor					
CO2	Ability to Study and identify applications of LASER in instrumentation & measurement					
CO3	Perceive different industrial applications through optical instrumentation					
CO4	To make precise and accurate measurement in medical applications					
CO5	Apply LASER and Optical fiber for various physical parameter measurements.					
CO6	Analyzing the optical sensor technology on various parameters of measurements.					

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Optical fiber and Transmission characteristics:** Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics – manufacturing of optical fiber. Attenuation, material absorption losses, scattering losses, nonlinear and linear scattering, fiber bend loss, dispersion, intermodal dispersion, dispersion modified single mode fiber, dispersion flattened fibers, polarization, nonlinear phenomena.Connectors and splicers –Fibre termination.	8	CO1 CO5

2	**Optical sources and detectors, Optical fiber sensors** (10 hrs) Optical sources – Optical detectors.Optical emission from semiconductor, semiconductor LASER, non-semiconductor LASER, LED as an optical source, optical detector principles, absorption, quantum efficiency, responsively, photo diodes, modulation. Introduction to fiber optics sensors, sensors based on intensity modulation, Fibre optic instrumentation system – Different types of modulators – Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain application of optical fiber for displacement, strain, stress and pressure measurement. Active multimode FO sensors, micro-bend optical fiber sensors, current sensors, phase modulated, polarization modulated optical fiber sensors, fiber optic gyroscope.	10	CO1 CO2 CO5 CO6
3	**Industrial and Medical Applications of Lasers:** Introduction, application of laser in biomedical instrumentation, Medical applications of lasers, laser and tissue interactive – Laser instruments for surgery, removal of tumours of vocal cards, brain surgery, plastic surgery, gynaecology and oncology. Laser interferometry, performance parameters, laser telemeters, measurement of distance, LIDAR, Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization. Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components measurement of strain, stress, bending moments and vibrations using hologram.	12	CO3 CO4 CO5
4	**Optical amplification and integrated optics:** Optical amplifiers, integrated optics integrated optical devices: beam splitters, directional couplers, modulators, switches, optoelectronics integration and differentiation, analog arithmetic operations, digital optics.	6	CO1 CO2 CO5 CO6

Text Books:

1. R.P.Khare, Fiber Optics and Optoelectronics, Oxford university press, 2008.
2. J. Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2001.
3. Jose Miguel Lopez, ―Optical fiber sensing technology‖, John Wiley & Sons, 2002
4. AjoyGhatak, ―Optics, Tata Mc- Graw Hill Publishing, 5thed., 2012

Reference Book:

1. Asu Ram Jha, Fiber Optic Technology Applications to commercial, Industrial, Military and Space
2. Optical systems, PHI learning Private limited, 2009.
3. M. Arumugam, Optical Fibre Communication and Sensors, Anuradha Agencies, 2002.
4. John F. Read, Industrial Applications of Lasers, Academic Press, 1978.
5. Joseph T Verdeyen, ―LASER Electronics‖, Prentice Hall of India, 3rded., 2003
6. John M. Senior, ―Optical fiber Communications Principles and Practice, PHI publication, 2nded., 2008

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-404	**Course Name: Program Elective- V** (v) Remote Sensing		**L** 3	**T** 1	**P** -	**C** 4
Year and Semester	**4th year** **8th Semester**	**Contact hours per week:** (4Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	Optics, EM theory, digital communication, image processing, DSP, Mathematics	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To expose the basic concepts of remote sensing and their application systems						
2. To provide adequate knowledge of remote sensing data applications.						
3. To provide basic concepts of sensors on board						
4. To provide knowledge about GIS						
5. To provide knowledge about Image processing						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Student will be able to Understand the working of different sensors					
CO2	Ability to Study and identify applications of satellite derived data					
CO3	Perceive different GIS applications through sustainable development.					
CO4	To make precise and accurate measurement in optimum resolution.					
CO5	Apply remote sensing data for various physical parameter measurements.					
CO6	Analyzing the spectral sensor technology on various parameters of measurements.					

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Concepts and Foundations of Remote sensing - Introduction: Energy sources and radiation principles; radiation laws; energy interactions in the atmosphere; energy interactions with earth surface features; data acquisition and interpretation; global positioning system; ideal remote sensing system; characteristics of real remote sensing system; successful applications of remote sensing systems; geographic information systems - introduction.	9	CO2 CO3 CO6
2	Sensors and Instruments: Introduction, Photographic sensors, active and passive sensors, Visible and near infrared sensors; thermal infrared sensors; microwave sensors; sonic sensors; IR spectrometer Radiometers, Scanners, Sensors and Platforms, Resolution : spatial and	9	CO1 CO4 CO5

	temporal, geometric, angular. Satellite systems: Introduction, Land observation satellites, satellite remote sensing, satellite orbits, Landsat systems, land observation satellites, current satellite systems (Landsat class, spot, IRS, broad scale coverage, AVHRR, SeaWiFS, IKONOS, Cartosatetc)		
3	Multispectral thermal and hyper spectral sensing: Introduction, along track, across track scanning; operating principles, examples of Multispectral scanners and data, thermal scanners, along + across track thermal scanning, radiometric calibration of thermal scanners, FLIR systems, hyperspectral sensing, Microwave and lidar sensing : radar development, SAR, geometric characteristics of side looking radar, transmission of radar signals, radar image interpretation, radar remote sensing from space, Seasat, radarsat, ERS, JERS, ALOS, etc. shuttle radar topography mission, Lidar – introduction, sensors, resolution, sensors, development and applications.	9	CO1 CO4 CO6
4	Digital image processing fundamentals: Image rectification, enhancement, contrast manipulation, spatial and multi-image manipulation, image interpolation, edge detection, image restoration, image classification, , color imaging, data merging and GIS integration Applications of Remote sensing data: Applications to atmosphere, geosphere, hydrosphere, cryosphere, environmental applications, applications of data collection systems.	9	CO1 CO2 CO5 CO6

Suggested Text / Reference Books:

1. Remote sensing by FA Sabins, 1992
2. Introduction to Remote sensing by AP Cracknell and LWB Hayes Taylor & Francis Publ. 1991
3. Remote sensing and image interpretation by Thomas M Lillisand, RW Kiffer, JW Chipaman, John Weily 2004
4. Digital Singal Image Processing by Tamal Bose, JohnWeily, 2004
5. Introduction to JB Campbell, Taylor & Francis Publ.2002

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code:	**Course Name:** Industrial Process Control	**L**	**T**	**P**	**C**

EI-PC-406		3	1	0	4
Year and Semester	**4th Year (VIIIth Semester)**	**Contact hours per week:** (4Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**Control engineering**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:
1. Basic concept and Study of FC and FO type control valve and their applications with examples, Gain of valve and concept of control valve sizing for liquid, Gas, vapor and steam. (Special reference to Masoneillian & Fisher Equation) and study control valve cavitation and flashing phenomenon
2. Study control Valve noise, its calculation & reduction techniques and Design & Construction of Globe Valve.
3. Study the characteristic function of PLC, its Architecture and various PLC programming languages and Demonstrate various PLC programming skill for industrial applications.
4. Detail study and applications of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS
5. Study DCS supervisory control techniques & considerations(Algorithms), Concept of field buses and their applications

Course Outcomes: On completion of the course, student would be able to:	
CO1	Able to understand FC and FO type control valve and Able to learn and analyze the various principles & concepts involved in valve sizing for liquid, Gas, vapor and steam and control valve cavitation and flashing phenomenon
CO2	Able to understand control Valve noise, its calculation, reduction techniques and Acquire the knowledge and demonstrating the constructional details of Globe Valve.
CO3	Acquire the knowledge of performance characteristic function of PLC and its Architecture.
CO4	Able to learn the various PLC programming languages and Demonstratevarious PLC programming skill for industrial applications.
CO5	Able to learn and analyze the various principles & concepts of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS
CO6	Acquire the knowledge of DCS supervisory control techniques, the concept of field buses and their Industrial applications.
CO7	To implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution for industry problems.

Module No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**Hrs**	**COs**
1	CONTROL VALVE DESIGN: Control valve flow characteristics, valve & process characteristics, effect of distortion coefficient on linear and percentage valve, range-ability of control valve, control valve sizing for liquid, Gas, vapor and steam. (Special reference to Masoneillian & Fisher Equation) control valve cavitation and flashing: flow control cavitation index, vibration curve cavitation index, calculation of flash fraction. Control valve gain, sequencing of control valve and viscosity correction of control valve.	**9**	**CO1, CO7**
2	Valve noise calculation & reduction: Sources of valve noise, noise control: path treatment source treatment valve noise calculation.	**9**	**CO2, CO7**

	Design & construction of Globe Valve: Valve trends, trim design, trim flow characteristics, flow rangeability, standard trim configuration, valve plug stems, Body form of single & double seated Globe valve, construction		
3	Discrete State Process Control System:Programmable controller, characteristic function of PLC, Architecture and block diagram of PLC, ladder diagram, ladder diagram elements, Development & analysis of ladder diagram, logic diagram from ladder diagram, Functional description of PLC difference between PLC & computer. Communication networking: Universal communications networking, Peer to Peer communications, PLC installations. Programming the Programmable controller: Programming languages, ladder diagram instructions, special functions, data transfer and data manipulation operations, arithmetic operations, flow control operations, Boolean mnemonics. Functional blocks data transfer operations arithmetic and logic operations, Programmable controller's industrial applications.	**9**	**CO3 CO4 CO5 CO7**
4	Distributed process control system: Functional requirement of DPCS, DCS configurations, control console equipment: Software configuration: Operating system configuration, controller function configuration, algorithm, libraries, relay rec. mounted equipment, communication between the components. DCS data high ways, field buses, multiplexers & party line system, DCS Supervisory computer and configurations: Supervisory computer functions, supervisory control techniques & considerations(Algorithms), DCS & Supervisory computer display, DCS. DCS system integration with PLC & computer.	**9**	**CO4 CO5 CO6 CO7**

Reference Books:

1. Microprocessor in process control: C.D.Johnson
2. Instrumentation for process measurement and control by N.A. Anderson.
3. Principles and practice of automatic process control: Carlos by A Smith.
4. Instrument Engineers' handbook - Process control by Bela G. Liptak.
5. Computer based Industrial Control by Krishan Kant

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-24	**Course Name:** Process Control Lab	**L** 0	**T** 0	**P** 3	**C** 1.5
Year and Semester	**4th Year VIIIth Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Control Engineering Lab.**	**Evaluation**			
		CIE: 30		**SEE: 45**	

Course Objectives:
1. To Familiarization of PLC Ladder Programming Instructions Set
2. To compile and execute programs in Ladder Programming
3. To study the PC and PLC based control systems
4. To study and write PLC program for the multiple process control systems
5. To study and write PLC program for different strategies of control system such as feedback, feed forward, cascade, ratio control etc.
6. To write PLC programs to solve the different control problems

Course Outcomes: On completion of the course, student would be able to:	
CO1	Ability to understand PC and PLC based control system and their implementation
CO2	Ability to develop PLC Ladder Programming skill
CO3	Analyse and implement PLC Ladder Programming for different type of process control system.
CO4	Ability to design and develop PLC program for different strategies of control system such as feedback, feed forward, cascade, ratio control for control of process variables

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	Familiarization of PLC Ladder Programming Instructions Set	**CO1, CO2, CO3, CO4**
2	**To Study** PC Based Traffic Light Control: Basic Traffic Light Sequence	
3	PLC Based Traffic Light Control: • PLC Connection Details • Dual Traffic Light Sequence • Traffic Counting • Green Time Alteration According to Traffic Flow • The Pedestrian Crossing • Complete System Control	
4	To Study Process Control – Ratio, feedback control flow & level	
5	To Study Rotary Transfer Unit :- • Movement of Rotary Table • Initialization • Station Counting • Dispensing • A Production Line System • Follow a Set Routine	
6	To Study Industrial Control Trainer	
7	To Study Multiprocess Control Trainer : Feedback, feedforward cascade and ration Control system for flow, temperature and level control	
8	To study of Pressure Control Unit: Proportional Control : Run a loop experiments using 'proportional only control' with the following sets of SP and	

	PG values. Record the eventual 'steady state' rate values in the table below, once the initial oscillations have decayed. • Proportional and Integral Control	
9	To design, Level Control PC :- • Proportional Control • Proportional and Integral Control	
10	To Study .Flow control PC & PLC :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Zeigler / Nichols Tuning	
11	To Study The System Rig :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Ziegler / Nichols Tuning • Temperature Control • Batch Volume Control • Fluid Level Control • Open Loop Control • Bode Plots • Flow Loop Model using Caldwell's Method • Flo Loop Model using Sundaresan's Method • Design of Controller for PCU Flow Loop • PRT Signal Conditioning • Flowmeter Signal Conditioning	
12	Process Control Experiment :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Ziegler / Nichols Tuning • Temperature Control • Batch Volume Control • Fluid Level Control • Open Loop Control • Bode Plots	

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PROE-26	**Course Name: Open Elective-V Lab.** **(i)** Artificial Intelligence Lab		**L** **0**	**T** **0**	**P** **3**	**C** **1.5**
Year and	**4th Year**	**Contact hours per week:** (3Hrs)				

Semester	VIIIth Semester	Exam: (3hrs.)	
Pre-requisite of course	**NIL**	**Evaluation**	
		CIE: 30	**SEE: 45**
Course Objectives:			
1. course introduces the basic concepts and techniques of Artificial Intelligence			
2. writing code for AI problems in Prolog			
3. Identify problems, errors in Prolog Programming codes			
4. Introduce knowledge representation in Prolog and write code for drawing inferences			
5. To Identify problems that are amenable to solution by specific AI methods			
Course Outcomes: On completion of the course, student would be able to:			
CO1	To compile and execute AI programs in Prolog.		
CO2	To identify the syntax errors and semantic errors in Prolog Programming.		
CO3	To Represent knowledge in Prolog and write code for drawing inferences		
CO4	Sensitive towards development of responsible Artificial Intelligence		

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	Write a Prolog Program to test existence of data in the knowledge	**CO1, CO2, CO3, CO4**
2	Design and develop a Prolog Program enquire relationships in a family tree using Horn clauses.	
3	Design and develop a Prolog Program to check efficacy of Prolog for computations such as roots of quadratic equation	
4	Design and develop a Prolog Program to test fail and cut predicate to identify who likes whom from the data(knowledge).	
5	Write a Prolog Program to test fail and cut predicate to identify who likes whom from the data(knowledge) based on similar interests using Lists.	
6	Develop, implement, and execute a Prolog Program to search a Number in a list using *linear searching* Technique.	
7	Develop an algorithm, implement, and execute a Prolog Program to find all the paths between two nodes.	
8	Design and develop a Prolog Program to rotate a list N places to the left.	
9	Develop, implement, and execute a Prolog Program to search a record by name and phone number in Artificial Intelligence	
10	Write a Design and develop a Prolog Program to solve Towers of Hanoi puzzle	

Text Books:

1. Prolog Programming for Artificial Intelligence, by Ivan Bratko, 4Th Edition, Pearson.
2. Prolog Programming in Depth, by Michael A. Covington, Donald Nute, Andre Vellino, Prentice-Hall.
3. Programming in PROLOG, by William F. Clocksin, Christopher S. Mellish, Springer

Web resources:

1. https://www.cpp.edu/~jrfisher/www/prolog_tutorial/contents.html#2
2. https://www.javatpoint.com/prolog-programs
3. https://www.cs.ccu.edu.tw/~dan/prologProgs.html

Program Name: B. Tech.-Electrical and Instrumentation Engineering

Course Code:	Course Name: Open Elective-V Lab.	L	T	P	C

EI-PROE-26	(ii) Robotics		0	0	3	1.5
Year and Semester	**4th Year** **VIIIth Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course		**Evaluation**				
		CIE: 30	**SEE: 45**			
Course Objectives:						
1. To introduce different types of robotics and demonstrate them to identify different parts and components.						
2. To write programming for simple operations.						
3. Simulate the work space for different industrial process						
Course Outcomes: On completion of the course, student would be able to						
CO1	Recognize different type of industrial robots and peripheral for simple industrial setup					
CO2	To programs different parts and peripheral for controlling industrial robots using different ways.					
CO3	Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots					
CO4						

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	Determination of maximum and minimum position of links.	**CO1, CO2, CO3, CO4**
2	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system	
3	Estimation of accuracy, repeatability and resolution.	
4	Robot programming and simulation for pick and place	
5	Robot programming and simulation for Colour identification	
6	Robot programming and simulation for Shape identification	
7	Robot programming and simulation for machining (cutting, welding)	
8	Robot programming and simulation for writing practice	
9	Robot programming and simulation for any industrial process (Packaging, Assembly)	
10	Robot programming and simulation for multi process.	

Kurukshetra University, Kurukshetra

(Established by the State Legislature Act XII of 1956)

('A+' Grade, NAAC Accredited)

।। योगस्थः कुरु कर्माणि ।।
समबुद्धि व योग युक्त होकर कर्म करो

(Perform Actions while Steadfasting in the State of Yoga)

DEPARTMENT OF INSTRUMENTATION (DOI)

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: M. Tech. - Electrical and Instrumentation Engineering

(For the Batches from 2020-2021in phased manner)

9481

(UTD Only)

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: M. Tech. - Electrical and Instrumentation Engineering

(For the Batches admittedfrom 2020-2021in phased manner)

VISION

Be globally acknowledged as a distinguished centre of academic excellence.

MISSION

To prepare a class of proficient scholars and professionals with ingrained human values and commitment to expand the frontiers of knowledge for the advancement of society**.**

DEPARTMENT VISION AND MISSION

VISION

- To become a model department as a Centre of quality education, research with innovation and recognition at National and International level for serving society.

MISSION

- **M1:** To provide quality education to aspiring young minds for improving their skills, inculcating values, creating leadership qualities and enhance research with innovative methods.
- **M2:** To produce young engineers capable to be utilized in the areas of New Technological Design, Environment, ethics and sustainable technologies.
- **M3:** To develop Teaching-Learning methods which can produce socially committed good professional human being who can contribute effectively in Nation building and represent Country Internationally.

Mapping of University Vision and Mission to Department Vision and Mission

Acclaimed as modal Centre of Learning and Research by

University Vision and Mission	Department Vision and Mission
High quality knowledge delivery through state of art infrastructure and ethical values to the students	**Yes**
Students excellence will make them professionals and innovators emerging as global leaders	**Yes**
Research and development will help in furtherance of Faculty knowledge	**Yes**

Programme Educational Objectives (PEOs):

The Department of Instrumentation in consultation with various stakeholders have formulated the Programme Educational Objectives (PEO's) that are broad statements that describe the career and professional accomplishments that the program is preparing its Post Graduate to achieve in few years, subsequent to receiving the degree. The PEO's of the M. Tech. programme in Electrical and Instrumentation Engineering are as follows:

- **PEO1:**The Post Graduate will become competent by applying their technical and managerial skills.
- **PEO2:**The Post Graduate will be able to adapt to any environment and succeed in higher positions in contemporary rapidly evolving technologies in Electrical and Instrumentation engineering field.
- **PEO3:**The Post Graduate will engage themselves in the life-long learning by pursuing higher education and participation in research and development activities to meet all challenges to transform them as responsible citizens of the nation

Program Specific Outcomes (PSO's):

- **PSO1:**Clearly understand the fundamental concepts of Electrical and Instrumentation Engineering
- **PSO2:** Post Graduate will be able to formulate and solve real life problems in the area of Electrical and Instrumentation Engineering
- **PSO3:** Post Graduate will possess the skills to communicate effectively in both oral and written forms, demonstrating the practice of professional ethics, and responsive to societal and environmental needs.

PEOs to Mission statement mapping

PEO's	MISSION OF THE DEPARTMENT		
	M1	M2	M3
PEO1	3	3	1
PEO2	2	3	2
PEO3	2	2	3

Program Outcomes (PO) with Post Graduate Attributes

Programme Outcomes are attributes of the Post Graduate from the programme that are indicative of the Post Graduate' ability and competence to work as an engineering professional upon graduation. Program Outcomes are statements that describe what students are expected to know or do by the time of graduation, they must relate to knowledge and skills that the students acquire from the programme. The achievement of all outcomes indicates that the student is well prepared to achieve the program educational objectives down the road. The Department of Instrumentation engineering has following twelve PO's. The course syllabi and the overall curriculum are designed to achieve these outcomes:

S. No.	Post Graduate Attributes	Program Outcomes (POs)
PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	Communication	Ability to communicate effectively on general and Technical topics with the engineering community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve Engineering and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific and engineering practices
PO8	Engineering and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional Engineering practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	Project Management	Ability to demonstrate knowledge and understanding of the engineering principles and apply these to manage projects

Mapping of PEO's with PO's

S. No.	Program Educational Objectives	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	The Post Graduate will become competent by applying their technical and managerial skills.	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2	The Post Graduate will be able to adapt to any environment and succeed in higher positions in contemporary rapidly evolving technologies in Electrical and Instrumentation engineering field.	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3	The Post Graduate will engage themselves in the life-long learning by pursuing higher education and participation in research and development activities to meet all challenges to transform them as responsible citizens of the nation			√	√		√	√	√	√		√	√	√	√

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: M. Tech. - Electrical and Instrumentation Engineering

Post Graduate Degree Program

General, Course structure & Theme & Semester-wise credit distribution

A. Definition of Credit:

1 Hour Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit
1 Hour Practical (P) per week and/or 2 Hours Practical(Lab)/week	0.5 credits 1 credit

B. Total credits:

Total credits for a student to be eligible to get Post Graduate degree in Engineering are 66.0 credits.

C. Structure of Undergraduate Engineering program:

S. No.	Category	Breakup of Credits (Total)
1.	**Professional Core Courses**	**52**
2.	**Program Elective Coursesrelevant to the branch**	**09**
3.	**Seminars**	**04**
4.	**Research Methodology &IPR**	**01**
	Total	**66**

D. Course code and definition:

Category of Course/ Code	Definitions
L	Lecture
P	Practical
C	Credit
CIE	Continuous Internal Evaluation
SEE	Semester End Examination
EI	Electrical and Instrumentation Engineering
RM	Research Methodology
PC	Professional Core Courses
PE	Professional Elective courses
PRPC/ PRPE/ PRS	Practical Professional Core/ Program Elective/Seminar
ADC	Mandatory Audit Courses

E. Details of Structure and distribution of credits to various courses:

S. No	Category	Course No.	Course Title	C	Teaching Schedule			
					L	T	P	Cont Hrs.
Professional Core Courses								
1	**PC**	**EI-PC-103**	Biomedical Instrumentation	3	3	0	0	3
2	**PC**	**EI-PC-105**	Advanced Electric Drive	3	3	0	0	3
3	**PC**	**EI-PC-107**	Advance Process Control	3	3	0	0	3
4	**PC**	**EI-PC-104**	Power Quality Monitoring and Conditioning	3	3	0	0	3
5	**PC**	**EI-PC-106**	PLC & DCS	3	3	0	0	3
6	**PC**	**EI-PC-108**	Embedded System Design	3	3	0	0	3
7	**PC**	**EI-PC-110**	Advanced Power System	3	3	0	0	3
8	**PC**	**EI-PC-201**	Smart & Micro Sensor Design	3	3	0	0	3
9	**PRPC**	**EI-PRPC-101**	Process Control Lab	1.5	0	0	3	3
10	**PRPC**	**EI-PRPC-103**	Advanced Electric Drive Lab	1.5	0	0	3	3
11	**PRPC**	**EI-PRPC-102**	Advanced Power System Lab.	1.5	0	0	3	3
12	**PRPC**	**EI-PRPC-104**	Embedded Systems Lab	1.5	0	0	3	3
13	**PRPC**	**EI-PRPC-203**	Dissertation Phase-1	06	0	0	12	12
14	**PRPC**	**EI-PRPC-204**	Dissertation	16	0	0	32	--
			Total	**52**	**24**		**56**	**48**
Program Elective Courses								
1	**PE**	**EI-PE-101**	**Program Elective-I**	3	3	0	0	3
			(i) Control system Design					
			(ii) Process Equipment Design					
			(iii) Industrial Environmental Engineering					
			(iv) Power Plant Engineering					
			(v) Energy Auditing and methodology					
			(vi) Energy Efficient Machines					
2	**PE**	**EI-PE-102**	**Program Elective-II**	3	3	0	0	3
			(i) Renewable & Non-Conventional Energy					
			(ii) Theory and Design of Neuro fuzzy controllers					
			(iii) Digital Control System					
			(iv) HVDC Transmission System					

			(v) Energy Management					
			(vi) Process Modeling and Control					
			(vii) Advance Power Electronics					
3	**PE**	**EI-PE-203**	**Program Elective-III**	3	3	0	0	3
			(i) Digital Signal Processing					
			(ii) Sensors and Transducers					
			(iii) Reliability Engineering					
			(iv) Electrical Vehicle Engineering					
			(v) System Theory					
			(vi) Intelligent Instrumentations					
			(vii) Industrial Power Electronics					
			Total	**09**	**09**	**0**	**0**	**09**
1	**RM**	**EI-RM-109**	Research Methodology & IPR	**1**	**2**	**0**	**0**	**2**
Seminars								
1	**PRS**	**EI-PRS-105**	Seminar-I	1	0	0	2	2
	PRS	**EI-PRS-106**	Seminar-II	1	0	0	2	2
	PRS	**EI-PRS-201**	Current Literature Report & Seminar	2	0	0	4	4
			Total	**04**	**0**	**0**	**08**	**08**

Department of Instrumentation

M. Tech Electrical and Instrumentation Engineering

SCHEME OF EXAMINATIONS

M. Tech. 1st YEAR (SEMESTER–I)(from 2020 – 2021in phased manner)

Course No.	Course Title	C	Teaching Schedule			Allotment of marks			Exam Duration in Hrs.
			L	P	Cont. Hrs.	CIE	SEE	Total	
EI-PE-101	Program Elective-I	3	3	0	3	40	60	100	3 Hrs
EI-PC-103	Biomedical Instrumentation	3	3	0	3	40	60	100	3 Hrs
EI-PC-105	Advanced Electric Drive	3	3	0	3	40	60	100	3 Hrs
EI-PC-107	Advance Process Control	3	3	0	3	40	60	100	3 Hrs
EI-RM-109	Research Methodology & IPR	2	2	0	2	20	30	50	3 Hrs
EI-PRPC-101	Process Control Lab	1.5	0	3	3	20	30	50	3 Hrs
EI-PRPC-103	Advanced Electric Drive Lab.	1.5	0	3	3	20	30	50	3 Hrs
EI-PRS-105	Seminar-I	1	0	2	2	50	--	50	
	Total	**18**	**14**	**8**	**22**	**270**	**330**	**600**	

M. Tech. 1stYEAR (SEMESTER–II)

Course No.	Course Title	C	Teaching Schedule			Allotment of marks			Exam Duration in Hrs.
			L	P	Cont. Hrs.	CIE	SEE	Total	
EI-PE-102	Program Elective-II	3	3	0	3	40	60	100	3 Hrs
EI-PC-104	Power Quality Monitoring and Conditioning	3	3	0	3	40	60	100	3 Hrs
EI-PC-106	PLC & DCS	3	3	0	3	40	60	100	3 Hrs
EI-PC-108	Embedded System Design	3	3	0	3	40	60	100	3 Hrs
EI-PC-110	Advanced Power System	3	3	0	3	40	60	100	3 Hrs
EI-PRPC-102	Advanced Power System Lab.	1.5	0	3	3	20	30	50	3 Hrs
EI-PRPC-104	Embedded Systems Lab	1.5	0	3	3	20	30	50	3 Hrs
EI-PRS-106	Seminar-II	1	0	2	2	50	--	50	
	Total	**19**	**15**	**8**	**23**	**290**	**360**	**650**	

Program Elective-1	**Program Elective-II**
(i) Control system Design	(i) Renewable & Non-Conventional Energy
(ii) Process Equipment Design	(ii) Theory and Design of Neuro fuzzy controllers
(iii) Industrial Environmental Engineering	(iii) Digital Control System

(iv) Power Plant Engineering	(iv) HVDC Transmission System
(v) Energy Auditing and methodology	(v) Energy Management
(vi) Energy Efficient Machines	(vi) Process Modeling and Control

NOTE:

i) A program may have one or two laboratory courses spread over 3 periods.

ii) Sufficient number of electives to be offered subject to the condition that each elective should have at least five students.

M. Tech. 2nd YEAR (SEMESTER–III)

Course No.	Course Title	C	Teaching Schedule			Allotment of marks			Exam Duration in Hrs.
			L	P	Cont. Hrs.	CIE	SEE	Total	
EI-PC-201	Smart & Micro Sensor Design	3	3	0	3	40	60	100	3 Hrs
EI-PE-203	Program Elective-III	3	3	0	3	40	60	100	3 Hrs
EI-PRS-201	Current Literature Report & Seminar	2	0	4	4	50	--	50	
EI-PRPC-203	Dissertation Phase-1	6	0	12	12	50	--	50	
	Total	**14**	**6**	**16**	**22**	**180**	**120**	**300**	

Program Elective-III
(i) Digital Signal Processing
(ii) Sensors and Transducers
(iii) Reliability Engineering
(iv) Electrical Vehicle Engineering
(v) System Theory
(vi) Intelligent Instrumentations
(vii) Industrial Power Electronics

NOTE: The Preparatory Work for Dissertation Phase-I shall be evaluated by a committee comprising the following {on the basis of one mid semester seminar and one end semester seminar presented and one end semester report submitted by the candidate.

1. Chairperson or faculty nominee proposed by Chairperson
2. Dissertation Supervisor (and co-supervisor).
3. Two senior most faculty members of the department

M. Tech. 2nd YEAR (SEMESTER–IV)

Course No.	Course Title	C	Teaching Schedule	Allotment of marks			Exam Duration in Hrs.
			P	CIE	SEE	Total	
EI-PRPC-204	Dissertation	16	32	100	200	300	Final Viva Voce Exam

NOTE: The Dissertation shall be evaluated by a committee comprising the following through presentation cum viva-voce examination.

1. Chairperson or faculty nominee proposed by Chairperson.
2. Dissertation Supervisor (and co-supervisor).
3. One external expert appointed by the department.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	Course Name: Program Elective-I CONTROL SYSTEM DESIGN (i)		L	T	P	C
			3	-	-	3
Year and Semester	1st Yr. 1st Semester	Contact hours per week: (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Control System	Evaluation				
		CIE: 40	SEE: 60			

Course Objectives:

1. Study Design Specifications of control system.
2. Study the concept of multi-criteria optimization, norms of scalar & vector signals, norms of SISO LTI & MIMO LTI systems, state space methods for computing norms.
3. Study closed loop convex design specifications, convexity & duality.
4. Study the concept of Reliability & closed loop stability, regulation specifications,differential sensitivity specifications, robustness specifications.
5. Study, analysis and design of Compensators & controller using various techniques including Root locus & Bode plots
6. Study the state variable analysis, controllability and observability, state feedback for SISO system and MIMO systems and their design
7. Introduction to design of non-linear system.

Course Outcomes: On completion of the course, student would be able to:

CO1	Ability to understand the concept of multi-criteria optimization, norms of scalar & vector signals, norms of SISO LTI & MIMO LTI systems, state space methods for computing norms.
CO2	Ability to understand the concept of closed loop convex design specifications, convexity & duality.
CO3	Ability to understand the concept of Reliability & closed loop stability, regulation specifications, differential sensitivity specifications, robustness specifications.
CO4	Ability to analysis and designof Compensators& controllers by different techniques.
CO5	Ability to understand concept of state feedback for SISO system and MIMO systems and their design.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	INTRODUCTION: Control System Architecture, Design Specifications Functional in-equally specifications, multi-criteria optimization, norms of scalar & vector signals, norms of SISO LTI & MIMO LTI systems, state space methods for computing norms, design specifications as sets, affine & convex sets and functions, closed loop convex design specifications, convexity & duality	**8**	**CO1, CO2**
2	DESIGN SPECIFICATIONS: Reliability & closed loop stability, I/O specifications, regulation specifications, actuator effort, combined effect of disturbances & commands, differential sensitivity specifications, robustness specifications via gain bounds.	**9**	**CO1, CO3**
3	Compensators & CONTROLLERS DESIGN: Selection criteria and design of lead, lag, lead-lag and cascade type of compensators using Root locus & Bode plots, Rate feedback. Controllers – configuration and fundamentals of design,	**10**	**CO3 CO4 CO5**

	cascade and feedback compensation using various controllers.		
4	STATE VARIABLE FEED BACK DESIGN: Introduction to state variable analysis, controllability and observability, state feedback for SISO system, state feedback design of SISO system using control canonical form. State variable feedback _ steady state error analysis, Use of steady state error coefficients, design of state observers, Introduction to design of MIMO systems. Introduction to design of non-linear system and software.	**10**	**CO4 CO5**

TEXT BOOKS/REFERENCE BOOKS:

1. Modern Control Systems – A manual of design methods by John A. Borrie (Prentice Hall International)
2. Control Systems – Principle & Design by M. Gopal (TMH publication)
3. Introduction to feed back control system by Pericles E. Manuel & Edward Leff (International Student Edition)
4. Linear controller designs – limits of performance by Stephen P. Boyd & Craig H. Barratt (Prentice Hall International).
5. Linear control analysis & design By John J. D'azzo& C. H. Houpis (McGraw Hill)

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	**Course Name: Program Elective I, Process Equipment Design(ii)**		**L** 3	**T** -	**P** -		**C** 3
Year and Semester	**1st Yr. 1st Semester**		**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**Process Control Systems**		**Evaluation**				
		CIE: 40				**SEE: 60**	
Course Objectives:							
1. It aims to equip the students with Equipment design							
2. To provide adequate knowledge about various types of equipment							
Course Outcomes: On completion of the course, student would be able to:							
CO1	Distinguish between various process devices and equipments						

CO2	Control and optimize process equipments
CO3	Characterize storage equipments
CO4	Design heat exchange equipment

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Valve Noise calculation and reduction: Sources of valve noise, noise control, path treatment, valve treatment, valve noise calculation. Design & construction of Globe valve: valve trends, trim design, trim flow characteristics, flow range ability, standard trim configuration, valve plug stems, Body form of single and double seated globe valve, Bonnet design of global valve. Construction and flow characteristics of butterfly valve.	**8**	**CO1**
2	Boiler control and optimization, compressor control and optimization, cooling tower control and optimization, distillation controls, evaporator controls Basics of Process Equipment Design: General design procedure, Computer design, Fabrication techniques, Equipment classification, Power of rotational motion, Drives for process equipment.	**8**	**CO1, CO2**
3	Pressure Vessels: Pressure vessel code, Operating conditions – at low temperatures, at elevated temperatures, Design considerations and stresses, fabrication, inspection and tests, unfired vessel codes, High pressure vessels: Constructional features, materials, solid walled, multi shell, vessel closures, Jacket for vessels, Examples. Storage Vessels: Storage of fluids, Non-volatile liquids, volatile liquids and gases, Design of tanks, rectangular tanks, nozzles and mounting, Large capacity storage tanks, Examples. Reaction Vessels: Materials for construction, agitation, classification of reaction vessels, heating systems.	**8**	**CO1, CO3**
4	Heat Exchangers: Types of heat exchangers, design of shell and tube heat exchangers. Evaporators and Crystallisers: Types of evaporators, entrainment separators, materials and design considerations, crystallisers, Examples.Process Hazards and Safety Measures in Equipment design. Process flow diagrams.	**8**	**CO1 CO4**

Text Books:

1. Instrument Computer Aided Process control by S.K. Singh PHI
2. Computer Based Industrial Control by Krishna Kant PHI
3. Instrument Engineers Handbook- Process Control by Bela G. Liiptak

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	**Course Name: Program Elective-I** INDUSTRIAL ENVIRONMENTAL ENGINEERING(iii)		**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**1st Yr. 1st Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)				
Pre-requisite of course	**Nil**	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To introduce the concept of air, water and noise pollution monitoring						
2. To study the concepts of emission type pollution controls						
3. To study the various air pollution monitoring instruments and methods for process industries.						
4. To introduce the pollution control and monitoring methods for pulp and paper industries.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Identify sources of air ,noise and water pollution and their effects					
CO2	Sample and analyze air pollutants					
CO3	Understand the air quality monitoring instruments					
CO4	Sample and analyze water borne pollutants					
CO5	Understand the water quality monitoring instruments					

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	INTRODUCTION: Source and classification of Air Pollution, Effect of Air Pollution in Human Health, Effect of Air Pollution on Animals, Effect of Air Pollution on Plants, Economics Effects of Air Pollution, Control of Air Pollution by Equipment, Control of Air Pollution by Process Changes, Air Pollution from Major Industrial Operations, Air Pollution legislation and regulation, Environment Protection Act, Air Pollution in Indian cities, Water & Noise Pollution. & its control, Green House effects & its control.	**8**	**CO1**
2	POLLUTION CONTROL FOR SPECIFIC POLLUTANTS: Industrial Pollution Emission and Indian Standards, Analysis of Pollutants, Control of BOD, Removal of Chromium, Removal of Mercury, Removal of Ammonia / urea, Treatment of Phenolic Effects, Removal of particular matter, Removal of Sulphur Dioxide, Removal of Oxides of Nitrogen, Removal of Vapour from Efficient case, Control of CO2 and CO.	**8**	**CO1, CO2**
3	POLLUTION CONTROL IN SELECTED PROCESS INDUSTRIES: General considerations of Pollution Control in Chemical Industries, Pollution Control aspects of fertilizer industries, Pollution Control in Petroleum & Petrochemical Units.	**8**	**CO2, CO3**
4	Pollution Control in Pulp & Paper Industries, Tanning Industries, Sugar Industries, Alcohol Industries, Electroplating & Metal Finishing Industries, Radioactive Wastes, Pollution Control methods used in Power Plants.	**8**	**CO1, CO4, CO5**

REFERENCE BOOKS:

1. Air Pollution by H V Rao, McGraw Hill
2. Pollution Control in Process Industries by S P Mahayar, McGraw Hill
3. Encyclopedia of Environmental Pollution & Control, Vol. 1 & 2, Enviro Media, Karad, India.
4. Environmental Water Pollution & its control by G R Chhatwal, M.C. Mehra& Others, Anmol Publication, Delhi.
5. Environmental Air Pollution & its control by G.R. Chhatwal& Others, Anmol Publication, Delhi.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	Course Name: Program Elective-I POWER PLANT ENGINEERING(iv)		L	T	P	C
			3	-	-	3
Year and Semester	1st Yr. 1st Semester	Contact hours per week: (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Basic Science	Evaluation				
		CIE: 40	SEE: 60			
Course Objectives:						
1. To study the concept of steam power plant.						
2. To study the concept of Hydro-electric power plants and Nuclear power plants						
3. To study the concept of gas turbine and diesel power plants.						
4. To study the combined operation of different power plants.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To understand the operation of steam power plant.					
CO2	To understand the operation of Hydro-electric power plants and Nuclear power plants					
CO3	To understand the operation of gas turbine and diesel power plants.					
CO4	To understand the combined operation of different power plants.					

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs

1	Steam generators, condensers and turbines: Classification of steam generators, selection, operation of locomotive, Babcock Wilcox, Cochran boilers, Types of condensers, effect of air in condensers, Dalton's law of partial pressure, cooling water calculations, steam nozzles, types of steam turbine efficiencies, compounding, governing and control. Steam power plant: Classification, Operation, Description of Rankin cycle, Regenerative cycle, Reheat-Regenerative Cycle, Binary Vapour Cycle, Selection of plant site and its layout, coal handling system, combustion system, Fluidised bed combustion, Ash handling, Feed pumps, Heat exchangers, Economizers, Super heaters, Reheaters, Air preheaters, Feed water heaters, Evaporators.	**8**	**CO1**
2	Hydro-electric power plants: Hydrological Cycle, Hydrograph, Flow duration curve, Selection of site, Essential features, Classification of hydro plants, Selection of water turbines for hydro power plant, Automatic and remote control of hydro-station, layout of hydro power plant. Nuclear power plants: Nuclear physics, Binding energy, Radioactive decay. Fertile material, Mass defect, Nuclear reactions type and application, Generation of nuclear energy by fission, Nuclear reactors. Site selections, safety measures, plant layout, Fusion reaction, Future of nuclear power.	**8**	**CO2**
3	Gas turbine: Elements of gas turbines, Open and closed cycles for gas turbines, Performance terms, Thermal refinement to gas turbines cycle, Plant layout, applications, gas turbines Cycle calculations. Diesel power plants: Classifications of IC Engines and their performance, Four stroke and two stroke diesel engines, combustion phenomenon; Essential components, Celane number, knocking, super charging, operation and layout of diesel power plant.	**8**	**CO3**
4	Combined operation of different power plants: Advantages of combined operation of plants, load division between power stations, coordination of different types of Power Plants. Pollution control: Pollution from thermal & nuclear plants, Particulate emission and control, electrostatic precipitator, solid waste disposal.	**8**	**CO4**

TEXT BOOKS/REFERENCE BOOKS:

1. Chakrabarti A., Soni, M.L. Gupta P.V. and Bhatanagar U.S., A Textbook on Power System Engineering, Dhanpat Rai & Co.
2. EI-Wakit M.M., Power Plant Engineering, McGraw Hill, USA
3. Rajput R.K., Power Plant Engineering, Luxmi Publications
4. Sharma P.C., Power Plant Engineering, Kataria& Sons
5. Skrotzki B.G.A. and Vapot W.A., Power Station Engineering and Economy, Tata McGraw-Hill

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	**Course Name: Program Elective-I** ENERGY AUDITING AND METHODOLOGY(v)			**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**1st Yr. 1st Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)					
Pre-requisite of course	**Electrical Measurements and Instruments**	**Evaluation**					
		CIE: 40	**SEE: 60**				
Course Objectives:							
1. To introduce the concept of Energy Management and Audit.							
2. To study the concepts of financial management.							
3. To study and analysis various type of appliance in electrical system.							
4. To study the conceptual theory and working of refrigeration system.							
Course Outcomes: On completion of the course, student would be able to:							
CO1	To understand the concept of Energy Management and Audit.						
CO2	To understand the concepts of financial management.						
CO3	To familiarize with various type of appliance in electrical system.						
CO4	To understand conceptual theory and working of refrigeration system.						

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Energy Scenario: Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features. Energy Management and Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.	**8**	**CO1**
2	Material and Energy balance: Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams. Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of energy savings companies (ESCOs).	**8**	**CO2**

3	Electrical system: Electricity tariff, Load management and maximum demand control, Power factor improvement, Distribution and transformer losses. Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, energy efficient motors. Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues Compressed air system: Types of air compressors, Compressor efficiency, efficient compressor operation, Compressed air system components, Capacity assessment, Leakage test Factors affecting the performance and efficiency.	**8**	**CO3**
4	High Voltage Alternating Current and Refrigeration System: Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting refrigeration and air conditioning system performance and savings opportunities, Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, Saving potential, Fans, Blowers and pumps- Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities.	**8**	**CO4**

TEXT BOOKS/REFERENCE BOOKS:

1. Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore
2. Diwan, P., Energy Conservation, Pentagon Press (2008).
3. Younger, W., Handbook of Energy Audits, CRC Press (2008)
4. Sawhney and Maheshwari, Solar Energy and Energy Conservation, Prentice Hall (India)
5. Rao S. and B. B. Parulkar, Energy Technology, Khanna Publishers
6. Sukhatme S. P., Solar Energy, Tata McGraw Hill
7. David S., Hand Book of Industrial Energy Conservation, Van Nostrand Reinhold Publishing Company.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	Course Name: Program Elective-I ENERGY EFFICIENT MACHENES(vi)		L	T	P	C
			3	-	-	3
Year and Semester	1st Yr. 1st Semester	Contact hours per week: (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Electrical Machines	Evaluation				
		CIE: 40	SEE: 60			

Course Objectives:

1. To introduce the concept of energy management and energy audit system.
2. To introduce the concept and Economics of Power factor improvements.
3. To study the concept of Energy efficient machines Energy efficient and Economics of Energy power generation.
4. To study the concept of economics of electrical energy distribution and electrical drives.

Course Outcomes: On completion of the course, student would be able to:

CO1	To Familiarize withthe concept of the concept of energy management and energy audit system
CO2	To understand the concept of Energy efficient machines and Economics of Power factor improvements.
CO3	To Familiarize with the concept of Energy efficient machines and Economics of Energy power generation.
CO4	To understand the concept of economics of electrical energy distribution and electrical drives.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	INTRODUCTION: Need for energy efficient machines, energy cost and two part tariff, energy conservation in industries and farms -a necessity, introduction to energy management and energy audit system. Review of induction motor characteristics.	**7**	**CO1**
2	POWER FACTOR: The power factor in sinusoidal systems, power factor improvement, power factor with nonlinear loads, Harmonics and the power factor.	**7**	**CO2**
3	ENERGY EFFICIENT MOTORS: Standard motor efficiency, why more efficient motors? An energy efficient motor, efficiency determination methods, Direct Measurement method, Loss segregation method, Comparison, motor efficiency labelling, energy efficient motor standards. Motor life cycle.	**8**	**CO3**
4	INDUCTION MOTORS AND ADJUSTABLE DRIVE SYSTEMS: Energy Conservation, adjustable speed systems, Application of adjustable speed systems to fans, pumps and constant torque loads.	**8**	**CO4**

TEXT /REFERENCE BOOKS:

1. Andreas John C., Energy efficient electric motors, Marcel Dekker Inc. 1992.
2. Thuman Albert, Introduction to Efficient Electric System Design, The Fairmount Press Prentice Hall.
3. Tripathi S.C. , Electric Energy Utilization and Conservation, Tata McGraw-Hill 1991.

4. Belove Charles, Handbook of Modem Electronics and Electrical Engineering, John Wiley & Sons.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-103	**Course Name: BIO-MEDICAL INSTRUMENTATION**		**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**1st Yr. 1st Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)				
Pre-requisite of course	Physics, Basic Electrical Engineering.	**Evaluation** **CIE: 40**	**SEE: 60**			
Course Objectives:						
1. To introduce the concept of Bio Instrumentation like Medical Bio Potential Electrodes and Biomedical Recorders.						
2. To studycardiac and Respiratory measurementssystem						
3. To studyInstrumentation for Measuring Nervous Function.						
4. To study Recent Trends in Biomedical Engineering.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To Familiarize with Bio Medical Instrumentation.					
CO2	To understand cardiac and Respiratory measurementssystem.					
CO3	To understand Instrumentation for Measuring Nervous Function.					
CO4	To understand the Recent Biomedical devices instrumentation.					

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Characteristics of Transducers and Electrodes for Biological Measurement: Introduction to human body; block diagram, classification, characteristics, various physiological events and suitable transducer for their recording, bioelectric potentials	**5**	**CO1**
2	Cardiac & System: Cardiac musculature, Electro cardiography, ECG recording, Phonocardiography, holter recoding ECG lead system, Heart rate meter, vector cardiography, Pacemakers, Defibrillators. Blood Pressure and Blood Flow Measurement: Invasive and non-invasive methods of Blood	**7**	**CO1, CO2**

	pressure, Characteristics of blood flow and heart sound, Cardiac output measurement, Plethysmography. Respiratatory System: Mechanics of breathing, Parameters of respiration, Respiratory system measurements, Respiratory therapy instruments		
3	Instrumentation for Measuring Nervous Function: EEG signal, frequency band classification, Lead systems, EEG recording, Clinical applications of EEG signal, X-ray CT scan, MRI, PET. Muscoskeletal systems: EMG, Clinical applications, and Muscles stimulator. Clinical Laboratory Instrumentation: Test on blood cell, Blood cell counter, Blood glucose monitors, auto analyzer, Pulse-oximeter.	**7**	**CO3**
4	Recent Trends in Biomedical Engg.: Patient care and monitoring, Non-invasive diagnostic instrumentation, Biotelemetry, Telemedicine, Prosthetic devices, Lie detector test, Application of lasers and ultrasonic in biomedical field. Troubleshooting & Electrical Safety of Biomedical Instruments: Physiological effect of current and safety measurement.	**7**	**CO4**

TEXT/REFERENCE BOOKS:

1. Medical instrumentation application & design, John G Webster, John wiley, 1998.
2. Review of medical physiology, W.F. Ganong, Medical publisher, 1977
3. Biomedical instrument and measurement, Cromwell, PHI, 2000
4. Handbook of biomedical instrument, R S Khandpur, TMH

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PC-105</td><td rowspan="2" colspan="2">Course Name: ADVACED ELECTRIC DRIVE</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
1st Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Electrical Machines, Power Electronics</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To introduce the concept of types of Electric Drives.</td></tr>
</table>

2. To introduce the DC Motor Drives.			
3. To introduce the AC Motor Drives.			
4. To study the Motor power rating.			
5. To implement Traction Drives.			
Course Outcomes: On completion of the course, student would be able to:			
CO1	To Familiarize with Dynamics and Control of Electric Drives.		
CO2	To understand efficient speed control techniques in DC Motor Drives.		
CO3	To understand efficient speed control techniques in AC Motor Drives.		
CO4	To understand the significance and selection of power rating.		
CO5	To familiarization of Load and choice of traction for suitable load.		
Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Electric Drive: Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Steady state stability, Transient stability. Multiquadrant operation of drives. Load equalization.	**8**	**CO1**
2	Motor power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination ofmotor rating for continuous, short time and intermittent duty, equivalent current, torque and power methods of determination of rating for fluctuating and intermittent loads. Effect of load inertia & environmental factors. Starting of Electric Drives: Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting. Braking of Electric Drives: Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking.	**8**	**CO1, CO2,**
3	DC motor drives: Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor current chopper controlled DC motor drives. Induction motor drives: Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme. Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control.	**8**	**CO2, CO3**
4	Synchronous motor drives: Variable frequency control, Self-Control, Voltage source inverter fed synchronous motor drive, Vector control. Introduction to Solar and Battery Powered Drive, Stepper motor, Switched Reluctance motor drive. Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.	**8**	**CO4, CO5**

TEXT/REFERENCE BOOKS:

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.

2. Electric Drives, VedamSubrahmanyam, TMH
3. A first course on Electrical Drives, S.K. Pillai, , New Age International Publication.
4. Electric motor drives, R. Krishnan, PHI
5. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
6. Electric Motor & Drives. Austin Hughes, Newnes.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PC-107</td><td colspan="2" rowspan="2">Course Name: ADVANCE PROCESS CONTROL</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
1st Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Control System</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Study the techniques used for PID controller tuning</td></tr>
<tr><td colspan="7">2. Development and synthesis the feedback controllers for specified close loop response</td></tr>
<tr><td colspan="7">3. Concept and Study of FC and FO type control valve and their applications with examples, Gain of valve and concept of control valve sizing for liquid, Gas, vapour and steam. (Special reference to Masoneillian&Fisher Equation) and study control valve cavitation and flashing phenomenon</td></tr>
<tr><td colspan="7">4. Study and development of advance control techniques for process control and automation</td></tr>
<tr><td colspan="7">5. Development of control techniques for safe design of process control and automation</td></tr>
<tr><td colspan="7">6. Study and development of Predictive control, Statistical control, Adaptive and Inferential control system</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Able to Analyze the effect of P, PI, PD and PID controllers on a control system and design suitable controller for a typical process</td></tr>
<tr><td>CO2</td><td colspan="6">Able to understand FC and FO type control valve and Able to learn and analyze the various principles & concepts involved in valve sizing for liquid, Gas, vapor and steam and control valve cavitation and flashing phenomenon</td></tr>
<tr><td>CO3</td><td colspan="6">Ability to understand analysis and development of advance control techniques for process control and automation</td></tr>
</table>

CO4	Ability to understand analysis and development of Predictive control, Statistical control, Adaptive and Inferential control system techniques for process control and automation

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	PID controller tuning procedures: Close loop oscillation based tuning, Ziegler-Nichol close-loop method. Tuning rules for first order + dead time processes: step testing quarter decay ratio response, Ziegler-Nichol open loop method, Cohen-Coon parameters. Synthesis of feedback controllers: Development of the controller synthesis formula, specifications of close loop response, direct synthesis for minimum and non-minimum phase processes, controller modes and tuning parameters derivative mode for dead time process. Dead Time Compensation (Algorithms for Smith Predictor), & effect of process modeling error.	**10**	**CO1**
2	Control Valve Design: Control valve flow characteristics, Valve & process characteristics, range availability of control valve, control valve sizing for gas, liquid, vapors and steam, Control valve cavitation and flashing, flow control cavitation index, vibration curve cavitation index, calculation of flash fraction, Control valve gain, sequencing of control valve . Valve application, selection, valve capacity testing.	**8**	**CO2**
3	Additional control techniques: Cascade control,. Selective control & Split range control, Cascade control for various processes , dynamic characteristics of Cascade control system and its tuning. Override and Auctioneering control system for various processes, Feedforward control system, Feedforward control of various processes. Design of Feedforward controllers, Feedforward –Feedback control & their relative advantages & disadvantages.	**10**	**CO3**
4	Ratio control system, Predictive control, Statistical control Adaptive and Inferential control system: Programmed Adaptive control, gain scheduling Adaptive control, Self tuning regulator (STR), MRAC, Multivariable Process Control.	**9**	**CO4**

TEXT BOOKS/REFERENCE BOOKS:

1. Principles and Practice of Automatic Process Control by Carlos A Smith, John wiley& sons
2. Computer Aided Process control by S.K. Singh PHI
3. Process Control Modeling, Design, and Simulation by B.WayaneBequette PHI
4. Chemical Process control by Stephanopolous PHI

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-RM-109	Course Name: Research Methodology and IPR	L	T	P	C
		2	-	-	2

Year and Semester	1st Yr. 1st Semester	Contact hours per week: (2Hrs) Exam: (3 Hrs)	
Pre-requisite of course	Nil	**Evaluation**	
		CIE: 20	**SEE: 30**

Course Objectives
1. To study the ideas of research methods.
2. To study about statistical analysis and sampling.
3. To study about regression and correlation analysis.
4. To study about edition, tabulation and testing of hypotheses.

Course Outcomes	
CO1	To formulate a route map for a particular problem or topic of research
CO2	How to test and validate the data through statistical techniques
CO3	To implement the suitable methods of sampling for individual problems
CO4	To compare and evaluate the results with others
CO5	To present the results with more informative details

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Nature and objective of the research: Methods of Research: Historical, descriptive and experimental. Alternative approaches to the study of the research problem and problem formulation. Formulation of hypotheses: Feasibility, preparation and presentation of proposal.	**8**	**CO1, CO5**
2	Introduction to statistical analysis: Probability and probability distributions, binomial, Poisson, exponential and normal distributions, and their applications. Sampling: Primary and secondary data, their collection and validation, methods of sampling, stratified random sampling, and systematic sampling.	**8**	**CO2 CO3**
3	Regression and correlation analysis: Tests of significance based on normal, t and chi square distributions, analysis of variance. Basic Principles of design of experiments, completely randomized and randomized block designs.	**8**	**CO2 CO3 CO4**
4	Edition, tabulation, & testing of hypotheses, Interpolation of results, presentation, styles for figures, tables, text, quoting of reference and bibliography. Use of software for statistical analysis like SPSS, Mini tab or MAT lab, Report writing, preparation of thesis.	**8**	**CO4 CO5**

TEXT BOOKS/REFERENCE BOOKS:

1. Research Methodology by C.R Kothari, VishwaPrakashan
2. Research Methodology by P.G .Tripathi
3. Research Methodology in Social Science by Sadhu Singh, Himalya Publishers
4. Business Research Methods, Donald cooper, Tata McGraw Hill
5. Statistical analysis for Engineers & Scientists, J. W. Barnes, McGraw Hill

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:EI-PRPC-101</td><td colspan="2" rowspan="2">Course Name: Process Control Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td>Year and Semester</td><td>1st Year
1stSemester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Control Engineering Lab.</td><td colspan="5">Evaluation</td></tr>
<tr><td>CIE: 20</td><td colspan="4">SEE: 30</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To Familiarization of PLC Ladder Programming Instructions Set</td></tr>
<tr><td colspan="7">2. To compile and execute programs in Ladder Programming</td></tr>
<tr><td colspan="7">3. To study the PC and PLC based control systems</td></tr>
<tr><td colspan="7">4. To study and write PLC program for the multiple process control systems</td></tr>
<tr><td colspan="7">5. To study and write PLC program for different strategies of control system such as feedback, feed forward, cascade, ratio control etc.</td></tr>
<tr><td colspan="7">6. To write PLC programs to solve the different control problems</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Ability to understand PC and PLC based control system and their implementation</td></tr>
<tr><td>CO2</td><td colspan="6">Ability to develop PLC Ladder Programming skill</td></tr>
<tr><td>CO3</td><td colspan="6">Analyse and implement PLC Ladder Programming for different type of process control system.</td></tr>
<tr><td>CO4</td><td colspan="6">Ability to design and develop PLC program for different strategies of control system such as feedback, feed forward, cascade, ratio control for control of process variables</td></tr>
</table>

Expt. No	**COURSE SYLLABUS CONTENTS OF MODULE**	**COs**
1	Familiarization of PLC Ladder Programming Instructions Set	**CO1,**

2	**To Study** PC Based Traffic Light Control :- • Basic Traffic Light Sequence	**CO2, CO3, CO4**
3	PLC Based Traffic Light Control: • PLC Connection Details • Dual Traffic Light Sequence • Traffic Counting • Green Time Alteration According to Traffic Flow • The Pedestrian Crossing • Complete System Control	
4	To Study Process Control – Ratio, feedback control flow & level	
5	To Study Rotary Transfer Unit :- • Movement of Rotary Table • Initialization • Station Counting • Dispensing • A Production Line System • Follow a Set Routine	
6	To Study Industrial Control Trainer	
7	To Study Multi-process Control Trainer : Feedback, feedforward cascade and ration Control system for flow , temperature and level control	
8	To study of Pressure Control Unit :-Proportional Control : Run a loop experiments using 'proportional only control' with the following sets of SP and PG values. Record the eventual 'steady state' rate values in the table below, once the initial oscillations have decayed. • Proportional and Integral Control	
9	To design, Level Control PC :- • Proportional Control • Proportional and Integral Control	
10	To Study .Flow control PC & PLC :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Zeigler / Nichols Tuning	
11	To Study The System Rig :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Ziegler / Nichols Tuning • Temperature Control • Batch Volume Control • Fluid Level Control	

	• Open Loop Control • Bode Plots • Flow Loop Model using Caldwell's Method • Flo Loop Model using Sundaresan's Method • Design of Controller for PCU Flow Loop • PRT Signal Conditioning • Flowmeter Signal Conditioning	
12	Process Control Experiment :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Ziegler / Nichols Tuning • Temperature Control • Batch Volume Control • Fluid Level Control • Open Loop Control • Bode Plots	

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	Course Name: Program Elective-II Renewable & Non-Conventional Energy(i)		L 3	T 0	P -	C 3
Year and Semester	**1st year 2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Basic Electrical Engineering and Engineering Science**	**Evaluation** **CIE: 40**	**SEE: 60**			

Course Objectives:	
1. To familiarize the energy scenario and the consequent growth of the power generation from renewable energy and non-conventional energy sources.	
2. To study the basic engineering science of renewable and non-conventional energies sources.	
3. To study the wind and solar energy conversion systems for electrical system.	
4. To study the energy conversion techniques for nonconventional sources and applications.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the energy scenario and the consequent growth of the power generation from renewable energy and non-conventional energy sources.
CO2	Understand the basic engineering science of renewable and non-conventional energies sources.
CO3	Understand the wind and solar energy conversion systems for electrical power system.
CO4	To understand the energy conversion techniques for nonconventional sources and applications.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**

1	**Introduction to Energy sources:** Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	**7**	**CO1**
2	**Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems.	**8**	**CO2, CO3**
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.	**7**	**CO2, CO3**
4	**Energy from Biomass:** Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas. **Hydrogen Energy and Fuel cell:** Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles. Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, and application of fuel cells.	**9**	**CO2, CO4**

Reference Books:

1. G.D. Rai, "Non-conventional Energy sources", Khanna Publishers.
2. Bansal Keemann and Meliss, "Renewable energy sources and conversion technology", Tata Mc-Graw Hill.
3. Ashok V. Desai, "Non conventional Energy", New Age International Publishers Ltd.
4. D.P. Kothari, "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	Course Name: Program Elective-II THEORY AND DESIGN OF NEURO – FUZZY CONTROLLERS(ii)		L	T	P	C
			3	0	-	3
Year and Semester	**1st Year 2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Basic Engineering Mathematics**	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To study and acquire the basic knowledge of neural network and fuzzy logic.						
2. To study the basic architecture and modeling of neural network control and Fuzzy logic control.						
3. To study various types of fuzzy logic and neural network controllers.						
4. To identify, formulate and solve the neuro fuzzy logic based problems.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To understand basic concept and working of neural network and fuzzy logic system.					
CO2	To understand the basic architecture and modeling of neural network control and Fuzzy logic control.					
CO3	Able to neural network and fuzzy logic techniques in different field, which involve perception, reasoning and learning.					
CO4	Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.					

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**NEURAL NETWORK THEORY:** Introduction, Biological neurons and their artificial models, Learning, adaptation and neural networks learning rules types of neural networks, Single layer, multiplayer, Feed forward, feedback networks; back propagation, Learning and training, Hop field network.	**8**	**CO1, CO2**
2	**NEURAL NETWORKS BASED CONTROL:** Neural network for non-linear systems, Schemes of neuro control, System identification forward model and inverse model, Indirect learning neural network control applications, Case studies.	**8**	**CO2, CO3, CO4**
3	**FUZZY LOGIC THEORY :** Fuzzy sets ,Fuzzy operation , Fuzzy arithmetic, Fuzzy relations ,Fuzzy relational equations, Fuzzy measure, Fuzzy functions , Approximate reasoning ,Fuzzy propositions ,Fuzzy quantifiers , If–then rules.	**8**	**CO1**
4	**FUZZY LOGICBASED CONTROL:**Structure of fuzzy logic controller,Fuzzification models, Database,Rule base Inference engine,defuzzification, Module ,Non-linear fuzzy control, PID like FLC,	**8**	**CO2, CO3, CO4**

	Sliding mode FLC,Sugeno FLC, Adaptive fuzzy control , Fuzzy control applications case studies.		

REFERENCE BOOKS

1. Jacek. M. Zurada, “Introduction to Artificial Neural Systems”, Jaico Publishing House, 1999.
2. Kosko, B. “Neural Networks and Fuzzy Systems”, Prentice Hall of India Pvt. Ltd., 1994.
3. Klir G.J. & Folger T.A. “Fuzzy sets, uncertainty and information”, Prentice Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J., “Fuzzy set theory and its application” Kluwer Academic Publishers, 1994. 5. Driankov, Hellendroon, “Introduction to Fuzzy Control”, Narosa Publishers.
5. FarinWah S.S., Filev, D. Langari, R. “Fuzzy control synthesis and analysis”, John Wiley and Sons, 2000.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PE-102</td><td colspan="2" rowspan="2">Course Name: Program Elective-II
DIGITAL CONTROL SYSTEM(iii)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td>Year and Semester</td><td colspan="2">1st Yr.
2nd Semester</td><td colspan="4">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td colspan="2" rowspan="2">Control System</td><td colspan="4">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="2">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Study the digital control system details: Signal flow graph, Time domain analysis, correlation between time response & root location in S & Z transform and stability in Z-plane</td></tr>
<tr><td colspan="7">2. Study the digital control system design by various methods in Z-plane</td></tr>
<tr><td colspan="7">3. Study of techniques for analysis of nonlinear system, concept of local, global, asymptotic and total stability of nonlinear system, Liapunov’s stability criterion.</td></tr>
<tr><td colspan="7">4. Study of Tuning procedure for PID controllers and Design considerations for Robust control.</td></tr>
<tr><td colspan="7">5. Study the concept, analysis and design of Adaptive and Learning system.</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
</table>

CO1	Ability to understand the concept, analyze the Digital control system and their stability
CO2	Ability to understand the digital control system design by various methods in Z-plane
CO3	Ability to understand the techniques for analysis of nonlinear system and their stability criterion
CO4	Ability to understand and skill of the Tuning procedure for PID controllers and Designing of Robust control.
CO5	Ability to understand the concept, analysis and design of Adaptive and Learning system

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	DIGITAL CONTROL: Introduction to digital control, sampling, Data reconstruction principles, Pulse transfer functions, Block diagram & signal flow graph, Digital Control Techniques-PID, Deadbeat. Time domain analysis, correlation between time response & root location in S & Z transform, effect of pole-zero configuration in Z-plane on maximum overshoot & peak time transient response, Stability in Z-plane using modified Rouths criteria, Jury's criteria.	**10**	**CO1**
2	Digital control system design : Design by Emulation, Direct design by root locus in z-plane, Frequency response method, Direct design method by Ragazzini. NON LINEAR CONTROL SYSTEM: Introduction to nonlinear feedback control system, special features of linear system; limit cycle, jump response, sub harmonics etc., describing function and phase plane techniques for analysis of nonlinear system, concept of local, global, asymptotic and total stability of nonlinear system, Liapunov's stability criterion.	**11**	**CO2 CO3**
3	PID CONTROL AND ROBUST CONTROL: Tuning procedure for PID controllers, modification of PID control schemes, two degrees of freedom control. Design considerations for Robust control.	**8**	**CO4**
4	ADAPTIVE AND LEARNING CONTROL SYSTEMS: Basic Principles of Adaptive and Learning Control Systems, Model Reference Adaptive Control, Types of Learning-Supervised and Unsupervised Learning Control Systems, On-line and Off-line Learning Control Systems.	**8**	**CO5**

TEXT BOOKS/ REFERENCE BOOKS:

1. Digital control system By B. C. Kuo (PHI)
2. Modern control engineering By Ogata (PHI)
3. Control System Engineering By Nagrath& Gopal (Wiley Eastern)
4. Control System Engineering By Phillips and Nagle (PHI Publications)
5. Control System Engineering by Norman S Nise, Wile
6. Modern Control System by R C Dorf, R H Bishop, Addision Wesley
7. Systems, Modeling & Analysis by I J Nagrath, M Gopal, TMH
8. Digital Control & State Variable Methods by M Gopal, TMH

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II HVDC TRANSMISSION SYSTEM(iv)**			**L** 3	**T** 0	**P** -	**C** 3
Year and Semester	**1st year 2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)					
Pre-requisite of course	**Power Electronics and Power System Engineering**	**Evaluation**					
		CIE: 40	**SEE: 60**				
Course Objectives:							
1. To study the basic concept, working theory and constructional detail of Direct Current (DC) power transmission line.							
2. To study the power converter interface and analysis in HVDC transmission line.							
3. To study the power converter controller in HVDC transmission line							
4. To study the effect of reactor and protection of DC line.							
Course Outcomes: On completion of the course, student would be able to:							
CO1	To understand the basic concept, working theory and constructional detail of Direct Current (DC) power transmission line.						
CO2	To impart technical knowledge of power converter interface and analysis in HVDC transmission line.						
CO3	To apprise with power converter control system in HVDC transmission line						
CO4	To understand the effect of reactor and protection of DC line.						

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Direct Current (DC) power transmission technology:** Introduction, comparison of Alternating Current (AC) and Direct Current (DC) transmission, application of DC transmission, application of DC transmission, description of DC transmission system, Configurations, planning for High Voltage Direct Current (HVDC) transmission, modern trends in DC transmission. Introduction to Device: Thyristor valve, valve tests, recent trends.	**6**	**CO1**
2	**Analysis of High Voltage Direct Current (HVDC) converters:** Pulse number, choice of converter configuration, simplified analysis of	**8**	**CO1, CO2**

	Graetzcircuit, converter bridge characteristics, and characteristics of a twelve-pulse converter, detailed analysis of converters with and without overlap.		
3	**Converter and HVDC system control:** General, principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link, power control, higher level controllers, telecommunication requirements. **Converter faults and protection:** Introduction, converter faults, protection against over-currents, over-voltages in a converter station, surge arresters, protection against over-voltages.	**8**	**CO2, CO3**
4	**Smoothing reactor and DC line:** Introduction, smoothing reactors, DC line, transient over voltages in DC line, protection of DC line, DC breakers, Mono-polar operation, effects of proximity of AC and DC transmission lines.	**6**	**CO4**

RECOMMENDED BOOKS:

1. E.W. Kimbark, “High Voltage DC Transmission”, Wiley-Interscience.
2. V. Kamaraju and M.S. Naidu, “High Voltage Engineering”, Tata McGraw-Hill Education.
3. R.S.Jha,“High Voltage Engineering”, Dhanpat Rai sons.
4. E. Kuffel and M. Abdullah, “High Voltage Engineering”, Pergamon Press.
5. C. L. Wadhwa, “High Voltage Engineering”, New Age Publications.
6. K.R. Padiyar, “HVDC Power Transmission Systems: Technology and System Interactions”, New Age International Publications.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td>Course Code:
EI-PE-102</td><td colspan="2">Course Name: Program Elective-II
ENERGY MANAGEMENT(v)</td><td>L
3</td><td>T
-</td><td>P
-</td><td>C
3</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
2nd Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Electrical Machine, Electrical Measurements and Instruments</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To introduce the various energy systems.</td></tr>
<tr><td colspan="7">2. To study the basics theory, and operation of renewable system.</td></tr>
<tr><td colspan="7">3. To study the concept ofenergy conservation and management.</td></tr>
</table>

4. To study various techniques for energy conservationand its management.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To familiarize with the various energy systems.
CO2	To understand the basics theory, operation renewable system.
CO3	To impart basic technical knowledge theenergy conservation system and management.
CO4	To learn the role of various techniques used for energy conservationsystem and its management.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	INTRODUCTION: Various Sources of Energy, Conventional and non-Conventional energy, Concept and Classification of Renewable energy, Concept of Energy Conservation and Energy Management, Present Energy Scenario in India (Conventional and non- Conventional energy).	**7**	**CO1**
2	RENEWABLE ENERGY SOURCES: Potential and Utilization status of Renewable Energy in India, Solar Energy: Solar Water Heater Systems, Solar Air dryer Systems, Solar Photo-voltaic Systems, Solar Cookers and Solar ponds, Wind Energy: Selection Criteria for Wind farms, Wind Mills, Bio Gas Plants-Construction and Operation, Bio Mass Gasification, Bio Mass Briquetting; Mini and Micro Hydel Power Plants, Geo-Thermal Energy, Ocean Energy.	**8**	**CO2**
3	ENERGY CONSERVATION AND MANAGEMENT: Actual energy requirement assessment techniques of any industry and energy consumption status, possibility of reduction of energy consumption by using various energy conservation techniques or equipments e.g. variable speed drives, constant voltage transformers, electronic chokes, CFLs etc.	**7**	**CO3**
4	ENERGY CONSERVATION INSTRUMENTATION:Importance of instrumentation and control techniques in the energy conservation and management, SCADA systems, Instruments required to carry out energy audit exercise, optimal mixing of renewable energy sources and load rationalization for reducing load on conventional energy sources.	**7**	**CO4**

TEXT/REFERENCE BOOKS:

1. Hand Book of Industrial Energy Conservation by S David; Van Nostrand Reinhold Publishing Company.
2. Energy Technology by S Rao & B. B. Parulkar; Khanna Publishers
3. Solar Energy by S. P. Sukhatme; TMH publications
4. Solar Energy & Energy Conservation by Sawhney&Maheshwari; PHI publication.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II PROCESS MODELLING AND CONTROL(vi)**		**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)				
Pre-requisite of course	**Mathematics,Control System**	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
1.	Study the Mathematical Modelling, Process dynamic of various type of processes.
2.	Simulation and Modelling of different process control system
3.	Study of various control system Models and Design of cross controllers and selection of loop using RGA.
4.	Study the concept, analysis and design of Adaptive and Learning system.
5.	Study the concept, analysis and design of Real time control system
6.	Study of Distributed computing systems, Software Process models
Course Outcomes:	On completion of the course, student would be able to:
CO1	Ability to understand and to derive Modelling, Process dynamic of various type of processes.
CO2	Ability to understand the various control system Models and Design of cross controllers and selection of loop using RGA.
CO3	Ability to understand concept, analysis and design of Adaptive and Learning system.
CO4	Ability to understand concept, analysis and design of Real time control system
CO5	Ability to implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution for industry problems.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Simulation and Modelling: Importance of Simulation, Mathematical Modelling, Process dynamic of fluid flow and heat transfer system, Mass transfer dynamics and distillation column, Reaction kinetics of chemical processes. Process control aim and objectives classification of process control system, techniques for process control. Modelling and simulation for plant Automation-case studies.	**8**	**CO1**
2	Predictive control system: Model based control system (Internal mode control, Model Predictive control and Process Model based control), Plant wide Control, Inferential control, Multiple-loop (Multivariable) control system. Interaction and Decoupling of control loops. Design of cross controllers and selection of loop using RGA. Prosperities and application of RGA.	**10**	**CO2**
3	ADAPTIVE AND LEARNING CONTROL SYSTEM: Basic principles of Adaptive and learning systems, MRAC & STAC, Adaptive control	**10**	**CO3** **CO5**

	techniques, Types of Learning- Supervised and Unsupervised Learning control system, On-line and Off-line Learning control system.		
4	Real time control system: Characteristics and classes of real time systems, program classification: Sequential, multitasking real time, concurrency and synchronization. Design strategies, Reability, fault detection, fault tolerance real time operating system, Distributed computing systems, Software Process models (Build and mix model, waterfall, rapid prototyping, Incremental and Spiral model) Design techniques and tools	**10**	**CO4 CO5**

TEXT BOOKS:

REFERENCE BOOKS:

1. Techniques of Process Modelling, Simulation and Control for Engineer by Astrom, Luyben, McGraw Hill.
2. Computer Controlled System by Astrom, K.J and B. Wittenmark PHI
3. Chemical Process Control by Stephanopolous PHI
4. Process Control Modeling ,Design and Simulation by B.WayaneBequette, PHI

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M.Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-104	**Course Name: Power Quality Monitoring and Conditioning**		**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**1st Year. 2nd Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**Power System, Electrical Machines**	**Evaluation** CIE: 40	**SEE: 60**			
Course Objectives:						
1. To familiarize the students about different power quality issues to be resolved.						
2. To understand the convention codes /guidelines issues by bodies like IEEE, IEC etc related to voltage, frequency and harmonics.						
3. To mentor the students about methods of power quality assessment.						
4. To monitor the power quality in the power system.						
5. To model a system for power quality enhancement.						
Course Outcomes: On completion of the course, student would be able to:						

CO1	Have the knowledge of various power quality issues in power system.
CO2	Work with international standards/guidelines related to power quality issues.
CO3	Quantitative analysis of power quality in system.
CO4	Monitor the power quality through measurement of various system parameters.
CO5	Decide the compensators and filters to keep the power quality indices within the standards.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**Cos**
1	UNIT I - POWER QUALITY - AN OVERVIEW: Power Quality definition, PQ characterization: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation–Power acceptability curves: CBEMA, ITIC – Sources for Electric Power Quality problem in power system: poor load power factor, Nonlinear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards and Guidelines.	**6**	**CO1**
2	VOLTAGE VARIATIONS: Voltage Sags - Magnitude & duration-Types-Sources of sags - Estimation of Voltage sag performance: Transmission system and Utility distribution system, Effect of sag on AC Motor Drives, Single-Phase Domestic and Office Loads, Monitoring and mitigation of voltage sag. Origin of Long & Short interruption -influence on various equipment.	**7**	**CO2**
3	POWER QUALITY ANALYSIS: Measurements of Voltage, Current, Power, Energy, power factor- Time domain methods and Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform. Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, Harmonic Indexes, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads.	**7**	**CO3**
4	POWER QUALITY MONITORING: Monitoring considerations: Power line disturbance analyser, power quality measurement equipment, harmonic / spectrum analyser, flicker meters, disturbance analyser. Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples	**8**	**CO4**
5	POWER QUALITY ENHANCEMENT: Harmonic filters: passive, Active and hybrid filters – Custom power devices: Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method – Custom power park.	**8**	**CO5**

Text Books:

1. Understanding Power Quality Problems-Voltage sag & Interruptions, Math Bollen H.J., IEEE Press, 2000.
2. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh , G. Ledwick, Kluwer Academic Publishers, 2002.

3. Electrical Power Systems Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.WayneBeaty, Quality”, McGraw Hill, 2003.
4. HVDC and FACTS Controllers: Applications of Static Converters in Power Systems, Vijay K Sood, Springer
5. Facts Controllers in Power Transmission and Distribution, K R Padiyar, TunbridgeWells : Anshan, ©2009.

Reference Books:
1. Electric Power Quality, Heydt G.T., Stars in a Circle Publications, 1994(2nd edition).
2. Handbook of Power Quality, Angelo Baggini ‘– Wiley

Note for Examiner(s): Question paper will comprise three sections,
1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:
1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PC-106</td><td colspan="2" rowspan="2">Course Name: PLC & DCS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td>Year and Semester</td><td>1st Yr.
2nd Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3 Hrs)</td></tr>
<tr><td rowspan="2">Pre-requisite of course</td><td rowspan="2">Control System</td><td colspan="5">Evaluation</td></tr>
<tr><td colspan="2">CIE: 40</td><td colspan="3">SEE: 60</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. Study the concept of Direct Digital Control</td></tr>
<tr><td colspan="7">2. Study and development of position and velocity control algorithm and their applications in
3. different control schemes</td></tr>
<tr><td colspan="7">4. Study the characteristic function of PLC, its Architecture and various PLC programming languages and Demonstratevarious PLC programming skill for industrial applications.</td></tr>
<tr><td colspan="7">5. Detail study and applications of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS</td></tr>
<tr><td colspan="7">6. Study DCS supervisory control techniques & considerations(Algorithms), Concept of field buses and their applications</td></tr>
<tr><td colspan="7">7. Detail study and applications of Supervisory control and Data Acquisition system(SCADA)</td></tr>
<tr><td colspan="7">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO1</td><td colspan="6">Ability to understand the concept of Direct digital control and able to development position and velocity control algorithm and their applications in different control schemes</td></tr>
</table>

CO2	Able to learn the various PLC programming languages and Demonstratevarious PLC programming skill for industrial applications.
CO3	Able to learn and analyze the various principles & concepts of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS
CO4	Acquire the knowledge of DCS supervisory control techniques, the concept of field buses and their Industrial applications.
CO5	To implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution for industry problems.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Direct Digital Control – Structure and Software: The position algorithm (simplifying PID control equation, deriving position algorithm); the velocity algorithm (velocity algorithm, deriving the velocity algorithm); Multi variable control (Cascade control using velocity algorithm, radio control using velocity algorithm).	**8**	**CO1**
2	Discrete State Process Control System: Development and analysis of ladder diagram, logic diagram from ladder diagram, Function description of PLC, Programming fundamentals , hardware and system sizing and selection, PLC peripherals, programming, PLC networking, PLC programmable languages, ladder diagrams language, Boolean mnemonics language, functional block language, PLCs.	**10**	**CO2 CO3**
3	Distributed Process Control System: Functional requirement of DPCS, DCS configurations/ architecture, data highway cables, field buses, protocols used in DCS, Software configuration: controller function configuration, multiplexer and party line system.	**10**	**CO3 CO4 CO5**
4	Supervisory control and Data Acquisition system (Functions of SCADA, channel scanning, conversion to engineering units, data processing, distributed SCADA system, Remote terminal unit). DCS supervisory computer and configurations: supervisory computer function, supervisory control techniques and consideration, Supervisory control algorithm, DCS system integration with PLC and computer. Fiber optic local area networks – map and top.Popular Distributed Control Systems: CP 80 system.	**9**	**CO3 CO4 CO5**

TEXT BOOKS/REFERENCE BOOKS:

1. Computer Aided Process control by S.K. Singh PHI
2. Computer Based Industrial Control by Krishna Kant PHI
3. Instrument Engineers Handbook- Process Control by Bela G. Liiptak
4. Microprocessor in Process control by C.D. Johnson
5. Principles and Practice of Automatic Process Control by Carlos& A Smith

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-108	**Course Name:** Embedded System Design		**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Microprocessor and Microcontrollers	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
1.	To provide an overview of Design Principles of Embedded System.
2.	To provide clear understanding about the role of firmware, operating systems in correlation with hardware systems.
Course Outcomes: On completion of the course, student would be able to:	
CO1	Expected to understand the selection procedure of Processors in the Embedded domain.
CO2	Design Procedure for Embedded Firmware.
CO3	Expected to visualize the role of Real time Operating Systems in Embedded Systems
CO4	Expected to evaluate the Correlation between task synchronization and latency issues

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction to Embedded Systems**: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	**7**	**CO1**
2	**Typical Embedded System:** Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.	**8**	**CO1 CO2**
3	**Embedded Firmware**: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	**7**	**CO2 CO3**
4	**RTOS Based Embedded System Design:** Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.	**6**	**CO3**
5	**Task Communication:** Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization	**8**	**CO3 CO4**

	Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.		

TEXT BOOKS:
1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.

REFERENCE BOOKS:
1. Embedded Systems - Raj Kamal, TMH.
2. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
3. Embedded Systems – Lyla, Pearson, 2013
4. An Embedded Software Primer - David E. Simon, Pearson Education.

Note for Examiner(s): Question paper will comprise three sections,
1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:
1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-110	**Course Name: ADVACED POWER SYSTEM**		**L** / **3**	**T** / **0**	**P** / **-**	**C** / **3**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)				
Pre-requisite of course	**Basics of Power System**	**Evaluation**				
		CIE: 40		**SEE: 60**		
Course Objectives:						
1. To study basics PU theory and modelling of electrical networks.						
2. To study working of theory of load flow parameters and its methods.						
3. To study the transient phenomena and type of faults in power system.						
4. To introduce the concept of transient stability theory and its method.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To understand the basic concept of PU system for electrical circuits and its modellings.					
CO2	To impart basic technical knowledge of load flow studies and its iteration solution methods.					
CO3	To understand and analyze various types of faults for different electrical equipments.					
CO4	To impart a technical knowledge of transient stability in electrical system and solution of its stability equations.					

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**SYSTEM MODELLING:** System modelling of synchronous machines, transformers, loads etc, per unit system, single line diagram of electrical	**8**	**CO1**

	networks, single phase impedance diagrams. Formulation of impedance and admittance matrices for the electrical networks.		
2	**LOAD FLOW STUDIES:** Data for the load flow studies, Swing Bus, Formulation of simultaneous equations, Iterative solutions by the Gauss-Seidal method and Newton Raphson Method.	**8**	**CO2**
3	**FAULT ANALYSIS:** Transients on transmission line, short circuit of synchronous machine, selection of circuit breakers, Algorithm for short circuit studies, Symmetrical Component transformation, and construction of sequence networks of power systems. Symmetrical Analysis of Unsymmetrical Line-to-ground (LG), Line-to line (LL), double line to ground (LLG) faults using symmetrical components.	**8**	**CO3**
4	**POWER SYSTEM STABILITY:** Steady state stability, Dynamics of a synchronous machine, Power angle equations, Transient stability, equal area criterion, Numerical solution of swing equation , factors effecting transient stability.	**8**	**CO4**

REFRENCE BOOKS RECOMMENDED:

1. O.I.Elgerd, "Electric Energy Systems Theory",Tata McGraw Hill
2. I.J Nagrath, D.P. Kolthari, "Modern Power System Analysis", Tata McGraw Hill
3. W.D.Stevenson, "Elements of Power System Analysis", McGraw Hill
4. I.J. Nagrath and D.P, Kothari, "Power System Engineering", Tata McGraw Hill
5. J. Arrillaga and C.P. Arnold, "Computer Analysis of Power Systems", John Wiley & Sons
6. W. Stagg Glenn and H. Ei-Abiad Ahmed "Computer Methods in Power System Analysis", Tata McGraw Hill
7. G.L. Kusic, "Computer Aided Power System analysis", Prentice Hall, India

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

<table>
<tr><td rowspan="2">Course Code:
EI-PRPC -102</td><td colspan="2" rowspan="2">Course Name: Advanced Power System Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td>Year and Semester</td><td>1st Year
2nd Semester</td><td colspan="5">Contact hours per week: (3Hrs)
Exam: (3hrs.)</td></tr>
</table>

Pre-requisite of course	Basic of Power System	**Evaluation**	
		CIE: 20	**SEE:30**
Course Objectives:			
1. To study the various parameters of power system like ABCD, Y-Bus, Z-Bus.			
2. To learn different methods for load flow analysis.			
3. To learn fault analysis methods			
4. To learn transient stability methods			

Course Outcomes: On completion of the course, student would be able to:

CO1	To apprise with the various parameters of power system like ABCD, Y-Bus, Z-Bus.
CO2	To develop a technical skill to analyze the load flow in power system
CO3	To develop a technical skill to analyze the transient stability of electrical system.
CO4	To analyze the performance of the transmission line system.

Expt. No	**COURSE SYLLABUS** **CONTENTS OF MODULE**	**COs**
1	To compute ABCD parameters and Regulation of a 3-Φ transmission line model.	**CO1** **CO2** **CO3** **CO4**
2	To study Formation of Admittance Matrices (Y-BUS).	
3	To study Formation of Impedance Matrices (Z-BUS).	
4	To study Load Flow Analysis using GAUSS SEIDAL Method.	
5	To study Load Flow Analysis using NEWTON-RAPHSON Method.	
6	To perform Short circuit analysis of 3-Φ synchronous machine.	
7	To study Power circle diagrams of a 3-Φ transmission line model.	
8	To perform Transient Stability Analysis for Single Machine connected to Infinite Bus by Point by Point method.	
9	To study Load – Frequency Dynamics of Single Area Power Systems.	
10	To study Load – Frequency Dynamics of Two Area Power Systems.	

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-104	**Course Name:** Embedded Systems Lab	**L**	**T**	**P**	**C**
		-	**-**	**3**	**1.5**
Year and Semester	**1st Yr.** **2nd Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	Microprocessor and Microcontrollers	**Evaluation**			
		CIE: 20		**SEE: 30**	

Course Objectives:

1. To provide an overview of Design Principles of Embedded System.
2. To provide clear understanding about the role of firmware, operating systems in correlation with hardware systems.

Course Outcomes: On completion of the course, student would be able to:

CO1	Expected to understand the selection procedure of Processors in the Embedded domain.
CO2	Design Procedure for Embedded Firmware.
CO3	Expected to visualize the role of Real time Operating Systems in Embedded Systems
CO4	Expected to evaluate the Correlation between task synchronization and latency issues

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	**Functional Testing Of Devices:** Flashing the OS on to the device into a stable functional state by porting desktop environment with necessary packages.	CO1 CO2 CO3 CO4
2	**Exporting Display On To Other Systems:** Making use of available laptop/desktop displays as a display for the device using SSH client & X11 display server.	
3	**GPIO Programming:** Programming of available GPIO pins of the corresponding device using native programming language. Interfacing of I/O devices like LED/Switch etc., and testing the functionality.	
4	**Interfacing Chronos eZ430:** Chronos device is a programmable texas instruments watch which can be used for multiple purposes like PPT control, Mouse operations etc., Exploit the features of the device by interfacing with devices.	
5	**ON/OFF Control Based On Light Intensity:** Using the light sensors, monitor the surrounding light intensity & automatically turn ON/OFF the high intensity LED's by taking some pre-defined threshold light intensity value.	
6	**Battery Voltage Range Indicator:** Monitor the voltage level of the battery and indicating the same using multiple LED's (for ex: for 3V battery and 3 LED's, turn on 3 LED's for 2-3V, 2 LED's for 1-2V, 1 led for 0.1-1V & turn off all for 0V)	
7	**Dice Game Simulation:** Instead of using the conventional dice, generate a random value similar to dice value and display the same using a 16X2 LCD. A possible extension could be to provide the user with option of selecting single or double dice game.	
8	**Displaying RSS News Feed On Display Interface:** Displaying the RSS news feed headlines on a LCD display connected to device. This can be adapted to other websites like twitter or other information websites. Python can be used to acquire data from the internet.	
9	**Porting Openwrt To the Device:** Attempt to use the device while connecting to a wifi network using a USB dongle and at the same time providing a wireless access point to the dongle.	
10	**Hosting a website on Board:** Building and hosting a simple website (static/dynamic) on the device and make it accessible online. There is a need to install server (eg: Apache) and thereby host the website.	
11	**Webcam Server:** Interfacing the regular usb webcam with the device and turn it into fully functional IP webcam & test the functionality.	
12	**FM Transmission:** Transforming the device into a regular fm transmitter capable of transmitting audio at desired frequency (generally 88-108 Mhz)	
	Note: Devices mentioned in the above lists include Arduino, Raspbery Pi, Beaglebone	
	Cycle 1: Programming in 8051	
1	Study of 8051 Evaluation Board Trainer kit and Keil IDE Software Tool.	
2	Serial Data Transmission	
3	Interface switches and LEDs	
4	Interface LCD	
5	Interface 4*4 matrix keyboard	
6	Interface stepper motor	
7	Interface 7 Segment Display using I2C	
8	ADC, DAC Interface	

	Cycle 2: Programming in PIC Processor	
9	Configure and Control General Purpose I/O Pins	
10	Interfacing LED & Switch Interface	
11	2*16 LCD Display	
12	Serial Communication	
13	I2C Interface & EEPROM Interface	
14	Buzzer Interface	
15	SD-MMC Card Interface	
Note: all the experiments are to be carried out independently by each student with different specifications. At least 12 experiments are to be carried out.		

Text Books:

1. Use the IDE tool effectively for developing and executing the programs using 8051.
2. Comprehend the usage of on-chip timers and serial communication of 8051 and their interrupts using programs
3. Interface devices like ADC, DAC, LCD, and Stepper Motor to 8051 and develop real time projects.
4. Use the keil software for the development of logic, proteus software for hardware simulation and flash magic for downloading the code on to the target system.
5. Develop the logic to interface devices like temp sensor, stepper motor, Buzzer to ARM microcontroller and analyse the working of GPIO, on-chip peripherals of ARM

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-201	**Course Name:** Smart & Micro Sensor Design	**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**2nd Yr. 3rd Semester**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**VLSI Design**	**Evaluation** **CIE: 40**	**SEE: 60**		
Course Objectives:					
3. It aims to equip the students with MEMS fabrication					
4. To provide adequate knowledge about tools at an intermediate to advanced level.					
5. To provide exposure to students towards advanced level of sensors					
Course Outcomes: On completion of the course, student would be able to:					
CO1	Understand of MEMS fabrication				
CO2	Apply various fabrication procedures				
CO3	Analyze the design of sensors				
CO4	Design and develop smart and intelligent systems				

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	MEMS: Introduction, principle of MEMS, Example of Mems, small and large scaling, fabrication technology, micromachining: photolithography, thin film deposition and doping, wet chemical etching, waferbonding, plasma etching, surface micromachining.	**8**	**CO1, CO2**

2	Mechanics of Membrane and beams: dynamics, string, beams, diaphragms and membrane Transduction of Deformation: Metal strain gauges, Semiconductor Strain Gauges, Capacitive Transducers, Force and Pressure sensors: Force Sensors, Pressure sensors, Thermocouples Semi conducting Thermo resistors, Fiber Optical sensors, concept of smart and intelligent sensor, bio sensors.	**8**	**CO3, CO4**
3	Acceleration Sensors: introduction, Bulk Michromachined Accelerometers, surface Michromachined accelerometers, force feedback, angular rate sensors, Flow Sensors: The laminar boundary layer, Heat Transport in the limit of very small Reynolds Numbers, Thermal Flow Sensors, Skin Friction Sensors, Dry fluid Flow Sensors, wet fluid flow sensors, Resonant Sensors: Basic principle and physics.	**8**	**CO3**
4	Definition of intelligence and of intelligent instrumentation system: Features characterizing intelligence and Features intelligent instrumentation, component of intelligent instrumentation. Design of intelligent instrumentation systems. Smart and Intelligent transmitters, smart features standard for smart sensing, setting standards for smart sensors and system, IEEE 1451.1, IEEE 1451.2, STIM, IEEE P1451.3, IEEEP 1451.4, Field buses systems.	**8**	**CO4**

Text Books:

1. E.O. Doeblin Measurement System Application and Design, McGraw Hill
2. Beeweth and Buck- Mechanical Measurement, Nares Puti
3. Nortan- Hand Book of transducers, PHI
4. Conside-Process and industrial instrumentation, McGraw Hill
5. Mechanical Microsensors, M.Elwenspoek, R. Wiegerink, Springer

Note for Examiner(s): Question paper will comprise three sections,

4. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

5. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

6. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

3. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

4. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code:	Course Name: Program Elective-III	L	T	P	C
EI-PE-203	DIGITAL SIGNAL PROCESSING(i)	3	0	-	3

Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)
Pre-requisite of course	**Basic Engineering Mathematics**	**Evaluation** **CIE: 40** | **SEE: 60**

Course Objectives:

1. To study the discrete linear Time Invariant systems in Z domain and in frequency domain.
2. To study the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its application.
3. To study different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
4. To study the digital filters for filtering applications.
5. To study the Multi-rate digital Signal Processing techniques and its applications

Course Outcomes: On completion of the course, student would be able to:

CO1	To analyze the Discrete linear Time Invariant systems in Z domain and in frequency domain.
CO2	To understand the different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
CO3	To learn the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its applications.
CO4	To Design digital filters for filtering applications.
CO5	To apprise with Multi-rate Signal Processing techniques.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction of Discrete Time Signals and Systems:** Discrete time systems, Analysis of discrete time linear time-invariant systems, Discrete time systems described by difference equations, Implementation of discrete system, Correlation of discrete time signals, Z-transform and properties of Z-transform, Rational Z-transformation, Inverse Z-transform, Analysis of linear time invariant systems in Z-domain. **Frequency Analysis of Signals and Systems:** Frequency analysis of continuous time signals, Frequency analysis of discrete time signals, Properties of Fourier Transform for discrete time signals, Frequency domain characteristics of linear time invariant systems, linear invariant systems as frequency selective filters.	**8**	**CO1**
2	**The Discrete Fourier Transform:** Frequency domain sampling, Properties of Discrete Fourier Transform (DFT), discrete Frequency analysis of signals using the DFT.FFTalgorithm : Decimation-in-time (DIT) algorithm andDecimation-in-frequency(DIF) algorithm, Linear filtering methods based on DFT. **Realization of digital systems**: Structure realizationsmethods of FIR and IIR system.	**8**	**CO2,CO3**
3	**Design of Digital Filters:** Generalized characteristics of discrete filters, Design of Finite Impulse Response (FIR) filters, FIR digital filter design using Fourier series method, window design techniques. Optimal equi-ripple design techniques, frequency sampling design techniques. Design of Infinite Impulse Response (IIR) filters from analog filters, Comparison of IIR and FIR filters.	**8**	**CO4**

4	**Multirate Digital Signal Processing:** Introduction, decimation by a factor D, Interpolation by a factor I, sampling rate conversion by a rational factor I/D, implementation of sampling rate conversion, multistage implementation of sampling rate conversion, sampling rate conversion of Band pass signals, sampling rate conversion by an arbitrary factor, applications of multi rate signal processing.	**8**	**CO5**

Suggested Text / Reference Books:

1. John G. Proakisand Dimitris G. Manolakis,"Digital Signal Processing", PHI Pub.
2. Allan Y. Oppenhein& Ronald W. Schater , "Digital Signal Processing", PHI, 2004.
3. J. R. Jhohnson, "Intorduction to Digital Signal Processing", PHI, 2000.
4. B. Somanthan Nair, "Digital Signal Processing: Theory, Analysis & Digital Filter Design", PHI, 2004
5. Sanjit K. Mitra, "DSP a Computer based approach", TMH, 2nd Ed., 2001.
6. S. Salivahanan, C. Gnanapriya, "Digital Signal Processing", McGraw Hill.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-203	**Course Name:Program Elective-III Reliability Engineering(iii)**		**L** 3	**T** 0	**P** -	**C** 3
Year and Semester	**2nd Year 3rd Semester**	**Contact hours per week: (3Hrs) Exam: (3hrs.)**				
Pre-requisite of course	**Basic Engineering Mathematics**	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. To study the basic concept of reliability, maintainability and availability engineering.						
2. To study the evaluation techniques of engineering models and reliability improvement methods.						
3. To study the concept of fault tree analysis and optimization techniques.						
4. To study evaluation model for reliability, maintainability, availability testing.						
5. To study the applications of fuzzy theory and neural networks to reliability engineering,						
Course Outcomes: On completion of the course, student would be able to:						
CO1	To understand the basic concept of reliability, maintainability and availability engineering.					

CO2	To understand the evaluation techniques of engineering models and reliability improvement methods.		
CO3	To learn the fault tree analysis and optimization techniques.		
CO4	Ability to do testing and evaluate the reliability, maintainability, availability of engineering models.		
CO5	To study the applications of fuzzy theory and neural networks to reliability engineering,		
Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Review of basic concepts in reliability engineering, reliability function, different reliability models etc., and reliability evaluation techniques for complex system: Non path set and cutest approaches, path set and cut set approaches, different reliability measures and performance indices, modeling and reliability evaluation of system subjected to common cause failures.	7	CO1
2	Reliability improvement, Reliability allocation/apportionment and redundancy optimization techniques,Fault tree analysis.	7	CO2, CO3
3	Maintainability Analysis: measure of system performance, types of maintenance, reliability centered maintenance, reliability and availability evaluation of engineering systems using Markov models. Reliability testing,Design for reliability and maintainability.	7	CO1, CO4
4	Applications of fuzzy theory and neural networks to reliability engineering,Typical reliability case studies.	7	CO5

Suggested Text / Reference Books:

1. M.L Shooman, "Probabilistic reliability- an engineering approach" RE Krieger Pub, 1990.
2. K.K Aggarwal, "Reliability Engineering" Springer Pub, 1993.
3. E. Balaguruswamy, "Reliability Engineering" McGraw hill, 2002.
4. R. Ramakumar, "Engineering Reliability" Prentice, NJ, 1993.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-203	**Course Name: Program Elective-III,** Electrical Vehicle Engineering (iv)	**L** 3	**T** 0	**P** -	**C** 3
Year and Semester	**2nd Year 3rd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			

Pre-requisite of course	Electrical Machines, Power Electronics, Basic Science Engineering	**Evaluation**	
		CIE: 40	**SEE: 60**

Course Objectives:

1. To introduce the upcoming technology of electric and hybrid system
2. To study the basics theory, operation and modeling of electric Hybrid system.
3. To study different topologies of electric Hybrid system
4. To study electric propulsion system in electric hybrid system

Course Outcomes: On completion of the course, student would be able to:

CO1	To familiarize with upcoming technology of electric and hybrid system
CO2	To understand the basics theory, operation and modeling of electric Hybrid system.
CO3	To understand and analyze different drive train topologies electric of Hybrid system.
CO4	To learn the role of electric propulsion system in electric hybrid system andits application.
CO5	To impart basic technical knowledge of electric hybrid vehicle system and apply it to technological fields.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction:**Introduction to hybrid electric vehicles: history of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional vehicles: basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.	7	CO1,CO2
2	**Hybrid Electric Drive:**Hybrid electric drive-trains: basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	7	CO3
3	**Electric Propulsion Unit:**Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC motor drives, configuration and control of induction motor drives, configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.	7	CO4
4	**Case Studies:**Design of a hybrid electric vehicle (HEV), design of a battery electric vehicle (BEV).	5	CO5

Suggested Text / Reference Books:

1. Iqbal Hussein, *"Electric and Hybrid Vehicles, Design Fundamentals"*, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, E Sebastian Gay, Ali Emadi, *"Modern Electric, Hybrid Electric and Fuel Cell VehiclesFundamentals", Theory and Design*, CRC Press, 2004.
3. James Larminie, John Lowry, *"Electric Vehicle Technology Explained"*, Wiley, 2003.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-203	**Course Name:** Program Elective III System Theory(v)		**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**2nd Yr. 3rd Semester**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**Control Systems**	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. It aims to equip the students with advanced concepts of control						
2. To provide adequate knowledge about tools at an intermediate to advanced level.						
3. To provide students to serve them well towards tackling more advanced level of control systems problems.						
4. To provide knowledge about different aspects like stability, controllability and observability.						
Course Outcomes: On completion of the course, student would be able to:						
CO1	Develop various models of control systems					
CO2	Evaluate controllability of the systems					
CO3	Evaluate observabilty of the systems					
CO4	Evaluate stability of the systems					
CO5	Develop state models of the systems					

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Controllability & Observability: Introduction, general concept of controllability, general concept of observability, controllability tests for continuous time systems, observability tests for continuous time systems, controllability & observability for discrete time systems, controllability & observability of state model in Jordan canonical form, loss of controllability & observability due to sampling, controllability & observability canonical forms of state model.	**8**	**CO1, CO2, CO3**
2	State variables and input output descriptions: introduction, input output maps from state models, LTI continuous time systems, LTI discrete time systems, linear time varying systems, output controllability, reducibility, state model from input output maps realization of scalar transfer functions, phase variable canonical forms, realization of transfer function matrices, realization of pulse transfer functions.	**8**	**CO1,CO5**
3	Stability: Introduction, equilibrium points, stability concepts and definitions, stability of linear time invariant systems, equilibrium stability of non-linear continuous time autonomous systems, direct method of Lyapunov and the linear continuous time autonomous systems, aids to find	**8**	**CO1, CO4**

	Lyapunov functions for non-linear continuous time autonomous systems, use of Lyapunovfunctions to estimate transients, the direct method of Lyapunov and discrete time autonomous systems.		
4	Model control: Introduction, controllable and observable companion forms for single input/single output systems & multi-input/multi-output systems, the effect of state feedback on controllability & observability, pole placement by state feedback, full order observers, the separation principle, reduced order observers, deadbeat control by state feedback, deadbeat observers.	**8**	**CO1,CO5**

Text Books:

1. Modern control system theory by M. Gopal (New age international)
2. Modern control systems – a manual of design methods by John A Borrie (Prentice hall international)
3. Digital control and state variable methods by M. Gopal (Tata McGraw Hill)

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-203	Course Name: Program Elective-III Intelligent Instrumentation (vi)		L	T	P	C
			3	-	-	3
Year and Semester	**2nd Year. 3rd Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)				
Pre-requisite of course	**Measurements and Instrumentations**	**Evaluation**				
		CIE: 40	**SEE: 60**			
Course Objectives:						
1. Study the concept of intelligent instrumentation system						
2. Study of intelligent instrumentation components						
3. Study the characteristic function of **Smart Sensors**						
4. Detail study of Standards for smart sensors						
5. Study and development of data acquisition system for smart sensor system						
6. Detail study and applications of Microelectro-mechanical systems						

Course Outcomes: On completion of the course, student would be able to:	
CO1	Ability to understand the concept of intelligent instrumentation system
CO2	Able to learn characteristic function of **Smart Sensors**
CO3	Acquire the knowledge of Standards for smart sensors and their Industrial applications.
CO4	Able to learn and analyze the various principles & concepts of data acquisition system for smart sensor system.
CO5	To implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution Smart sensors development including Microelectro-mechanical systems

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Definition of intelligence and of an intelligent instrumentation system; features characterizing intelligence and features of intelligent instrumentation; components of intelligent instrumentation; Block diagram of an intelligent instrumentation system.	**8**	**CO1 CO2**
2	**Smart Sensors:** Primary sensors**;** Excitation**;** Amplification; Filters**;** Converters; Compensation (Nonlinearty**:** look up table method**,** polygon interpolation, polynomial interpolation**,** cubic spline interpolation, Approximation & regression; Noise & interference**;** Response time**;** Drift; Cross-sensitivity)**;** Information Coding/ Processing**;** Data Communication**;** Standards for smart sensor interface**;** The automation.	**10**	**CO2 CO3**
3	**Interfacing Instruments & Computers:** Basic issues of interfacing; Address decoding; Data transfer control; A/D converter; D/A converter; Other interface considerations.	**10**	**CO4**
4	**Software Filters(Digital Filters)** : Description of Spike Filter**,** Low pass filter, High pass filter etc. **Recent Trends in Sensor Technologies:** Introduction**;** Film sensors (Thick film sensors, Thin film sensors)**;** Semiconductor IC technology –standard methods; Microelectro-mechanical systems (Micro-machining, some application examples)**;** Nano-sensors**.**	**9**	**CO4 CO5**

TEXT BOOKS:

REFERENCE BOOKS:

1. Alan S. Morris, 'Principles of measurement & Instrumentation', PHI.
2. Wai-Kai Chen, 'Passive and Active Filters: Theory and Implementations', John Willey & Sons (Asia) Ptr. Ltd., New Delhi.
3. D. Patranabis, 'Sensors & Transducers', PHI, 2003.
4. Roman Kuc, 'Introduction to Digital Signal Processing', Mc Graw Hill Introduction Edition N.York.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-203	Course Name: Program Elective-III, INDUSTRIAL POWER ELECTRONICS(vii)		L	T	P	C
			3	-	-	3
Year and Semester	2nd Yr. 3rdSemester	Contact hours per week: (3Hrs) Exam: (3 Hrs)				
Pre-requisite of course	Power Electronics	Evaluation				
		CIE: 40	SEE: 60			

Course Objectives:
1. To study the basic working theory of different power electrons devices.
2. To study the control of DC drive with the help of power electrons devices.
3. To study different industrial application of power electronic devices.
4. To study the control of AC electric drive with the help of power electrons devices.

Course Outcomes: On completion of the course, student would be able to:

CO1	To apprise with the basic working theory of different power electrons devices.
CO2	To understand the control of DC drive with the help of power electrons devices.
CO3	To understand different industrial application of power electronic devices.
CO4	To understand the control of AC electric drive with the help of power electrons devices.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	INTRODUCTION: Review of semiconductor power devices (Power diodes, Power Transistors, MOSFETS, IGBT, SCR, GTO, MCT, DIAC, TRAIC, PUT, SUS, SCS), Review of choppers, converters, inverters, cyclo-converters. CLOSED LOOP CONTROL OF DC DRIVES: Single Quadrant variable speed drives; Four Quadrant variable speed drives, Armature voltage control at constant field, field weakening, details of various blocks of closed loop drives; drive employing armature reversal by a contractor, drive employing a dual converter with non- simultaneous and simultaneous control.	**8**	**CO1, CO2**
2	INDUSTRIAL APPLICATION OF POWER ELECTRONIC DEVICES: Control of electric drives used in manufacturing and process industries, protection of electric drives using solid state devices and controllers, analysis of drive systems. Testing for drive controllers: Design and testing if microprocessor based drive controllers, analysis of solid state control of industrial drives, design and testing of thyristor based controllers for electric drives.	**8**	**CO2, CO3**
3	FREQUENCY CONTROLLED INDUCTION MOTOR DRIVES: Control of IM by VSI-3 phase VSI, six step inverter voltage control, PWM inverter,	**8**	**CO4**

	breaking and multi-quadrant control, VSI variable frequency drives; control of IM by CSI- 3 phase CSI, current sources, Braking, PWM in a thyristor CSI, PWM GTO CSI, CSI variable frequency drives.		
4	SELF -CONTROLLED SYNCHRONOUS MOTOR DRIVES: Self-control, brushless &commutator less, DC & AC motors synchronous motor control-operation of a wound field and permanent magnet synchronous motor from a variable frequency current source; source, permanent magnet, operation of a permanent magnet motor at the maximum torque to armature current ratio and at the maximum torque to flux ratio; operation of self-controlled synchronous motor drives- CSI drives, VSI drives, cyclo-converters drives, brush-less and commutator-less AC & DC motor drives and their applications.	**8**	**CO4**

TEXT BOOKS:

REFERENCE BOOKS:

1. Industrial Electronics by Frank D. Petruzella (Mc Graw- Hill)
2. Industrial Electronics by Morris (McGraw-Hill)
3. Power semiconductor drives by G.K.Dubey, Prentice Hall Inc, New Jersey

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Department of Political Science
Kurukshetra University Kurukshetra

Syllabus and Scheme of Examination for M.A. Defence and Strategic Studies under (CBCS/LOCF)
w.e.f. 2020-2021 in phased manner for regular students of UTD

Time	:	03 Hours
Maximum Marks	:	100 Marks
Theory	:	80 Marks
Internal Assessment	:	20 Marks, Division of Marks as given below:-

One Test/ Seminar: 50% (For Each Paper)
One Class Test:25% (One Period Duration)

Attendance: 25%, Marks of attendance will be given as under:-

*	91 % onwards	:	05 Marks
*	81% to 90%	:	04 Marks
*	75% to 80%	:	03 Marks
*	70 % to 74%		02 Marks
*	65 % to 69%		01 Marks

* For students engaged in co-curricular activities of the University only/ authenticated medical grounds duly approved by the concerned Chairperson.

Scheme of examination of the Course alongwith POs, PSOs, COs and Mapping Matrix

PROGRAMME OUTCOMES (POs):-

PO 1 KNOWLEDGE :- Demonstrate knowledge of historical emergence, questions asked, and distinctive contributions of the social science disciplines to the analysis of human behavior and social issues.

PO 2 PROBLEM SOLVING:-Visualize, conceptualize, articulate, and solve complex problems through experimentation and observation using theoretical framework of social science disciplines.

PO 3 CRITICAL THINKING:-Critically analyze everyday problems faced by the society, evaluate specific policy proposals, compare arguments with different conclusions to a specific societal issue, and assess the role played by assumptions in such arguments.

PO 4 SCIENTIFIC ENQUIRY:- Develop the capability of defining problems, formulate hypothesis, collect relevant data, develop empirical evidence and interpret the results of such analyses.

PO 5 USAGE OF ANALYTICAL TOOLS:-Develop the ability to apply appropriate quantitative/qualitative techniques used in social science disciplines along with ICT, softwares etc.

PO 6 SPECIALIZATION AND EMPLOYBILITY: - Develop deeper understanding, creativity, originality, analytical and critical skills in chosen specialized areas of social science disciplines leading to employability.

PO 7 INTERDISCIPLINARY KNOWLEDGE & ADAPTATION: Enhance the ability to integrate as well as synthesize the acquired knowledge within the social sciences and beyond.

PO 8 SELF DIRECTED LEARNING: - Develop the ability to work independently as well as effectively in the changing environment.

PO 9 ETHICS: Articulate and apply ethics, values and ideals that demonstrate awareness of current societal challenges.

PO 10 LEADERSHIP: - Build skills to work as part of a team and lead others, setting directions and formulating inspiring vision.

PO 11 COMMUNICATION: Communicate conclusions, interpretations and implications clearly, concisely and effectively, both orally and in writing for different types of audiences.

PO 12 PROJECT MANAGEMENT: - Use investigative skills necessary for conducting disciplinary- projects/ research documents/ term papers etc.

PROGRAMME SPECIFIC OUTCOMES (PSOs):-

PSO1 The students will be able to understand and analysis of the key issues and concepts in the discipline.

PSO2 The students will be able to conduct scholarly research, express ideas and construct evidence-based arguments in both written and oral form.

PSO3 The students would be able to analyze issues in international and national security affairs along with understanding the problems arising out to International peace and security.

PSO4 The students shall possess an integrated understanding of the conduct of strategy, military operations, and its relationship to policy.

Scheme of Examination for M.A. Defence and Strategic Studies under (CBCS/LOCF) w.e.f. 2020-2021 in phased manner for regular students

The M.A. Examination in Defence & Strategic Studies has been divided into four Semesters spread over two years. Every student has to pass 84 Credits **(80 Compulsory and 2 in Semester-II and 2 in Semester-III from Optional Elective Paper from Other Department)** to earn the degree under the new scheme i.e. **Choice Based Credit System**.

In each semester, **20 Compulsory Credits** shall be offered to the students. In addition to this **One Optional Elective Paper from Other Department of 2 Credits each in Semester-II & III are required to earn the Masters Degree in Defence & Strategic Studies.** However, the choice of Optional Credits is subjected to the availability of teaching faculty in the Department. The semester-wise details of the paper-scheme is as follow:-

Course No.	Name of the Subject/Paper	No. of Credit	Teaching Scheme (Hrs/Week)			Examination Scheme (Marks)			Duration of Exam/ Time
			L	T	P	(Sem. Theory Exam)	Internal Assess-ment	Total	
M.A. (Previous) Semester-I Defence & Strategic Studies									
DSS(C) - 01	Evolution of Strategic Thought-I	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 02	National Security: Conceptual Aspects	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 03	International Relations-I	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 04	Theory and Practice of War-I	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 05	Research Methodology-I	4	4	½ hrs/G	-	80	20	100	3 hrs
M.A. (Previous) Semester-II Defence & Strategic Studies									
DSS(C) - 06	Evolution of Strategic Thought-II	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 07	National Security: Indian Context	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 08	International Relations-II	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 09	Theory and Practice of War-II	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 10	Research Methodology-II	4	4	½ hrs/G	-	80	20	100	3 hrs
OESS	**Candidate is required to take one option elective, other than Defence & Strategic Studies, from the Common list of Papers of Social Sciences (Syllabus enclosed in the end)**	**2**	**2**	-	-	-	-	**50**	**2 hrs**
M.A. (Final) Semester-III Defence & Strategic Studies									
DSS(C) - 11	Defence Economics-I	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 12	Psychological Dimensions of War	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 13	Area Studies- Pakistan	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 14	Science & Technology in Relation to Warfare-I	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 15	International Law –I	4	4	½ hrs/G	-	80	20	100	3 hrs
OESS	**Candidate is required to take one option elective, other than Defence & Strategic Studies, from the Common list of Papers of Social Sciences of the same subject as taken in Semester-II (Syllabus enclosed in the end)**	**2**	**2**	-	-	-	-	**50**	**2 hrs**
M.A. (Final) Semester-IV Defence & Strategic Studies									
DSS(C) - 16	Defence Economics-II	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 17	Sociological Dimensions of War	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 18	Area Studies-China	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 19	Science & Technology in Relation to Warfare-II	4	4	½ hrs/G	-	80	20	100	3 hrs
DSS(C) - 20	International Law –II	4	4	½ hrs/G	-	80	20	100	3 hrs

Semester- I
DSS(C) – 01
Evolution of Strategic Thought-I

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper deals with the strategic theorists having propounded doctrines related to the art of warfare. Strategic thinking can be used in any organization seeking to gain a competitive edge. With a focus on improvement, often through creativity and innovation, strategic thinking builds a vision for an organization's future prior to the linear process of developing a strategic plan. This paper traces the evolution of strategic ideas. Thinkers whose concepts have stood the text of time is outlined in this paper.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-01.1 Have broad understanding of the concepts of strategic thinking as propounded by prominent classical and modern thinkers.
DSS(C)-01.2 Develop analytical thinking regarding the ideas of Vauban and Mahan.
DSS(C)-01.3 Understand the theories of important strategic thinkers and theories that have shaped and influenced the modern world.
DSS(C)-01.4 Understand the theories of geo-political and economic thinkers.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Kautilya's Philosophy of war; Sun Tzu- The Art of war; Machiavelli's views on the Art of war.

Unit: II Vauban: The impact of science on war and, Frederick, the Great: His views on National War. Mahan's Views on Sea Power and Naval Warfare.

Unit: III Clausewitz's theories on war: war and its relationship with Policy, Strategy and Tactics; Jomini's theories on the concept of mass army, strategy, tactics & logistics.

Unit: IV Hamilton and Adam Smith: Their views on Importance of Military Power. Mackinder and Houshoffer: Their ideas on geo-politics and geo-strategy.

Suggested Readings

Dass, S.T.	An Introduction to the art of war
Earl, E.M.	Makers of Modern Strategy
Fuller, J.F.C.	Armament and History
Fuller, J.F.C.	The Conduct of war
Shapherd, E.W	A Study of Military History
Shama Shastri	Kautilya's Arthshastra
Tzu, Sun	The Art of War
Cohen, S.B.	Geography and Politics in a divided world
Duffy, Christopher	Siege Warfare
Ropp, Theodore	War in the Modern World
Beaufre, Andre	Deterrence and Strategy
Fukuyama, F.	The End of History
Heilbrunn, Otto	Conventional Warare in the Nuclear Age
Huntington, Samunal	The Clash of Civilizationa
Mao-Tse-Tung	On the Protracted War: Selected works
Nasution, Abdul Haris	Fundamentals of Guerrilla Warfare
Reid, Brain Holden	J.F.C.Fuller: Military Thinker
Fuller, J.F.C.	The Second World War
Greene, T.N.	The Gurrilla and how to fight him
Mccuen, John J.	The Art of Counter revolutionary
Adhikari, Shekhar	Modern Strategic Thought Machiavelli to Nuclear Warfare

Mapping Matrix of Course DSS(C)-01

Mapping: Mapping is a process of representing the correlation between COs and POs, Cos and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-01) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-01

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-01.1	3	3	3	3	2	3	2	2	3	2	2	3
DSS(C)-01.2	3	3	3	3	2	3	2	2	3	2	2	3
DSS(C)-01.3	3	3	3	3	2	3	2	2	3	2	2	3
DSS(C)-01.4	3	3	3	3	2	3	2	2	3	2	2	3
Average	3	3	3	3	2	3	2	2	3	2	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-01) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-01

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-01.1	3	3	3	2
DSS(C)-01.2	3	3	3	2
DSS(C)-01.3	3	3	3	2
DSS(C)-01.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 02

National Security: Conceptual Aspects

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper deals with the conceptual aspects of national security; its objective, nature, character and emerging trends. It is hoped that through participation in the course students will gain not only an appreciation of the broad array of challenges that a country faces. The significance of National Security of any Nation State is due to its compulsive participation in the international system. This paper attempts to conceptualize this compulsion and offers a broader perspective of its understanding.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-02.1 Acquire better knowledge of the key concepts of defence and security.
DSS(C)-02.2 Understand the core elements of national security.
DSS(C)-02.3 Identify the growing internal and external national security challenges.
DSS(C)-02.4 Develop a better understanding about the international strategic environment and challenges to International security.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Security: Definition, Concept, Types, and Objectives; and, National Defence and Security Policies: Formulations & Linkages.

Unit: II Elements of National Security: Geographical, Social & Political Factors, Economic & Industrial Potential, Scientific & Technological Potential, National Unity & National Morale, Transport & Communication, Defence Potential & Defence Preparedness and Intelligence.

Unit: III Challenges to National Security: Internal and External; and Responses to National Security. International terrorism.

Unit: IV International Strategic environment in cold-war & post-cold war period. Contemporary trends in Arms proliferation; and, Challenges to International security: Proliferation of Weapons of Mass Destruction (WMD).

Suggested Readings

Buzan, Barry(1987)	People Fear and State: New Delhi, Transasia Publications.
Buzan, Barry and Waever, Ole(eds)(2003)	Regions and Powers: Cambridge.
Bajpai,U.S.(1986)	India and its Neighbourhood: New Delhi, Lancer International.
Baranwal, S.P.(1984)	Measures of Civil Defence in India: New Delhi, Guide Publications.
Bobbing, Ross and Gordon, Sandy(eds)(1992)	India's Strategic Future: Delhi, Oxford University Press.

Chatterjee,R.K.(1978)	India's Land Borders- Problems and Challenges: New Delhi, Sterling Publishers.
Chaudhury, Rahul Roy(1995)	Sea Power and India's Security, London, Brassey's.
Chowdhury, Subrata Roy (1966)	Military Alliances and Neutrality in War and Peace: New Delhi, Orient Longman.
Dass, S.T.(1987)	National Security in Perspective: Delhi, Gian Publishers.
Frankal, Joseph(1970)	National Interest: London, Macmillian.
Garnett, John(ed)(1970)	Theories of Peace and Security: Macmillan St. Martin's Press.
Karnard, Bharat(1994)	Future Imperiled: New Delhi, Viking.
Kavic, Lorne J.(1967)	India's Quest For Security: Defence Policies 1947-1965: LA, University of California Press.
Khera,S.S.(1968)	India's Defence Problems: New Delhi, Orient Longmans
Menon, V.P.(1961)	The Story of the Integration of Indian States: New Delhi, Orient Longmans.
Misra, R.N.(1986)	Indian Ocean and India's Security: Delhi, Mittal Publications.
Nayar, V.K.(1992)	Threats From Within: New Delhi, Lancer Publications.
Palmer, Norman D. and Perkins, Howard C. (1968)	International Relations: Calcutta, Scientific Book Agency
Rao, Ramakrishna and Sharma, R.C.(ed)(1991)	India's Borders: New Delhi, Scholars' Publishing Forum.
Rao, P.V.R.(1970)	Defence Without Drift: Bombay, Popular Prakashan.
Singh, Jaswant(1999)	Defending India: Banglore, Macmillan India Ltd.
Singh, Nagendra(1974)	The Defence Mechanism and the Modern State: New Delhi, Asia Publishing House.
Venkateshwaran(1967)	Defence Organisation in India: New Delhi, Ministry of Information and Broadcasting, Government of India.
Yadav, R.S.(ed.) (1993)	India's Foreign Policy : Towards 2000 A.D., New Delhi, Deep & Deep.
Yadav, R.S. (2013)	Bharat Ki Videsh Niti: Ek Vishleshan, New Delhi, Pearson.
Yadav, R.S.& Suresh Dhanda (eds.) (2009)	India's Foreign Policy: Contemporary Trends, New Delhi, Shipra.

SIPRI Year Books.

Mapping Matrix of Course DSS(C)-02

<u>Mapping</u>: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

<u>Table 1: Scale of mapping between COs and POs</u>

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: <u>(CO-PO Mapping Matrix)</u>

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-02) assuming that there are 12 POs and 4Cos

.

<u>Table 2: CO-PO Matrix for the Course DSS(C)-02</u>

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-02.1	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
DSS(C)-02.2	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
DSS(C)-02.3	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
DSS(C)-02.4	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
Average	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: <u>(CO-PSO Mapping Matrix)</u>

Table 3 shows the CO-PSO mapping matrix for a course (<u>DSS(C)-02</u>) assuming that there are 4 PSOs and 4COs.

<u>Table 3: CO-PSO Matrix for the Course DSS(C)-02</u>

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-02.1	**3**	**3**	**3**	**2**
DSS(C)-02.2	**3**	**3**	**3**	**2**
DSS(C)-02.3	**3**	**3**	**3**	**2**
DSS(C)-02.4	**3**	**3**	**3**	**2**
Average	**3**	**3**	**3**	**2**

DSS(C) – 03
International Relations-I

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper gives out the various theories and concepts of international relations including issues of current relevance. The objective of the course is to develop a basic understanding of the theoretical and practice related perspectives of the conduct of International Relations which is very relevant for nation states and would lead towards a holistic appreciation of National Security studies and allied aspects. In the contemporary world the survival of mankind is conditioned by the facts of war and peace. The conditions of war and peace are influenced by various actors, viz., State actors, Non-State and International Organizations.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-03.1 Understand the nature, scope of international relations and its various theories.
DSS(C)-03.2 Comprehend the concepts of international relations and their relevance.
DSS(C)-03.3 Have an in-depth knowledge of nation state system.
DSS(C)-03.4 Have well grounded understanding of the Impact of global developments on international relations and working of UN.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I International Relations: Concept, Nature, Scope & Development; Contending Theories of International Relations: Realist theory, Decision making theory, Systems theory & Game and Bargaining Theory.

Unit: II National interest: Definition, types & methods of securing National Interest, Role of National Interest in the formulation of Foreign and Defence Policies. Balance of Power: Nature, Strategies and its relevance in contemporary times

Unit: III State, Nation & Nation-State System; Origin, Issues of Ethnicity, Pluralism, Multiculturalism and Nation-State System in Contemporary times. Arms Control and Disarmament since World War-II.

Unit: IV The United Nations: Purposes, Structure and Powers, The Principal Organs, Contribution to World-Peace and Security. Collective Security: Meaning, Basic postulates and its working under the League of Nation & UN.

Suggested Readings

John Baylis & Steve Smith	Globalization of World Politics
Couloumbis, Theodore. A & James H. Wolfe	Introduction to International Relations
Dyke, Vernon Van	International Politics
Morgenthau, Hans J.	Politics among Nations
Palmer and Perkins	International Relations
Wright, Quincy	The Study of International Relations
Said, A.A.	Theory of International Relations
Mahender Kumar	Theoretical Aspects of International Politics
Larche and A.A.Said	Concept of International Politics
Rosenau, James N.,(ed.)	International Politics & Foreign Policy
Sanders, Bruce L.and A.C.Durbin.	Contemporary International Policies.
Hartmann F.H.	The Relations of Nations.
Calvocoressi, Peter	World Politics since 1945
International Encyclopedia of Social Science.	
Journals	Foreign Affairs, World Politics

Mapping Matrix of Course DSS(C)-03

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-03) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-03

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-03.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-03.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-03.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-03.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-03) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-03

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-03.1	3	3	3	2
DSS(C)-03.2	3	3	3	2
DSS(C)-03.3	3	3	3	2
DSS(C)-03.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 04
Theory and Practice of War-I

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: A theory of war could be developed through studying the history of war, but this theory could only be used to educate judgment and depends upon by the context in which theoretical principles are applied, and by the commander's judgment and skill in applying them. This paper aims to acquaint the students about theory and practice of war from Primitive to Modern time. The history of mankind is highlighted by incidents of war. It is therefore necessary to have in depth knowledge of these concepts for better understanding and clarity.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-04.1 Understand concept of war along with its theories and techniques.
DSS(C)-04.2 Acquire comprehensive knowledge of various types and characteristics of war.
DSS(C)-04.3 Comprehend the theories of nuclear war in detail.
DSS(C)-04.4 Develop the skill to understand the art of psychological warfare and its various aspects.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I War: Concept, Nature and Scope, Theories of War; Causes, Assumptions, Functions and Techniques: Animal Warfare, Primitive Warfare, Historical Warfare, Modern Warfare.

Unit: II Guerilla Warfare and Low Intensity Conflict: Concept, Origin, Scope and objectives; and, Limited War: Meaning, Origin, Scope and Objectives.

Unit: III War in Nuclear Age: Beginning of Nuclear Era, Main effects of Nuclear Energy, Flash, Heat, Blast and Nuclear Radiation; Theories of Nuclear Deterrence: Preventive, Pre-emptive, Massive Retaliation, Flexible Response. Ballistic Missile Defence: Missiles and their classification, Ground Based ABM System, Counter Measures: NMD, TMD

Unit: IV Psychological Warfare: Concept, Definition, Functions and Limitations including various Psychological Aspects of War i.e. Leadership, Discipline, Motivation and Fear and Panic.

Suggested Readings

Howard, Michael	Theory and Practice of War
Howard, Michael	The Causes of war
Bernard, Black L.	War and its causes
Wright, Quincy	A study of war
Mao-Tse-Tung	Guerilla Warfare
Laqueur, Walter	Guerilla Warfare
Robert E.Osgood	Limited war- The Challenge to American Strategy
Rees David	Korea, the limited war
Kitson, Frank	Low, intensity Operations, Subversion, Insurgency, Peace Keeping
Osanka, F.M.	Modern Guerilla Warfare
Nasution, Abdul Haris	Fundamentals of Guerilla warfare
Brodie, Bernard	Strategy in the missile age
Sampooran Singh	India and the Nuclear Bomb
Tirpathi, K.S.	Evolution of Nuclear Strategy
Gupta, Rakesh	Militarisation of outer-space
Halperin Morton H.	Defence Strategies for the seventies
Mir Publications	Weaponry in space, The Dilemma of Society
Hart, Liddle	History of First World War
Hart, Liddle	History of Second World War
Fuller, J.F.C.	History of Second World War
Fuller, J.F.C.	The conduct of war
Khan, J.A.	Probing War & Warfare. APH Publishing, 2005

Mapping Matrix of Course DSS(C)-04

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-04) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-04

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-04.1	3	3	3	3	2	3	2	2	3	2	2	3
DSS(C)-04.2	3	3	3	3	2	3	2	2	3	2	2	3
DSS(C)-04.3	3	3	3	3	2	3	2	2	3	2	2	3
DSS(C)-04.4	3	3	3	3	2	3	2	2	3	2	2	3
Average	3	3	3	3	2	3	2	2	3	2	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-04) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-04

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-04.1	3	3	3	2
DSS(C)-04.2	3	3	3	2
DSS(C)-04.3	3	3	3	2
DSS(C)-04.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 05
Research Methodology-I

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper intends to enable the students to understand the nature of social research. While discussing various approaches to Social Science research, the paper acquaints the students with concepts like Models, Paradigms and Theories. It also explores themes like Scientific Method and the building blocs of Social Scientific Research.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-05.1 Understand the meaning, nature and types of social research along with various approaches.
DSS(C)-05.2 Develop the understanding of model, paradigm and theory.
DSS(C)-05.3 Grasp various methods used in carrying out research.
DSS(C)-05.4 Examine and assess the building blocks of research viz. hypothesis, concepts and variables.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit-I
Social Research- Its Nature and Types.
Traditional Approaches- Philosophical, Institutional, Marxian and Gandhian.
Behavioural Revolution in Political Science and its Criticism.
Post-Behaviouralism

Unit-II
Models, Paradigms and Theories- Conceptual and Theoretical Models.
Meaning and Types of Paradigms.
Theory-Meaning, Goals and Types.
Construction of a Theory and Relationship Between Theory and Research.

Unit-III
Scientific Method-Basic Assumptions, Steps and Limitation. Scientific Study of Political Science.
Historical Method, Comparative Method, Analytical Method and Psycho-Analysis.
Methods of Popper and Kuhn.

Unit-IV
The Building Blocs of Social Scientific Research-Hypotheses, Concepts and Variables, Generalization and Law.

Suggested Readings

H.N. Blalock — An Introduction to Social Research, Englewood Cliffs NJ, Prentice Hall, 1970.
H.N. Blalock (ed.) — Casual Models in the Social Sciences, London, Macmillan, 1972.
J. Blondel — Thinking Politically, London, Wildwood House, 1976.

A. Bryman, Quantity and Quality in Social Research, London, Unwin Hyman, 1988.

T.L. Burton & G.L. Cherry Social Research Techniques, London, Unwin Hyman, 1989.

A.F. Chalmers Science and Its Fabrication, Milton Keynes, Open University Press, 1990.

D.A. De Vaus Surveys in Social Research, 2nd edn., London, Unwin Hyman, 1991.

M. Duverger An Introduction to the Social Sciences with Special References to their Methods, Translated by M. Anderson, New York, Frederick A. Praeger, 1964.

S.V. Evera Guide to Methods for Students of Political Science, Ithaca, NY, Cornell University Press, 1997.

J. Galtung Theory and Methods of Social Research, New York, Columbia University Press, 1987.

E. Gellner Relativism and Social Science, Cambridge, Cambridge University Press, 1985.

A.Giddens Profiles and Critiques in Social Theory, London Macmillan, 1982.

W.J. Goode and P.K. Hatt Methods of Social Research, New York, McGraw Hill, 1952.

A.C. Isaak, Scope and Methods of Political Science, Homewood Illinois, Dorsey Press, 1985.

J.B. Johnson &R.A. Joslyn Political Science Research Methods, Washington DC, C.Q. Press, 1986.

F.N. Kerlinger Behavioural Research, New York, Holt, Rinehart and Winston, 1979.

T.Kuhn The Structure of Scientific Revolution, Chicago, University of Chicago Press, 1970.

D. Marsh & G. Stoker(ed.) Theory and Methods in Political Science, Basigstoke, Macmillan, 1995.

C.A. McCoy & C. Playford (eds.) Apolitical Politics : A Critique of Behaviouralism, New York, Thomas Crowell, 1967.

R. K. Merton (ed.) Social Theory and Social Structure, New York, The Free Press, 1957.

D. Miller (ed.) Pocket Popper, London, Fontana, 1997.

G. Mydral Objectivity in Social Science, New York, Pantheon Books, 1969.

Sir, K.R. Popper The Logic of Scientific Discovery, London, Hutchinson, 1959.

Sir, K. R. Popper Conjectures and Refutations : The Growth of Scientific Knowledge, London, Rougtledge and Kegan Paul, 1963.

Sir, K.R. Popper The Poverty of Historicism, London, Reoutledge, 1991.

A.Ryan (ed.) The Philosophy of Social Sciences, London, Macmillan, 1970.

H.J. Rubin Applied Social Research, Columbus, North Illinois University Press, 1983.

B. Smith Political Research Methods, Boston, Hougton Milton, 1976.

G.W. Snedecor Statistical Methods, 5th edn., Iowa, State College, 1965.

M. Weber The Methodology of Social Science, translated and edited by E.A. Shils and H.A. Finch, New York, The Free Press, 1949.

P.V. Young Scientific Social Surveys and Research.

Robert A. Dahl Modern Political Analysis, Englewood Cliffs, NJ Prentice Hall, 1963.

C. Charlesworth (ed.) Contemporary Political Analysis, New York, Free Press, 1967.

Michael Hoas, Henry S. Kariel Approaches to the Study of Political Science, California, Chandler Publishing Co., 1970.

Roland Young	Approaches to the Study of Politics, Evanston, Ill, North Western University Press, 1958.
E.J. Meehan	The Theory and Method of Political Analysis, Homewood, Illinois, Dorsey Press, 1965.
Stephen L. Wasby	Political Science - The Discipline and Its Dimensions, Calcutta, Scientific Book Agency, 1970.

Mapping Matrix of Course DSS(C)-05

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-05) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-05

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-05.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-05.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-05.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-05.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-05) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-05

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-05.1	3	3	3	2
DSS(C)-05.2	3	3	3	2
DSS(C)-05.3	3	3	3	2
DSS(C)-05.4	3	3	3	2
Average	3	3	3	2

Semester- II
DSS(C) – 06, Evolution of Strategic Thought-II

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: This paper provides basic knowledge about the concepts of selected strategic thinkers. The growing significance of the economic and political consideration for waging war and the profound influence of this on the art of war attracted the attention of more and more men of intellectual bent. Their writings on the subject of war hold a special position in the realm of strategic thought. All aspects of military affairs had been subjected to analysis in the revival of interest in the theory of war and its implication in contemporary world.

Course Outcomes:
After the completion of this course, the students will be able to:
DSS(C)-06.1 Have broad understanding of the concept of mobile and total warfare.
DSS(C)-06.2 Develop analytical thinking regarding relevance of air power in modern era.
DSS(C)-06.3 Have deeper understanding of military concept of social revolutionaries.
DSS(C)-06.4 Comprehend the theories of nuclear war and deterrence.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I J.F.C.Fuller: Concept of mobile warfare; Liddell Hart: Mobile Defence and Total war.

Unit: II Douhet and Mitchell: Their views on the Role of Air Power in Modern Warfare; and, Seversky's Views on Warfare.

Unit: III Engel and Marx: Military concept of the Social Revolutionaries; Mao-Tse-Tung's views on Guerrilla warfare; and, Lenin: Theory of Imperialism and Warfare.

Unit: IV F. Fukuyama- The End of History; and, Samuel P. Huntington- The Clash of Civilizations. Dulles and Andre Beaufre - Theories of Nuclear War and Deterrence.

Suggested Readings

Dass, S.T.	An Introduction to the art of war
Earl, E.M.	Makers of Modern Strategy
Fuller, J.F.C.	Armament and History
Fuller, J.F.C.	The Conduct of war
Shapherd, E.W	A Study of Military History
Shama Shastri	Kautilya's Arthshastra
Tzu, Sun	The Art of War
Cohen, S.B.	Geography and Politics in a divided world
Duffy, Chistopher	Siege Warfare
Ropp, Theodere	War in the Modern World
Beaufre Andre	Deterrence and Strategy
Fukuyama, F.	The End of History
Heil Brunn, Otto	Conventional Warare in the Nuclear Age
Huntington, Samunal	The Clash of Civilizationa
Mao-Tse-Tung	On the Protracted War: Selected works
Nasultion, Abdul Haris	Fundamentals of Guerrilla Warfare
Reid, Brain Holden	J.F.C.Fuller: Military Thinker
Fuller, J.F.C.	The Second World War
Greene, T.N.	The Gurrilla and how to fight him
Mccuen, John J.	The Art of Couter revolutionary
Adhikari, Shekhar	Modern Strategic Thought Machiavelli to Nuclear Warfare

Mapping Matrix of Course DSS(C)-06

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-06) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-06

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-06.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-06.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-06.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-06.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-06) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-06

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-06.1	3	3	3	2
DSS(C)-06.2	3	3	3	2
DSS(C)-06.3	3	3	3	2
DSS(C)-06.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 07
National Security: Indian Context

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The significance of National Security of any Nation State is due to its compulsive participation in the international system. This paper attempts to conceptualize this compulsion and offers a broader perspective of its understanding.To develop a special subject knowledge on the vital concept of National Security and the approaches to achieve National Security.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-07.1 Understand the security problems emerged after partition of India.
DSS(C)-07.2 Examine the role and structure of Indian paramilitary forces and internal security challenges.
DSS(C)-07.3 Understand the maritime security of India and threats from sea.
DSS(C)-07.4 Develop an understanding of Indian nuclear, missile and defence policies.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I India's Security problems as a result of partition: Geo-political impact of partition, Effects of partition over Indian Armed Forces, & their reorganization; Security problems related to the merger of states – Jammu and Kashmir, Junagarh, Hydrabad and Goa; Higher Defence Organization in India;

Unit: II Role and Structure of Paramilitary Forces; India's internal security problems: Terrorism in Jammu and Kashmir, Insurgency in North Eastern States, & Problem of Naxalism.

Unit: III India's Maritime Security: Maritime boundary, Maritime zones, Maritime routes & Island territories, Threats from Sea, & Role of Navy and Coast Guards. India's Security problems related to Pakistan, China, Nepal, Bangladesh, Sri Lanka.

Unit: IV India's Nuclear policy: Nuclear doctrine & Nuclear and Missile capabilities of India; Civil Military relations in India; Civil Defence Organisation in India; and, India's Defence policy and planning.

Suggested Readings

Yadav, R.S.(ed.) (1993)	India's Foreign Policy : Towards 2000 A.D., New Delhi, Deep & Deep.
Yadav, R.S. (2013)	Bharat Ki Videsh Niti: Ek Vishleshan, New Delhi, Pearson.
Yadav, R.S. & Suresh Dhanda (eds.) (2009)	India's Foreign Policy: Contemporary Trends, New Delhi, Shipra.
Bajpai,U.S.(1986)	India and its Neighbourhood: New Delhi, Lancer International.
Baranwal, S.P.(1984)	Measures of Civil Defence in India: New Delhi, Guide Publications.
Bobbing, Ross and Gordon, Sandy(eds)(1992)	India's Strategic Future: Delhi, Oxford University Press.
Chatterjee,R.K.(1978)	India's Land Borders- Problems and Challenges: New Delhi, Sterling Publishers.
Chaudhury, Rahul Roy(1995)	Sea Power and India's Security, London, Brassey's.
Dass, S.T.(1987)	National Security in Perspective: Delhi, Gian Publishers.
Karnard, Bharat(1994)	Future Imperiled: New Delhi, Viking.
Kavic, Lorne J.(1967)	India's Quest For Security: Defence Policies 1947-1965: LA, University of California Press.
Khera,S.S.(1968)	India's Defence Problems: New Delhi, Orient Longmans
Menon, V.P.(1961)	The Story of the Integration of Indian States: New Delhi, Orient Longmans.
Misra, R.N.(1986)	Indian Ocean and India's Security: Delhi, Mittal Publications.
Nayar, V.K.(1992)	Threats From Within: New Delhi, Lancer Publications.
Rao, Ramakrishna and Sharma, R.C.(ed)(1991)	India's Borders: New Delhi, Scholars' Publishing Forum.
Rao, P.V.R.(1970)	Defence Without Drift: Bombay, Popular Prakashan.
Singh, Jaswant(1999)	Defending India: Banglore, Macmillan India Ltd.
Singh, Nagendra(1974)	The Defence Mechanism and the Modern State: New Delhi, Asia Publishing House.
Venkateshwaran(1967)	Defence Organisation in India: New Delhi, Ministry of Information and Broadcasting, Government of India.
Buzan, Barry(1987)	People Fear and State: New Delhi, Transasia Publications.
Buzan, Barry and Waever, Ole(eds)(2003)	Regions and Powers: Cambridge.
Das, S.T.(1987)	National Security in Perspective: Delhi, Gian Publishing House.
Frankal, Joseph(1970)	National Interest: London, Macmillian
Garnett, John(ed)(1970)	Theories of Peace and Security: Macmillan St. Martin's Press.
Palmer, Norman D. and Perkins, Howard C. (1968)	International Relations: Calcutta, Scientific Book Agency
Chowdhury, Subrata Roy (1966)	Military Alliances and Neutrality in War and Peace: New Delhi, Orient Longman.
SIPRI Year Books.	

Mapping Matrix of Course DSS(C)-07

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-07) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-07

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-07.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-07.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-07.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-07.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-07) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-07

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-07.1	3	3	3	2
DSS(C)-07.2	3	3	3	2
DSS(C)-07.3	3	3	3	2
DSS(C)-07.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 08
International Relations-II

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The objective of this course is to impart knowledge and create awareness on the importance and significance of International Relations and global issues in the context of National Defence and Security. It also aims to throw light on India's foreign policy and India's relations with the world. A historical survey of the cold war, post cold war, major trends in world affairs will be analyzed from Indian perspective.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-08.1 Understand the concept and theories of the cold war.
DSS(C)-08.2 Acquire comprehensive knowledge about foreign policy of India and its relation with her neighbors.
DSS(C)-08.3 Develop the skills to analyze the India's relations with big powers.
DSS(C)-08.4 Understand the India's relation with different regional organisations.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Cold-War: Definition, Theories of its origin, Historical evolution & Consequences; and, Diplomacy and its role in settling international disputes.

Unit: II Basic determinants of India's Foreign Policy and India's Relations with her neighbours (Pakistan, Bangladesh, Nepal, & Sri Lanka).

Unit: III India's relations with big powers (U.S.A., Russia, & China).

Unit: IV Regional Cooperation & India: ASEAN, SAARC & IOR-ARC.

Suggested Readings

John Baylis & Steve Smith	Globalization of World Politics
Couloumbis, Theodore. A & James H. Wolfe	Introduction to International Relations
Dyke, Vernon Van	International Politics
Morgenthau, Hans J.	Politics among Nations
Palmer and Perkins	International Relations
Wright, Quincy	The Study of International Relations
Said, A.A.	Theory of International Relations
Mahender Kumar	Theoretical Aspects of International Politics
Larche and Said	Concept of International Politics
Rosenau, James N.,(ed.)	International Politics & Foreign Policy
Sanders, Bruce L. and A.C. Durbin.	Contemporary International Policies.
Hartmann F.H.	The Relations of Nations.
Calvocoressi, Peter	World Politics since 1945
International Encyclopedia of Social Science.	
Journals	Foreign Affairs, World Politics

Mapping Matrix of Course DSS(C)-08

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-08) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-08

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-08.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-08.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-08.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-08.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-08) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-08

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-08.1	3	3	3	2
DSS(C)-08.2	3	3	3	2
DSS(C)-08.3	3	3	3	2
DSS(C)-08.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 09
Theory and Practice of War-II

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: This Paper aims to acquaint the students to understand the causes, Strategy, Tactics, Outcome and conduct of warfare from world wars to recent wars with detail. To make the students learn about some of the important wars those were fought between year1914 to 2003. On completion of the paper, the students will be in a position to analyses the causes for war in modern period.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-09.1 Critically analyse the world war I in detail.
DSS(C)-09.2 Have indepth knowledge of causes of world war II and the strategies adopted by nations.
DSS(C)-09.3 Grasp the causes, and outcome of korean and vietnam war in detail.
DSS(C)-09.4 Have well grounded understanding of indo-pak and gulf wars.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I World War-I (1914-18): Causes (in brief), War plans of belligerents, Organisation of theatres of war (in brief) of contending nations & outcome, Strategy, Tactics.

Unit: II World War-II (1939 to 1945): Causes (in brief), War plans of belligerents, Organisation of theatres of war (in brief) of contending nations and outcome, Strategy, & Tactics.

Unit: III Korean War (1950-1953): Causes (in brief), War belligerents and their plans, Outline of main operations, & Consequences; and, Vietnam war (1954-1974): Causes, Main events (in brief) & Consequences.

Unit: IV Indo-Pak War-1965, 1971 & 1999) : Causes, Main events (in brief) & Consequences. Gulf War (1990 & 2003): Causes, War belligerents, Outline of main operations, & Consequences.

Suggested Readings

Howard, Michael	Theory and Practice of War
Howard, Michael	The Causes of war
Bernard, Black L.	War and its causes
Wright, Quincy	A study of war
Mao-Tse-Tung	Guerilla Warfare
Legueur Walter:	Guerilla Warfare
Robert E.Osgood	Limited war- The Challenge to American Strategy
Rees David	Korea, the limited war
Kitson, Frank	Low intensity Operations, Subversion, Insurgency, Peace Keeping
Osanka FM	Modern Guerilla Warfare
Nasution, Abdual H.	Fundamentals of Guerilla warfare
Brodie,Bernard	Strategy in the missile age
Sampooran Singh	India and the Nuclear Bomb
Tirpathi, K.S.	Evolution of Nuclear Strategy
Gupta, Rakesh	Militarisation of outer-space
	Encyclopedia Britannica
Halperin Morton H.	Defence Strategies for the seventies
Mir Publications	Weaponry in space, The Dilemma of Society
Hart, Liddle	History of First World War
Hart, Liddle	History of Second World War
Fuller, J.F.C.	History of Second World War
Fuller, J.F.C.	The conduct of war
Khan, J.A.	Probing War & Warfare. APH Publishing, 2005

Mapping Matrix of Course DSS(C)-09

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-09) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-09

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-09.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-09.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-09.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-09.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-09) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-09

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-09.1	3	3	3	2
DSS(C)-09.2	3	3	3	2
DSS(C)-09.3	3	3	3	2
DSS(C)-09.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 10
Research Methodology-II

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper deals with the course in research methodology to make students conversant with the various research work and related techniques. The paper intends to enable the students to understand the nature of social research. While discussing various approaches to Social Science research, the paper acquaints the students with concepts like Research Design, Problem, Analysis and presentation of data and Paper writing.

Course Outcomes:

After the completion of this course, the students will be able to:

DSS(C)-10.1 Identify the research problem and formulation of various types of research designs.
DSS(C)-10.2 Understand and explain the types of data and methods of data collection.
DSS(C)-10.3 Analyse the secondary data and the use of statistics in research work.
DSS(C)-10.4 Develop the skill to present data and learn how to write a research report, paper and thesis.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit-I Identification and Formulation of Problem.

Research Design: Formation, Experimental and Non-Experimental Designs

Sampling-Principles and Methods.

Unit-II Data-Types and Sources, Observation, Questionnaire, Schedule and Interview.

Survey Method- Utility, Application and Limitations.

Unit-III Analysis of Secondary Data-Archival and Library Research, Document Analysis, Using Written Records, Scrutinizing the Evidences, Content Analysis.

Quantification in Social Research: Statistics- Meaning, Purpose and Scope, Statistical Techniques of Data-Analysis.

Unit-IV Presentation of Data- Textual, Graphic and Tabular.

Presentation of Research- Paper Writing, Report Writing and Thesis Writing.

Suggested Readings

H.N. Blalock	An Introduction to Social Research, Englewood Cliffs NJ, Prentice Hall, 1970.
H.N. Blalock (ed.)	Casual Models in the Social Sciences, London, Macmillan, 1972.
J. Blondel	Thinking Politically, London, Wildwood House, 1976.
A. Bryman,	Quantity and Quality in Social Research, London, Unwin Hyman, 1988.
T.L. Burton & G.L. Cherry	Social Research Techniques, London, Unwin Hyman, 1989.
A.F. Chalmers	Science and Its Fabrication, Milton Keynes, Open University Press, 1990.
De D.A. Vaus	Surveys in Social Research, 2nd edn., London, Unwin Hyman, 1991.
M. Duverger	An Introduction to the Social Sciences with Special References to their Methods, Translated by M. Anderson, New York, Frederick A. Praeger, 1964.
S.V. Evera	Guide to Methods for Students of Political Science, Ithaca, NY, Cornell University Press, 1997.
J. Galtung	Theory and Methods of Social Research, New York, Columbia University Press, 1987.
E. Gellner	Relativism and Social Science, Cambridge, Cambridge University Press, 1985.
A.Giddens	Profiles and Critiques in Social Theory, London Macmillan, 1982.
W.J. Goode and P.K. Hatt	Methods of Social Research, New York, McGraw Hill, 1952.
A.C. Isaak,	Scope and Methods of Political Science, Homewood Illinois, Dorsey Press, 1985.
J.B. Johnson &R.A. Joslyn	Political Science Research Methods, Washington DC, C.Q. Press, 1986.
F.N. Kerlinger	Behavioural Research, New York, Holt, Rinehart and Winston, 1979.
T.Kuhn	The Structure of Scientific Revolution, Chicago, University of Chicago Press, 1970.
D. Marsh & G. Stoker(ed.)	Theory and Methods in Political Science, Basigstoke, Macmillan, 1995.

C.A. McCoy & C. Playford (eds.)	Apolitical Politics : A Critique of Behaviouralism, New York, Thomas Crowell, 1967.
R. K. Merton (ed.)	Social Theory and Social Structure, New York, The Free Press, 1957.
D. Miller (ed.)	Pocket Popper, London, Fontana, 1997.
G. Mydral	Objectivity in Social Science, New York, Pantheon Books, 1969.
Sir, K.R. Popper	The Logic of Scientific Discovery, London, Hutchinson, 1959.
Sir, K. R. Popper	Conjectures and Refutations : The Growth of Scientific Knowledge, London, Rougtledge and Kegan Paul, 1963.
Sir, K.R. Popper	The Poverty of Historicism, London, Reoutledge, 1991.
A.Ryan (ed.)	The Philosophy of Social Sciences, London, Macmillan, 1970.
H.J. Rubin	Applied Social Research, Columbus, North Illinois University Press, 1983.
B. Smith	Political Research Methods, Boston, Hougton Milton, 1976.
G.W. Snedecor	Statistical Methods, 5th edn., Iowa, State College, 1965.
M. Weber	The Methodology of Social Science, translated and edited by E.A. Shils and H.A. Finch, New York, The Free Press, 1949.
P.V. Young	Scientific Social Surveys and Research.
Robert A. Dahl	Modern Political Analysis, Englewood Cliffs, NJ Prentice Hall, 1963.
C. Charlesworth (ed.)	Contemporary Political Analysis, New York, Free Press, 1967.
Michael Hoas, Henry S. Kariel	Approaches to the Study of Political Science, California, Chandler Publishing Co., 1970.
Roland Young	Approaches to the Study of Politics, Evanston, Ill, North Western University Press, 1958.
E.J. Meehan	The Theory and Method of Political Analysis, Homewood, Illinois, Dorsey Press, 1965.
Stephen L. Wasby	Political Science - The Discipline and Its Dimensions, Calcutta, Scientific Book Agency, 1970.

Mapping Matrix of Course DSS(C)-10

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-10) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-10

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-10.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-10.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-10.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-10.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-10) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-10

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-10.1	3	3	3	2
DSS(C)-10.2	3	3	3	2
DSS(C)-10.3	3	3	3	2
DSS(C)-10.4	3	3	3	2
Average	3	3	3	2

OESS-01
Indian Security Concerns

Credit: 02 Maximum Marks – 50
Time – 2 Hours

Objective: The paper is aimed at to acquaint the student about the basic concepts and challenges to Indian Security. The aim of the course is to increase the knowledge and understanding on various concepts of national security and its different dimensions; its challenges and threats to India's National Security and to understand the India's effective and efficient response.

Course Outcomes:
After the completion of this course, the students will be able to:

OESS-01.1 Critically analyse the key concepts of security from Indian view.
OESS-01.2 Have in-depth knowledge of Indian security objectives, interests and problems.
OESS-01.3 Identify the growing internal and external national security challenges.
OESS-01.4 Develop a better understanding about the Indian defence mechanism.

Note: Attempt any four questions out of the eight questions. All questions carry equal marks.

Unit-I Key Concepts of Security : National Power and National Security, Balance of Power, Regional Security, Collective Security, Comprehensive Security, Common Security, Equal Security, Non Alignment, Neutrality.

Unit-II Problems of India's Security: The Conceptual Framework- Global, Regional and Local environment and its impact on Security thinking**. –**National Security Objectives: Core Values, National Interests.

Unit –III Challenges to Indian Security: Individual, Sub – National; National, Regional and International Levels.

Unit- IV National Security Organizations in India: Higher Defence Structure in India, National Security Council, Para – Military and Civil Defence.

Suggested Readings

Gautam Sen	Conceptualizing Security for India in the 21st Century, Atlantic Publishers & Distributors, New Delhi ,2007.
Prabhakaran Paleri	National Security: Imperatives and Challenges, : Tata McGraw-Hill Pub. Co.New Delhi 2008.
J. N. Chaudri	India's Problems of National Security, United Service Institution of India, 1973
K. Subramaniam	India's Security perspectives, ABC Publishing House, 1982
Kanti P. Bajpai & Harsh V. Pant (Author, ed.)	India's National Security: A Reader (Critical Issues in Indian Politics), Oxford 2013
Rahul K.Bhonsle	India- Security Scope 2006: The New Great Game Kalpaz Publication, (Delhi 2006)
R.S. Yadav	Bharat Ki Videsh Niti (In Hindi), Pearson, New Delhi, 2013
R.S. Yadav &	India’s Foreign Policy: Contemporary Trends, New Delhi, Shipra, 2009
R.S. Yadav (ed.)	India’s Foreign Policy Towards 2000 A.D., New Delhi.
Deepak & Shrikant Paranjpe (ed.)	India' s Internal Security : Issues and Perspectives (Kalinga, New Delhi,2009)
Sujeet Samaddar.	Defence Development and National Security: Linkages in the Indian Context. (Gyan Publishing House. New Delhi 2005).
Shrikant Paranjpe	India's Internal Security: Issues and Perspectives

Mapping Matrix of Course OESS – 01

<u>Mapping:</u> Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

<u>Table 1: Scale of mapping between COs and POs</u>

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: <u>(CO-PO Mapping Matrix)</u>

Table 2 shows the CO-PO mapping matrix for a course (OESS–01) assuming that there are 12 POs and 4COs.

<u>Table 2: CO-PO Matrix for the Course OESS– 01</u>

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
OESS-01.1	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
OESS-01.2	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
OESS-01.3	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
OESS-01.4	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
Average	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**2**	**3**

Note: *It is not necessary that each CO has a correlation with all the POs.*

Mapping of Course Outcomes to Programme Specific Outcomes: <u>(CO-PSO Mapping Matrix)</u>

Table 3 shows the CO-PSO mapping matrix for a course (OESS–01) assuming that there are 4 PSOs and 4COs.

<u>Table 3: CO-PSO Matrix for the Course OESS – 01</u>

CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
OESS-01.1	**3**	**3**	**3**	**2**
OESS-01.2	**3**	**3**	**3**	**2**
OESS-01.3	**3**	**3**	**3**	**2**
OESS-01.4	**3**	**3**	**3**	**2**
Average	**3**	**3**	**3**	**2**

Semester- III
DSS(C) - 11, Defence Economics-I

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper pertains to the determinants of economic potential linked to defence and development. To provide a frame work of knowledge relating to the concepts and practice of Economics in Indian context and to make the students understand the application of Economic principles in the strategic sector. Also, to provide insight on the most pressing issue Defence Production, Defence Expenditure and the right size of Defence Budget.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-11.1 Understand the relevance and thought of classical economic thinkers.
DSS(C)-11.2 Comprehend the economic impacts of war.
DSS(C)-11.3 Have comprehensive understanding of economic warfare and the concept of defence budgeting.
DSS(C)-11.4 Understand the effects of war on national economy.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Defence Economics: Meaning, Definition, Scope and Relevance; and The Economic Foundation of Military Power: Theories of Adam Smith and Alexander Hamilton.

Unit: II Economic Impacts of War. Economic Mobilization in War, War potential of a Nation (resources of war) - Natural, Physical, Industrial and Man power resources; and Economic control during war.

Unit: III Economic Warfare-Definition, Scope and Nature; Defence Budget: Definition, Scope, Determinants/Principles, Structure and Processes.

Unit: IV War and Peace Economy; Effect of War on National Economy (Problems of Inflation, Balance of Payment and Real Cost); and Economic Impact of Defence Expenditure.

Suggested Readings

Aggarwal, A.N.	Economic Mobilization for Defence.
Aggarwal, R.K.	Defence Production and Development.
Clark, J.J.	The New Economics of Nations Defence.
Hatfield, Marko	The Economics of Defence, Newyork; Praeger Publishers.
Hitch, G.J. & Mckean	The Economics of Defence in the Nuclear age.
Jack, D.T.	Studies in Economic Warfare.
Knor, Klaus	War Potential of the Nations.
Pandey, S.P.	Defence Economics Allahabad; Bhanumati Publication.
Robinson, L.R	The Economic Problems in War & Peace.
Singh Jasjit	India's Defence Spending.
Ludra, K.S.	Understanding War: its implications and effects.
J. N. Sharma	Defence Expenditure.
Narang, S.C.	A handbook of defence economics.
Sinha, D.K.	War and Defence Economics.

Mapping Matrix of Course DSS(C)-11

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-11) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-11

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-11.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-11.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-11.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-11.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-11) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-11

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-11.1	3	3	3	2
DSS(C)-11.2	3	3	3	2
DSS(C)-11.3	3	3	3	2
DSS(C)-11.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 12
Psychological Dimensions of War

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: Military psychology is the research, design, and application of psychological theories and empirical data towards understanding, predicting, and countering behaviours in friendly and enemy forces, or in civilian populations. There is particular emphasis on behaviours that may be undesirable, threatening, or potentially dangerous to the conduct of military operations. Military psychology utilizes multiple psychology sub-disciplines to encourage resiliency among military troops and counteract enemy forces for military victories.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-12.1 Understand the significance of military psychology and psychological factors of war.
DSS(C)-12.2 Learn the importance of psychological weapons and emotional problems of war.
DSS(C)-12.3 Understand the military leadership and problems of war neurosis.
DSS(C)-12.4 Acquire analytical skills to identify various human qualities in armed forces.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Military psychology-Definition, scope and significance during peace and War; and Psychological factors in Conventional, Nuclear, Biological and Chemical Warfare.

Unit: II Psychological Weapons of War: Propaganda, Rumor and Indoctrination; and Emotional Problems and Adjustments during War and Peace. Fear and Panic in war: Causes, Consequences and Management

Unit: III Military Leadership: Meaning, Attributes, Importance and Role of Training; and Discipline: Definition, Purpose and Tools of Maintaining Discipline. War Neurosis: Meaning, Causes, Symptoms and Effects.

Unit: IV The Significance of Personality: Traits, Group-Behavior and Communication Skills in Armed Forces; and Motivation & Morale and their Relevance in the Armed Forces.

Suggested Readings:

Bartlett, F.C.	Psychology and the Soldier, Cambridge, Cambridge University Press.
Baynes, John	Morale:A study of Men and courage London, Cassell, 1967.
Boring. E.G(ed.)	Psychology for the Armed Services, Dehradun, Natraj Publishers.
Chibber, M.L.	Military Leadership to Prevent Military Coup, New Delhi, Lancer International.
Copeland, Norman	Psychology and the soldier, Dehradun, English book Depot, 1967.
Gupta, Col.Ranjit Sen (Retd.)	Management of Internal Security, New Delhi, Lancer Publications, Pvt. Ltd., 1994.
Hasnain, Qmar	Psychology for the fighting man, Dehradun, English Book Depot, Publishing Company, 1967.
Lienbarger, P.M.A.	Psychological Warfare, Washington, D.C. Combat Press, 1954.
Likert, Rensis and J.B. Likert	New ways of managing conflict, New-York, Mac Graw Hill Book Company.
Raj Narain	Military Psychology, Agra: national Psychological Co-operation 1st Edition, 1979.
Rajender Nath	Military Leadership in India form Vadic time to Indo-Pak War.
Maheswari, Nidhi	Military psychology(Sanay manovigyan)
Maheswari, Nidhi	Military Psychology: Concepts, Trends and Interventions
Kumar, Updesh	The Routledge International Handbook of Military Psychology and Mental Health
Janice H. Laurence	The Oxford Handbook of Military Psychology

Mapping Matrix of Course DSS(C)-12

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and Pos

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)
Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-12) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-12

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-12.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-12.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-12.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-12.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)
Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-12) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-12

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-12.1	3	3	3	2
DSS(C)-12.2	3	3	3	2
DSS(C)-12.3	3	3	3	2
DSS(C)-12.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 13
Area Studies-Pakistan

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper dwells on military geography, politics, defence policy and security problems of Pakistan besides focusing on its relations with regional and extra regional powers. This paper introduces the students to all the geographical and strategic factors of Pakistan. Pakistan is bordered by India to the east, Afghanistan to the northwest and Iran to the west while China borders the country in the northeast. The nation is geopolitically placed within some of the most controversial regional boundaries which share disputes and wars with neighbours.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-13.1 Understand the basic concept of area studies and military geography of Pakistan.
DSS(C)-13.2 Acquire knowledge about Pakistan and role of military in politics of Pakistan.
DSS(C)-13.3 Understand the determinants of Pakistan's foreign and defence policy.
DSS(C)-13.4 Examine the relation of Pakistan with its neighbours.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Military Geography of Pakistan- Its Geo-Strategic Significance; and Population, Composition and Characteristics of Major Ethnic Groups. Nuclear and Defence Potential of Pakistan.

Unit: II Pakistan's Politics and Role of Military; and Internal Security Factors in Pakistan. Areas of Conflict and Cooperation between India and Pakistan.

Unit: III Determinants of Foreign and Defence Policy of Pakistan; and Role of United States of America in Pakistan's Politics.

Unit: IV Pakistan's Relations with its Neighbhours China, India, Afghanistan and Iran; and Pakistan and Terrorism- The Emerging Manifestations.

Suggested Readings

Jai Parkash Sharma	Federal systems of India and Pakistan: A comparative perspective, Printwell Publishers: Jaipur,j India: 1987.
Jagdish P Jain China,	Pakistan, and Bangladesh, Radiant Publishers, New Delhi, 1974.
Saeed Shafqat (ed.)	Contemporary issues in Pakistan studies, Lahore: Azad, 1998.
K.K. Bhardwaj	Pakistan's March to Democracy and Liberalism, Anmol Publications, New Delhi, 1999.
Rajvir Singh	U.S.- Pakistan and India: Strategic relations, Chugh Publications, Allahabad, 1985.
Sahdev Vohra	Fifty Years of Pakistan, Intellectual book Corner, New Delhi, 1998
Verinder Grover & Ranjana Arora,(eds.)	50 years of Indo-Pak relation, (3 Vols), Deep & Deep Publications, New Delhi, 1998.
Jaswinder Kumar	Irritants in Indo-Pak relation, Deep & Deep Pub., New Delhi, 1989
B.P. Barua	Politics and constitution-making in India and Pakistan, Deep & Deep Publications, New Delhi, 1984
Shuja Nawaz	Crossed Sword- Pakistan, its Army, and the Wars within, Oxford University Press, New York, 2008
Bidanda M.Chengappa	Pakistan: Islamisation, army and foreign policy, A.P.H. Publications, New Delhi, 2004
E. Sridharan	The India-Pakistan Nuclear Relationship: Theories of Deterrence and International Relations, Routledge, 2007
Rizwan Zeb, & Suba Chandran	Indo-Pak Conflicts, Cambridge University Press, 2005
Kapil Kak,A.Matto& Happymon Jacob(eds)	India & Pakistan: Pathways Ahead, K W Publishers, NewDelhi,2007
Gurmeet Kanwal	Pakistan's Proxy War, Lancer Publishers, 2002

Mapping Matrix of Course DSS(C)-13

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-13) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-13

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-13.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-13.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-13.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-13.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-13) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-13

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-13.1	3	3	3	2
DSS(C)-13.2	3	3	3	2
DSS(C)-13.3	3	3	3	2
DSS(C)-13.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 14
Science & Technology in Relation to Warfare-I

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The objective of this paper is to introduce the social science student to the developments in science and technology that have had an impact on the approaches to security over the ages. The changes in weapon systems and the method of warfare that come about due to innovations in science and technology are sought to be introduced in the course on Science, Technology and war. Science is linked with the warfare by research funding, the direction of technological change, the criteria for important scientific problems and the structure of the scientific community.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-14.1 Acquire comprehensive knowledge of impact of science and technology on war.
DSS(C)-14.2 Understand the relevance of science and technology in national security.
DSS(C)-14.3 Acquire comprehensive knowledge of role of dual use of critical technologies and transfer of technology.
DSS(C)-14.4 Examine implications of the India's growing nuclear power and space technology.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Impact of Science and Technology on warfare; and Relationship between Technology and Weapon Systems.

Unit: II Relevance of Science and Technology in National Security. Impact of Emerging Technologies on Strategy and Tactics; and Military Technology and its Impact on Land, Sea and Air-Power.

Unit: III Dual Use of Critical Technologies and its Impact on India's Security. International Inter-Dependence and Transfer of Technology; and Political, Military and Economic Impact of Transfer of Technology.

Unit: IV Growth and Development of Nuclear Power in India; and Growth and Development of Space Technology in India.

Suggested Readings

Deva, Yashwant	Duel-use of Information Technology (An Indo Centric perspective): New Delhi, IDSA, 1996.
Hard, David	Nuclear power in India: London, George Allen.
Jayant Baranwal	S.P's Military year book: New Delhi, Guide Publishers, 1983.
John Ericson	The Military Technical revolution: Its impact on strategy and foreign policy: New York, Frederic A Prager, 1996.
Khana, S.K	India: a Nuclear Power: New Delhi, Commonwealth Publishers, 1998.
Lal, A K	Space warfare and Military strategy. (An Indian Perspective): New Delhi, USI of India, 2003.
Rajan, Y.S.	Empowering India (with Economic, Business and Technology, Strengths for the twenty first century): New Delhi, Har Anand, 2001.
Sen, S.K.	Military Technology and Defence Industrialization: New Delhi, Manas Publishers, 2000.
Siddhartha, K.	Oceanography, A brief introduction 3rd edition: New Delhi, Kisalaya Publishers, 1999.
Tellis, A.	India's Emerging nuclear posture: Oxford, Oxford University Press, 2001.
Tiwari, V.M	The High-Tech War of twentieth century: New Delhi, Vika Publishers House, 1996.
Thee, Marek	Military technology, Military Strategy and Arms Race: London, Groom Helm, 1986.
Ghosh, C N	Tomorrows War:21st Century Defence Strategies, Manas Publications. NewDelhi, 2011.
Ahmed, Asif	Science Technology and War, Twenty First Century Publications, Patiala, 2014.

Mapping Matrix of Course DSS(C)-14

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)
Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-14) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-14

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-14.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-14.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-14.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-14.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)
Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-14) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-14

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-14.1	3	3	3	2
DSS(C)-14.2	3	3	3	2
DSS(C)-14.3	3	3	3	2
DSS(C)-14.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 15
International Law –I

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: This paper aims at introducing the students to different aspects of International Law. The laws which govern the conduct of war, Laws of neutrality, Intervention and the Settlement of International Disputes covered in this paper. This course intends to enhance the knowledge and skills of the students with the legal aspects of International Security.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-15.1 Grasp the nature, basis and sources of International law.
DSS(C)-15.2 Examine the subjects of international law and its relationship with municipal law.
DSS(C)-15.3 Understand the Intervention, State Territory and Law of the Seas.
DSS(C)-15.4 Acquire comprehensive knowledge about the pacific and coercive means of settlement of international disputes and international law regarding weapons of mass destruction.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Definition, Nature, Basis and Sources of International Law. Treatment of Aliens; Asylum; and Extradition.

Unit: II Relationship between International Law and Municipal Law; and Subjects of International Law.

Unit: III Intervention – Meaning and Grounds; State Territory and Modes of Acquisition and Loss of Territory; and Law of the Seas.

Unit: IV Pacific and Coercive Means of Settlement of International Disputes; and International Law Regarding Weapons of Mass Destructions (WMDs)

Suggested Readings

J.G. Starke	Introduction of International Law (10th ed), Aditya Books, New Delhi, 1994.
Oliver J, Lissitgyn	International Law- Today and tomorrow, Debbs Ferry, New York, 1965.
Perry E. Corbett	The Growth of World Law, Princeton, New Jersey, USA, 1971
W. Friedmann	Changing Structure of International Law, Steven & Sons, London, UK, 1964.
Aggrawal, S.K., (ed)	Essays on the Law of Treaties.

Anand, R.P	New States and International Law, Vikas Publications, New Delhi, 1972
Rhyue, O.R	International Law.
S.K. Kapoor	International Law, Central Law Agency, Allahabad, 1992
C. Wilfred Jenks,	The Common Law of Mankind", Stevens & Sons, London, UK, 1958
W. F Friedmann,	Changing Structure of International Law", Steven & Sons, London, UK, 1964
M.A. Kaplan and Node B. Katzenback	The Political foundations of International Law", John Wiley & Sons, London, UK, 1961
Dr. Nagendra Singh	India and International Law", S. Chand & Co., New Delhi, 1969

Mapping Matrix of Course DSS(C)-15

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-15) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-15

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-15.1	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
DSS(C)-15.2	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
DSS(C)-15.3	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
DSS(C)-15.4	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**
Average	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-15) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-15

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-15.1	**3**	**3**	**3**	**2**
DSS(C)-15.2	**3**	**3**	**3**	**2**
DSS(C)-15.3	**3**	**3**	**3**	**2**
DSS(C)-15.4	**3**	**3**	**3**	**2**
Average	**3**	**3**	**3**	**2**

OESS 11
Global Security Concerns

Maximum Marks – 50 (Two Credits)
Time – 2 Hours

Objective: This paper is aimed to explore both the modern security issues of the global community and the efforts to prevent problems and maintain security. There are many security issues that the world will have to face as a global community from terrorism to drug trafficking to border disputes and arms & nuclear proliferation to climate change etc. It analyses that help students to understand political, military, and economic trends around the world; the sources of potential regional conflict; and emerging threats to the global security environment.

Course Outcomes:
After the completion of this course, the students will be able to:

OESS-01.1 Critically analyse the key concepts of security from global view.
OESS-01.2 Have in-depth knowledge of international strategic environment after cold war.
OESS-01.3 Examine the growing challenges faced by UN system and need of reforms.
OESS-01.4 Develop a better understanding about the International and regional security organizations and arrangements.

Note: Attempt any four questions out of the eight questions. All questions carry equal marks

Unit-I The Issue of Global Security in the New Century: Basic Ideas, Weapons of Mass Destruction and Global Security and International Terrorism
Unit-II End of Cold War and emergence of New World Order. Nuclear Proliferation & NPT, CTBT, MTCR, NMD.
Unit-III U.N.O. – World Peace and Security, Challenges to the UN System**:** Reform and Restructur ing**.**
Unit-IV International and Regional Security Organizations**:** Military Alliances and Pacts, Peace Treaties, Defence Cooperation, Strategic Partnership and Security Dialogue.

Suggested Readings

K.P.Saksena Reforming the United Nations (New Delhi: Sage, 1993).

M.S.Rajan World Order and the United Nations (New Delhi: Har Anand, 1995).

P. M. Kamath Reforming and Restructuring the United Nations, New Delhi, Anamika Publishers & Distributors (P) Ltd, 2007.

Ramesh Thakur Global Governance and the UN: An Unfinished Journey, Indiana University Press, 2010.

Rumki Basu The United Nations: Structures and Functions of an International Organization, New Delhi: Sterling Publishers Pvt. Ltd., 1994.

Sean Kay Global Security in the Twenty-First Century: The Quest for Power and the Search for Peace, Rowman & Littlefield, 2015.

Stephen Aris, and Regional Organisations and Security : Conceptions

Andreas Wenger(Ed.)	Practices, Taylor & Francis, 2015.
SJR Bilgrami	International Organination, (New Delhi: Vikas, 1983).
Sugatha Ramcharrit	United Nations and World Politics (New Delhi: Kaniksha, 1998).
Thomas G. Weiss & Ramesh Thakur	The United Nations, Peace and Security: From Collective security to the Responsibility to Protect, Cambridge University Press, 2006.
Vincent Pouliot	International Security in Practice: The Politics of NATO-Russia Diplomacy, Cambridge University press, 2010
Werner Feld, Robert--Jordan, and Leon Hurwitz(eds.,)	International Organizations: A Comparative Approach, Praeger, Michigan, 1988.

Mapping Matrix of Course OESS – 11

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (OESS–11) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course OESS – 11

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
OESS-11.1	**3**	**3**	**3**	**-**	**-**	**3**	**2**	**3**	**3**	**2**	**2**	**3**
OESS-11.2	**3**	**3**	**3**	**-**	**-**	**3**	**2**	**3**	**3**	**2**	**2**	**3**
OESS-11.3	**3**	**3**	**3**	**-**	**-**	**3**	**2**	**3**	**3**	**2**	**2**	**3**
OESS-11.4	**3**	**3**	**3**	**-**	**-**	**3**	**2**	**3**	**3**	**2**	**2**	**3**
Average	**3**	**3**	**3**	**-**	**-**	**3**	**2**	**3**	**3**	**2**	**2**	**3**

Note: *It is not necessary that each CO has a correlation with all the POs.*

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (OESS–11) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course OESS – 11

CO	PSO 1	PSO 2	PSO 3	PSO 4
OESS-11.1	**3**	**3**	**3**	**3**
OESS-11.2	**3**	**3**	**3**	**3**
OESS-11.3	**3**	**3**	**3**	**3**
OESS-11.4	**3**	**3**	**3**	**3**
Average	**3**	**3**	**3**	**3**

Semester- IV
DSS(C) – 16
Defence Economics-II

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: To provide a frame work of knowledge relating to the concepts and practice of Economics in the field of defence. It helps to make the students understand about the Contemporary Economic Systems. Also, to provide insight on the most pressing issue defence and development and economic constraints in defence management.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-16.1 Understand the contemporary economic systems.
DSS(C)-16.2 Evaluate the concept of defence and development and its implications for India.
DSS(C)-16.3 Examine the Indian defence policy and defence management from economic viewpoint.
DSS(C)-16.4 Understand the India's policy on defence production.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Contemporary Economic Systems: Capitalism, Socialism and Mixed Economy.

Unit: II Defence and Development: Concept and its Implications for India; and Determinants of Defence Expenditure: Threat Perceptions, Capabilities and Policies. Contemporary Trends in India's Defence Expenditure.

Unit: III Economic Constraints in Defence Management; Economic Implications of Technological Changes with Reference to Defence Production in India: The Rationale for Self – Reliance and Problems of Imported Technology in Defence Production.

Unit: IV India's policy on Defence Production: Department of Defence Production, Ordnance Factories and Defence Public Sector Undertakings (DPSUs); and Role of Private Sector in Defence Production. Defence Production of the following in India: Armament, Ammunition and Explosives, Tanks and Infantry Combat Vehicles, Air-Crafts, Naval Ships and Missiles.

Suggested Readings

Chatterji, Manas	Arms Spending development and security, New Delhi; APH Publishing corporation.
Deger, Saadet	Military Expenditure in Third World Countries.
Downey, John	Management in the Armed Forces, McGraw-Hill Inc.,US
Ghosh, Amiya Kumar	India's Defence Budget and Expenditure Management, New Delhi; Lancer Publications.
Jalan, B	India's Economic Policy- Preparing for 21st century.
Thingan, M.L.	The Economic of Development and Planning; Delhi; Vrinda Pub. Ltd.
Mathews, Ron	Defence Production in India.
Mckinlay, Robert	Third World Military Expenditure, London: Pinter Pub.
Prasad, Bisheshwar	India War Economy.
Subrahmanyam K.	Perspective in Defence Planning.
Thomas, Raju G.C.	The Defence of India, A budgetary perspective of Strategy & Politics.
Vohra, Bharat	Defence Economics, Sumit Enterprises.New Delhi.2010.

Mapping Matrix of Course DSS(C)-16

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-16) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-16

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-16.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-16.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-16.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-16.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-16) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-16

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-16.1	3	3	3	2
DSS(C)-16.2	3	3	3	2
DSS(C)-16.3	3	3	3	2
DSS(C)-16.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 17

Sociological Dimensions of War

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper aims to acquaint the students with the military as a social group rather than as an organization. This highly specialized sub-discipline examines issues related to service personnel as a distinct group with coerced collective action based on shared interests linked to survival in vocation and combat, with purposes and values that are more defined and narrow than within civil society. It also concerns civil-military relations and interactions between other groups or governmental agencies.

Course Outcomes:

After the completion of this course, the students will be able to:

DSS(C)-17.1 Develop an unique understanding about military sociology and sociological dimensions of war.

DSS(C)-17.2 Understand the post-war social problems and its impact on society and military.

DSS(C)-17.3 Analyze civil military relations and develop analytical skill to strengthen the relation.

DSS(C)-17.4 Examine the social background of military personnel and the changing role of women in armed forces.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Sociology of War: Social Causes of War, Social Mobilization for War; and Social Effects of War: Adjustments and Emotional Problems during War, Social Aspects of Victory, Defeat and Occupation.

Unit: II Post-War Social Problems: Impact on Society (Problem of re-settlement of War Victims and Post-War Reconstruction), Impact on Military (Demobilization, Rehabilitation and Social Adjustment of Released Personnel) and Social Problem of Military Personnel (Killed or Disabled and Implications for their Families).

Unit: III Civil-Military Relations: History and Contemporary Trends; Military Coup: Causes and Consequences; and Civil-Military Relations in India.

Unit: IV Social Background of Military Personnel in India; and Problems of Ex-Servicemen in India. Women & Armed Forces: Role, Limitations, Impact and Contemporary Trends.

Suggested Readings:

Alix Stracheys	The Unconscious Motives of War, London, Allen, 1957.
Anil Kumar Singh	Military and Media, New Delhi, lancer Publishers & Distributors, 2006.
C.W. Mills	The Power Elite, New York, Oxford University Press, 1959.
D. Feld Maury	Structure of violence: Armed forces as social systems, New Delhi, Sage Publications, 1977.
Eric A. Nordlinger	Soldiers in Politics: Military Coups and Governments, London, Prentic-Hall, 1977.
J.A. Khan	Indian Armed Forces and Society, (Set Of 2 Vols.) 2006.
Jacques Van Doorn, (edit)	Armed Forces and Society: sociological Essays, Mouton, 1968.
Johnson John (edit)	Race, Class & Military: The role of the Military in Under-Developed Countries, Princeton, Princeton University Press, 1962.
Morris Janowitz	The Professional Soldier. A Social and Political Portrait New York, Free Press, 1964.
Leena Parmar (Ed.)	Military Sociology:Global Perspectives, Rawat Publications. Jaipur & NewDelhi, 1999.
Leena Parmar	Society Culture and Military System, Rawat Publications. Jaipur & New Delhi.
Martinshaw (ed.)	War, State & Society, London, Macmillan Press 1984.
Asha Sougaijam	Military Sociology: Past, Present and Future.
E Ouellet (Ed.)	New Directions in Military Sociology.
Joseph Soeters	Sociology and Military Studies (Cass Military Studies) 1st Edition

Mapping Matrix of Course DSS(C)-17

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-17) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-17

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-17.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-17.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-17.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-17.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-17) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-17

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-17.1	3	3	3	2
DSS(C)-17.2	3	3	3	2
DSS(C)-17.3	3	3	3	2
DSS(C)-17.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 18
Area Studies – China

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: The paper focuses on geography and history of China with special emphasis on its defence policy, strategy, military modernization plans and relations with other countries. The paper also explores areas of conflict and co-operation between China and India as well as China's relations with the US and Pakistan. The nation is geopolitically placed within some of the most controversial regional boundaries which share disputes and escalated military tensions with many other states.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-18.1 Understand the geo-strategic significance of China.
DSS(C)-18.2 Acquire comprehensive understanding of China's foreign policy.
DSS(C)-18.3 Examine the China-India relations after independence.
DSS(C)-18.4 Have understanding of China's with USA and Pakistan.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Military Geography of China- Its Geo-Strategic Significance; and Population, Composition and Characteristics of Major Ethnic Groups.

Unit: II Peoples Liberation Army (PLA): Origin, Organization, Structure and Process; and Foreign Policy of China; Objectives and Determinants.

Unit: III Areas of Conflict and Cooperation between China and India with Special Reference to Sino-Indian War of 1962.

Unit: IV China's Relations with United States of America and Pakistan. China's Nuclear and Defence Potential; and China's Strategic Postures towards India.

Suggested Readings:

Susant Shirk	China- Fragile Superpower, Oxford University Press, New York, 2007.
Alka Acharya	China and India- Politics of Incremental Engagement, Har-Anand Publications, New Delhi, 2008.
Ravi Vohra P.K. Ghosh(eds)	China and the Indian Ocean region, National Maritime Foundation, Anamaya Publishers, New Delhi, 2008.
B.R. Deepak	India- China Relations: In the first half of the 20th Century, APH Publishing House, New Delhi, 2001.
Dinesh Lal	Indo-Tibet-China Conflict, Kalpaz Publications, New Delhi, 2008
Vishun Saraf	India and China: Comparing the Incomparable, Macmillan Publishers India, 2008.
R.V. Kumar	Chinese Air Force threat: An Indian Perspective, Manas Publication, New Delhi, 2003.
M.L. Sali	India- China Border dispute: A case study of Eastern Sector, A.P.H. Publishing, New Delhi, 1998.
John R.R. Faust Judith F. Kornberg	China in World Politics- Policies Processes and Prospects, Lynne Rienner Publishers, Boulder, USA, 1995.
C.K. Kapur	Chinese Military Modernization, Manas Publications New Delhi, 2003.
Andrew Scobell	China's Use of Military Force, Cambridge University Press, New York, 2003.
Jasjit Singh (ed)	India, China and Panchsheel, Sanchar Publication House, New Delhi, 1996.
T.R. Tregear	A Geography of China, Routledge; 2007.
Liu Xuecheng	The Sino-Indian border dispute and Sino-Indian relations, University Press of America, 1994.
Immanuel C.Y. Hsu	Rise of modern China, Oxford University Press, New York, 2000.
Shen Qurong & Bhabani Sengupta (eds),	China looks at the World, Konark Publisher Pvt. Ltd. Delhi, 1999.

Mapping Matrix of Course DSS(C)-18

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-18) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-18

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-18.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-18.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-18.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-18.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-18) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-18

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-18.1	3	3	3	2
DSS(C)-18.2	3	3	3	2
DSS(C)-18.3	3	3	3	2
DSS(C)-18.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 19
Science & Technology in Relation to Warfare-II

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: Military technology often seems to be the dark side of innovation but need a lot of serious attention and proper study as an evil genius. Military machines and instruments can nonetheless be understood using the same concepts and categories that scholars apply to technology in general. This can help demystify the arcane and often secretive world of military research and development and also clarify the impact on society of all complex technological systems. It offers students a set of conceptual tools for thinking about change in warfare over time and the role that technological innovation has played in that process. It has made war more terrible than it ever was before.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-19.1 Comprehend the role of revolution in military affairs.
DSS(C)-19.2 Understand the concept and application of electronic warfare and information warfare.
DSS(C)-19.3 Analyze the new technologies and their relevance to modern security systems.
DSS(C)-19.4 Acquire knowledge about the DRDO and Ocean technology in India.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I Revolutions in Military Affairs (RMA); and Impact of RMA on Indian Defence.

Unit: II Electronic Warfare- Concept and Application; and Information Warfare- Concept, Application and Implications.

Unit: III New Technology and their Relevance to Security Systems- Rockets, Bio-Technology, LASERS/Satellite, Cyber, Missiles, Bio-Metrics, Stealth and NMD.

Unit: IV Growth and Development of Ocean Technology in India; and India's Achievements, Problems and Limitations in Ocean Technology. Defence Research and Development Organization (DRDO): Objectives, Achievements and Limitations.

Suggested Readings

B.S. Nanda,	Science Technology in India's Transformation, New Delhi, Concept, 1986.
Asian Productivity Organization	Intra-national Transfer of Technology, Asian Productivity Organization, 1976.
D.M. Desoutter	Aircraft and Missiles: What They are, What They Do and How They Work, London, Faber, 1989.
G.D. Bakshi	War in the 21st Century, Delhi, Lancer Publisher, 1997.
Gerald Wendt	Prospects of Nuclear Power and Technology, Van Nostrand, 1957.
Iqtidar Alam Khan	Gunpowder and firearms, Warfare in Medieval India, New Delhi, Oxford University Press, 2004.
J.N. Nanda	Science and Technology in India's transformation.
Jayanta Kumar Ray	Security in the missile age, University of Michigan, 2006.
Macacy Kannets	Technology in World Arms and Armour, London, 1961.
Michael O. Hanlon	Technology Change and the Future of Warfare, (New Delhi, Manas Publication, 2005).
Paul Leventhal, Sharon Tanzer and Steven Dolley,	Nuclear Power and The Spread of Nuclear Weapons: can we have one without the other?, Brassey's, 2002.
R.K. Suri, T.N. Chhabra	Cyber Crime, New York, Pentagon Press, 2004.
R.L. Jetley	Rockets, guided missiles and satellites.
Samir K. Sen	Military Technology and Defence Industrialization, New Delhi, Manas Publication, 2000.
Asif Ahmed	Science Technology and War, Twenty First Century Publications, Patiala, 2014.
Thomas & Hamnas	On War in the 21st Century, Delhi, Manas Publications, 2004.

Mapping Matrix of Course DSS(C)-19

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: **(CO-PO Mapping Matrix)**

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-19) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-19

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-19.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-19.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-19.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-19.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: **(CO-PSO Mapping Matrix)**

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-19) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-19

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-19.1	3	3	3	2
DSS(C)-19.2	3	3	3	2
DSS(C)-19.3	3	3	3	2
DSS(C)-19.4	3	3	3	2
Average	3	3	3	2

DSS(C) – 20
International Law-II

Credits:04

Max. Marks: 100
Internal Assessment : 20
External Marks: 80
Time: 3 Hours

Objective: This paper aims at introducing to the students different aspects of International Law. The laws which govern the conduct of war, Laws of neutrality and the organization of the International court of Justice are covered in this paper.

Course Outcomes:
After the completion of this course, the students will be able to:

DSS(C)-20.1 Examine war and Its Legal Character and human rights.
DSS(C)-20.2 Understand the significance of the laws of land, air and sea warfare.
DSS(C)-20.3 Understand the war crimes, different trials and concept of neutrality.
DSS(C)-20.4 Acquire knowledge about the rights of angary, belligerent and concept of continuous voyage.

Note: The question paper will consist of nine questions. The candidate shall attempt five questions in all. Question No. 1 will be compulsory. The compulsory question will consist of four short answer type conceptual/thematic questions of equal marks (i.e. 4 marks each) spread over the whole syllabus. The Candidate shall attempt four more questions selecting at least one from each Unit. Each question will carry 16 marks.

Unit: I War: Its Legal Character and Effects; Enemy Character; Genocide and Human Rights.

Unit: II Laws of War: Land, Air and Sea. Blockade. Prize Court.

Unit: III War Crimes and Different Trials- Tokyo, Nuremberg and Milosevic; Termination of War; Neutrality: Concept and Evolution; and Rights and Duties of Neutral States.

Unit: IV Right of Angary; Contraband and Doctrine of Continuous Voyage; Belligent Rights of Visit & Search.

Suggested Readings:

Brownline	Principles of Public International Law, Oxford, Clarendon Press, 1973, Second Edition.
C.G. Fenwick	International Law, Bombay, Vakils, 1971.
J.G. Starke	An Introduction to International Law, London, Butterworths, 1972.
P.E. Corbett	Law and Diplomacy, Princeton NJ, Princeton University Press, 1959.
K. Deutsc and S. Hoffman (ed.)	The Relevance of International Law, Oxford, Clarendon Press, 1955.
L. Duguit	Law in the Modern State, New York, B.W. Huebsch, 1919.
W. Friedmann	The Changing Structure of International Law, New York, Columbia University Press, 1964.
H. Kelsen	Principles of International Law, New York, Rinehart and Co., 1952.
J. Mattern	Concepts of State, Sovereignty and International Law, Baltimore, Johns Hopkins Press, 1928.
L. Oppeheimer	International Law Vol. 1, 1969, Revised edn., Vol II, 1953.
J. Stone	Legal Controls of International Conflict, New York, Rinehart and Company, 1954.
C. de Visscher	Theory and Reality in Public International Law, Princeton NJ, Princeton University Press, 1957.
Sir J.F. Williams	Aspects of Modern International Law, New York, Oxford University Press, 1939.
Bimal N. Patel	National Security of India and International Law.
Leslie Green	The Contemporary Law Of Armed Conflict.
Travers McLeod	Rule of Law in War, Oxford University Press. 2015.

Mapping Matrix of Course DSS(C)-20

Mapping: Mapping is a process of representing the correlation between COs and POs, COs and PSOs in the scale of 1 to 3 as follows (Table 1):

Table 1: Scale of mapping between COs and POs

Scale	
1	If the contents of course have low correlation (i.e. in agreement with the particular PO to a small extent) with the particular Programme outcome
2	If the contents of course have medium correlation (i.e. in agreement with the particular PO to a reasonable extent) with the particular Programme outcome
3	If the contents of course have strong correlation (i.e. in agreement with the particular PO to a large extent) with the particular Programme outcome

Same scale may be used to define the correlation between Cos and PSOs

Mapping of Course Outcomes to Programme Outcomes: (CO-PO Mapping Matrix)

Table 2 shows the CO-PO mapping matrix for a course (DSS(C)-20) assuming that there are 12 POs and 4COs.

Table 2: CO-PO Matrix for the Course DSS(C)-20

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
DSS(C)-20.1	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-20.2	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-20.3	3	3	3	3	2	3	2	2	3	3	2	3
DSS(C)-20.4	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	3	3	3	2	3	2	2	3	3	2	3

Note: It is not necessary that each CO has a correlation with all the POs.

Mapping of Course Outcomes to Programme Specific Outcomes: (CO-PSO Mapping Matrix)

Table 3 shows the CO-PSO mapping matrix for a course (DSS(C)-20) assuming that there are 4 PSOs and 4COs.

Table 3: CO-PSO Matrix for the Course DSS(C)-20

CO	PSO 1	PSO 2	PSO 3	PSO 4
DSS(C)-20.1	3	3	3	2
DSS(C)-20.2	3	3	3	2
DSS(C)-20.3	3	3	3	2
DSS(C)-20.4	3	3	3	2
Average	3	3	3	2

Scheme/Structure of the Programme B.Sc. with Mathematics as one subject

1. **Name of the Programme (Course): B.Sc.**
2. **Definitions/ Abbreviations:**

   1 credit=1 Hour Theory Lecture (L) per week
   1 credit= 2 Hours Practical (P) per week
   1 credit = 25 marks
   2 Hours = 3 periods of 45/40 minutes
   3 Hours = 4 periods of 45/40 minutes
   CC = Core Course
   DSC = Discipline Core Course
   AECC = Ability Enhancement Compulsory Course
   SEC = Skill Enhancement Course
   DSE = Discipline Specific Elective Course
   GE = Generic Elective

3. **One Batch(Practical Group) will consist of 15 students.**
4. **Scheme will be effective from the session 2020-21 in phased manner.**
5. **Each End Term Examination will be of three hours.**

Credit Distribution for Mathematics subject in the B.Sc. Programme

	Core Courses (CC)	Ability Enhancement Compulsory Courses (AECC)	Discipline Specific Elective Courses(DSE)	Skill Enhancement Courses(SEC)	Total Credits
Theory	24	-	8	4	36
Practical	8	-	4	-	12
Total	32	-	12	4	48

Semester wise Distribution of Credits in the subject of Mathematics

	First year Credit		Second year Credit		Third year Credit		Total Credits
	1st Sem	2nd Sem	3rd Sem	4th Sem	5th Sem	6th Sem	
Ability Enhancement Compulsory Courses (AECC)	-	-			-	-	-
Core Courses (CC)	8	8	8	8	-	-	32
Discipline Specific Elective Courses(DSE)	-	-	-	-	6	6	12
Skill Enhancement Courses(SEC)	-	-	2	-	2	-	4
Total	8	8	10	8	8	6	48

Contact hours for Mathematics subject in the B.Sc. Programme

	Core Courses (CC)	Ability Enhancement Compulsory Courses (AECC)	Discipline Specific Elective Courses(DSE)	Skill Enhancement Courses(SEC)	Total hours
Theory	24	-	8	4	36
Practical	16	-	8	-	24
Total	40	-	16	4	60

Program Outcomes (PO) for Under Graduate Programme (CBCS) in the Faculty of Sciences, Kurukshetra University, Kurukshetra

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO3	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO4	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO5	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO6	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO7	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO8	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout the life
PO9	Environment and Sustainability	Ability to design and developmodern systems which are environmentally sensitive and to understand the importance of sustainable development.
PO10	Ethics	Apply ethical principles and professional responsibilities in scientific practices
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

Program Specific Outcomes (PSO) for Under Graduate CBCS Programme in the subject of Mathematics

After successful completion of the programme, a student will be able to:

PSO1	Have basic understanding and knowledge in different core areas of Mathematics such as algebra, analysis, calculus, differential equations, mechanics, numerical analysis and in some of the other elective areas. Demonstrate understanding of the concepts /theories/methods from such areas of Mathematics.
PSO2	Have **a** broad background in Mathematics and develop the essential mathematical reasoning, knowledge, skills and aptitude to pursue further studies and research in Mathematics.
PSO3	Communicate mathematics effectively and precisely by written, computational and graphical means.
PSO4	Apply knowledge, understanding, methods, techniques and skills of Mathematics to analyse, evaluate and solve problems of Mathematics and/or the mathematical problems having applications in engineering/science/technology/life sciences/social sciences so as to enhance career prospects in different fields.

Scheme/Structure of the Programme B.Sc. with Mathematics subject w.e.f. the session 2020-21 in phased manner

Semester-I

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam. Hours
						Ext.	Int.	Total	
AECC-1		AECC Course-I		2					
Core Course Mathematics-I	B-MAT 101	Mathematics Theory Course 1	Calculus	3	3	60	15	75	3
	B-MAT102	Mathematics Theory Course 2	Algebra and Number Theory	3	3	60	15	75	3
	B-MAT103	Mathematics Practical Course 1	Practical-I	2	4	40	10	50	3
Core Course (Elective Discipline 1)-I									
Core Course (Elective Discipline 2)-I									

Semester-II

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam. Hours
						Ext.	Int.	Total	
AECC-2		AECC Course-II		2					
Core Course Mathematics-II	B-MAT 201	Mathematics Theory Course 3	Advanced Calculus	3	3	60	15	75	3
	B-MAT202	Mathematics Theory Course 4	Differential Equations	3	3	60	15	75	3
	B-MAT203	Mathematics Practical Course 2	Practical-II	2	4	40	10	50	3
Core Course (Elective Discipline 1)-II									
Core Course (Elective Discipline 2)-II									

Semester-III

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam Hours
						Ext.	Int.	Total	
AECC-3		AECC Course-III		2					
SEC-1	B-MAT 301	Mathematics/ Comp. Sc. Theory Course 5	Programming Skills with C	2	2	40	10	50	3
Core Course Mathematics-III	B-MAT 302	Mathematics Theory Course 6	Real Analysis -I	3	3	60	15	75	3
	B-MAT303	Mathematics Theory Course 7	Mechanics -I	3	3	60	15	75	3
	B-MAT304	Mathematics Practical Course 3	Practical -III	2	4	40	10	50	3
Core Course (Elective Discipline 1)-III									
Core Course (Elective Discipline 2)-III									

Semester-IV

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam Hours
						Ext.	Int.	Total	
SEC-2		SEC Course-II							
Core Course Mathematics -IV	B-MAT 401	Mathematics Theory Course 8	Abstract Algebra	3	3	60	15	75	3
	B-MAT402	Mathematics Theory Course 9	Numerical Analysis	3	3	60	15	75	3
	B-MAT403	Mathematics Practical Course 4	Practical IV	2	4	40	10	50	3
Core Course (Elective Discipline 1)-IV									
Core Course (Elective Discipline 2)-IV									

Semester-V

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam Hours
						Ext.	Int.	Total	
SEC-3 Mathematics	B-MAT 501	Mathematics Theory Course 10	Vector Calculus	2	2	40	10	50	3
	B-MAT 502		Special Functions						
Discipline Specific Elective-Mathematics-I	B-MAT 503	Mathematics Theory Course 11	Linear Algebra	2	2	40	10	50	3
	B-MAT 504		Partial Differential Equations and Integral Transforms						
	B-MAT 505	Mathematics Theory Course 12	Analytical Geometry	2	2	40	10	50	3
	B-MAT 506		Mechanics -II						
	B-MAT 507	Mathematics Practical Course 5	Practical -V	2	4	40	10	50	3
Discipline Specific Elective (Elective Discipline 1)-I									
Discipline Specific Elective (Elective Discipline 2)-I									

Semester-VI

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam Hours
						Ext.	Int.	Total	
SEC-4		Skill Enhancement Course-IV							
Discipline Specific Elective Mathematics-II	B-MAT 601	Mathematics Theory Course 13	Real Analysis -II	2	2	40	10	50	3
	B-MAT 602		Complex Analysis						
	B-MAT 603	Mathematics Theory Course 14	Linear Programming	2	2	40	10	50	3
	B-MAT 604		Probability and Statistics						
	B-MAT 605	Mathematics Practical Course 6	Practical -VI	2	4	40	10	50	3
Discipline Specific Elective (Elective Discipline 1)-II									
Discipline Specific Elective (Elective Discipline 2)-II									

CO-PSO matrix for the course B-MAT 101: Calculus

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 101.1	3	3	3	3
B-MAT 101.2	3	3	3	3
B-MAT 101.3	3	3	3	3
B-MAT 101.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 101: Calculus

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 101.1	3	3	3	3	3	3	3	3	3	-	3
B-MAT 101.2	3	3	3	3	3	3	2	3	2	-	3
B-MAT 101.3	3	3	3	2	2	3	2	3	2	-	2
B-MAT 101.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**2.75**	**2.75**	**3**	**2.5**	**3**	**2.5**	**-**	**2.75**

CO-PSO matrix for the course B-MAT102 : Algebra and Number Theory

COs	PSO1	PSO2	PSO3	PSO4
B-MAT102.1	3	3	3	3
B-MAT 102.2	3	3	3	3
B-MAT 102.3	3	3	3	3
B-MAT 102.4	3	3	2	2
Average	**3**	**3**	**2.75**	**2.75**

CO-PO matrix for the course B-MAT 102 : Algebra and Number Theory

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT102.1	3	3	3	3	3	3	2	3	2	--	2
B-MAT 102.2	3	3	3	3	3	3	3	3	3	--	2
B-MAT 102.3	3	3	3	3	3	2	2	3	3	--	2
B-MAT 102.4	3	3	3	2	2	2	2	3	2	--	2
Average	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**2.25**	**3**	**2.5**	**--**	**2**

CO-PSO matrix for the course B-MAT103 : Practical -I

	PSO1	PSO2	PSO3	PSO4
B-MAT 103.1	3	3	3	3
B-MAT 103.2	3	3	3	3
B-MAT 103.3	3	3	3	3
B-MAT 103.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 103 : Practical -I

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 103.1	3	3	3	3	3	3	2	3	2	-	2
B-MAT 103.2	3	3	3	3	3	3	2	3	2	-	2
B-MAT 103.3	3	3	3	3	3	3	3	3	3	--	3
B-MAT 103.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**3**	**2.5**	**-**	**2.5**

CO-PSO matrix for the course B-MAT201: Advanced Calculus

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 201.1	3	3	3	3
B-MAT 201.2	3	3	3	3
B-MAT 201.3	3	3	3	3
B-MAT 201.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 201: Advanced Calculus

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 201.1	3	3	3	2	2	2	2	3	2	-	2
B-MAT 201.2	3	3	3	3	3	3	3	3	3	-	3
B-MAT 201.3	3	3	3	3	3	3	3	3	3	--	2
B-MAT 201.4	3	3	3	3	3	3	2	3	3	-	3
Average	**3**	**3**	**3**	**2.75**	**2.75**	**2.75**	**2.5**	**3**	**2.75**	**-**	**2.5**

CO-PSO matrix for the course B-MAT202 : Differential Equations

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 202.1	3	3	3	3
B-MAT 202.2	3	3	3	3
B-MAT 202.3	3	3	3	3
B-MAT 202.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 202 : Differential Equations

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 202.1	3	3	3	3	3	3	3	3	3	-	3
B-MAT 202.2	3	3	3	3	3	3	3	3	3	-	3
B-MAT 202.3	3	3	3	3	3	3	3	3	3	--	3
B-MAT 202.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**

CO-PSO matrix for the course B-MAT203 : PRACTICAL-II

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 203.1	3	3	3	3
B-MAT 203.2	3	3	3	3
B-MAT 203.3	3	3	3	3
B-MAT 203.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 203 : PRACTICAL-II

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 203.1	3	3	3	3	3	3	3	3	2	--	3
B-MAT 203.2	3	3	3	3	3	3	3	3	2	--	3
B-MAT 203.3	3	3	3	3	3	3	3	3	2	--	3
B-MAT 203.4	3	3	3	3	3	3	3	3	2	--	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**--**	**3**

CO-PSO matrix for the course B-MAT301 :Programming Skills with C

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 301.1	2	3	3	2
B-MAT 301.2	2	3	3	3
B-MAT 301.3	2	3	3	3
B-MAT 301.4	2	3	3	3
Average	**2**	**3**	**3**	**2.75**

CO-PO matrix for the course B-MAT 301 : Programming Skills with C

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 301.1	3	3	3	3	3	3	3	3	2	-	3
B-MAT 301.2	3	3	3	3	3	3	3	3	2	-	3
B-MAT 301.3	3	3	3	3	3	2	3	3	2	-	3
B-MAT 301.4	3	3	3	3	3	3	3	3	2	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	-	**3**

CO-PSO matrix for the course B-MAT302 : Real Analysis -I

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 302.1	3	3	2	3
B-MAT 302.2	3	3	3	3
B-MAT 302.3	3	3	3	3
B-MAT 302.4	3	3	2	2
Average	**3**	**3**	**2.5**	**2.75**

CO-PO matrix for the course B-MAT 302 : Real Analysis –I

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 302.1	3	3	3	2	3	2	2	3	2	-	2
B-MAT 302.2	3	3	3	2	3	2	2	3	2	-	3
B-MAT 302.3	3	3	3	2	3	2	2	3	2	--	3
B-MAT 302.4	3	3	3	2	3	2	2	3	2	-	2
Average	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**-**	**2.5**

CO-PSO matrix for the course B-MAT303 : Mechanics -I

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 303.1	3	3	3	3
B-MAT 303.2	3	3	3	3
B-MAT 303.3	3	3	3	3
B-MAT 303.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 303 : Mechanics -I

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 303.1	3	3	3	3	3	2	3	3	3	--	3
B-MAT 303.2	3	3	3	3	3	2	3	3	3	--	2
B-MAT 303.3	3	3	3	3	3	2	3	3	3	--	3
B-MAT 303.4	3	3	3	3	3	2	3	3	3	--	3
Average	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**--**	**2.75**

CO-PSO matrix for the course B-MAT304 : Practical -III

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 304.1	2	3	3	3
B-MAT 304.2	2	3	3	3
B-MAT 304.3	2	3	3	3
B-MAT 304.4	2	3	3	3
Average	**2**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 304 : Practical -III

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 304.1	3	3	3	3	3	3	3	3	2	-	3
B-MAT 304.2	3	3	3	3	3	3	3	3	2	-	3
B-MAT 304.3	3	3	3	3	3	3	3	3	2	--	3
B-MAT 304.4	3	3	3	3	3	3	3	3	2	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**

CO-PSO matrix for the course B-MAT401 : Abstract Algebra

Cos	PSO1	PSO2	PSO3	PSO4
B-MAT401.1	3	3	3	3
B-MAT 401.2	3	3	2	2
B-MAT 401.3	3	3	2	3
B-MAT 401.4	3	3	2	2
Average	**3**	**3**	**2.25**	**2.5**

CO-PO matrix for the course B-MAT 401 : Abstract Algebra

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT401 .1	3	3	3	2	3	2	2	3	-	-	2
B-MAT 401 .2	3	3	3	2	2	2	2	3	-	-	2
B-MAT 401 .3	3	3	3	2	3	2	3	3	--	--	2
B-MAT 401 .4	3	3	3	2	2	2	2	3	-	-	2
Average	**3**	**3**	**3**	**2**	**2.5**	**2**	**2.25**	**3**	**-**	**-**	**2**

CO-PSO matrix for the course B-MAT402 : Numerical Analysis

	PSO1	PSO2	PSO3	PSO4
B-MAT 402.1	3	3	3	3
B-MAT 402.2	3	3	3	3
B-MAT 402.3	3	3	3	3
B-MAT 402.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 402 : Numerical Analysis

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 402.1	3	3	3	3	3	3	3	3	3	-	3
B-MAT 402.2	3	3	3	3	3	3	3	3	3	-	3
B-MAT 402.3	3	3	3	3	3	3	3	3	3	--	3
B-MAT 402.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**

CO-PSO matrix for the course B-MAT403 : PRACTICAL-IV

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 403.1	2	3	3	3
B-MAT 403.2	3	3	3	3
B-MAT 403.3	2	3	3	3
B-MAT 403.4	3	3	3	3
Average	**2.5**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 403 : PRACTICAL-IV

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 403.1	3	3	3	3	3	3	3	3	3	--	3
B-MAT 403.2	3	3	3	3	3	3	3	3	3	--	3
B-MAT 403.3	3	3	3	3	3	3	3	3	3	--	3
B-MAT 403.4	3	3	3	3	3	3	3	3	3	--	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**--**	**3**

CO-PSO matrix for the course B-MAT 501: Vector Calculus

CO	PSO1	PSO2	PSO3	PSO4
B-MAT 501.1	3	3	3	3
B-MAT 501.2	3	3	3	3
B-MAT 501.3	3	3	3	3
B-MAT 501.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 501: Vector Calculus

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 501.1	3	3	3	3	3	3	3	3	2	-	3
B-MAT 501.2	3	3	3	3	3	3	3	3	2	-	3
B-MAT 501.3	3	3	3	3	3	3	3	3	2	--	3
B-MAT 501.4	3	3	3	3	3	3	3	3	2	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**

CO-PSO matrix for the course B-MAT 502: Special Functions

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 502.1	3	3	3	3
B-MAT 502.2	3	3	3	3
B-MAT 502.3	3	3	3	3
B-MAT 502.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 502: Special Functions

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 502.1	3	3	3	3	3	3	2	3	2	-	2
B-MAT 502.2	3	3	3	3	3	3	3	3	2	-	3
B-MAT 502.3	3	3	3	3	3	3	3	3	2	--	3
B-MAT 502.4	3	3	3	3	3	3	2	3	2	-	2
Average	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**3**	**2**	**-**	**2.5**

CO-PSO matrix for the course B-MAT503 : Linear Algebra

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 503.1	3	3	3	2
B-MAT 503.2	3	3	3	3
B-MAT 503.3	3	3	3	3
B-MAT 503.4	3	3	3	2
Average	**3**	**3**	**3**	**2.5**

CO-PO matrix for the course B-MAT 503 : Linear Algebra

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 503.1	3	3	3	2	3	2	2	3	-	--	2
B-MAT 503.2	3	3	3	3	3	3	2	3	2	--	3
B-MAT 503.3	3	3	3	3	3	3	2	3	2	--	3
B-MAT 503.4	3	3	3	2	3	2	2	3	-	--	2
Average	**3**	**3**	**3**	**2.5**	**3**	**2.5**	**2**	**3**	**2**	**--**	**2.5**

CO-PSO matrix for the course B-MAT 504 :Partial Differential Equations and Integral Transforms

CO	PSO1	PSO2	PSO3	PSO4
B-MAT 504 .1	3	3	3	3
B-MAT 504 .2	3	3	3	3
B-MAT 504 .3	3	3	3	3
B-MAT 504 .4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 504 :Partial Differential Equations and Integral Transforms

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 504 .1	3	3	3	3	3	3	3	3	2	-	3
B-MAT 504 .2	3	3	3	3	3	3	3	3	3	-	3
B-MAT 504 .3	3	3	3	3	3	3	3	3	3	--	3
B-MAT 504 .4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.75**	**-**	**3**

CO-PSO matrix for the course B-MAT 505 : Analytical Geometry

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 505.1	3	3	3	3
B-MAT 505.2	3	3	3	3
B-MAT 505.3	3	3	3	3
B-MAT 505.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 505 : Analytical Geometry

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 505.1	3	3	3	3	3	3	3	3	2	-	2
B-MAT 505.2	3	3	3	2	3	3	3	3	3	-	3
B-MAT 505.3	3	3	3	3	3	3	3	3	3	--	3
B-MAT 505.4	3	3	3	2	2	2	2	3	2	-	2
Average	**3**	**3**	**3**	**2.5**	**2.75**	**2.75**	**2.75**	**3**	**2.5**	**-**	**2.5**

CO-PSO matrix for the course B-MAT 506 : Mechanics -II

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 506.1	3	3	3	3
B-MAT 506.2	3	3	3	3
B-MAT 506.3	3	3	3	3
B-MAT 506.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 506 : Mechanics -II

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 506.1	3	3	3	3	3	3	3	3	3	--	3
B-MAT 506.2	3	3	3	3	3	3	3	3	2	--	2
B-MAT 506.3	3	3	3	3	3	3	3	3	3	--	3
B-MAT 506.4	3	3	3	3	3	2	3	3	2	--	3
Average	**3**	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**2.5**	**--**	**2.75**

CO-PSO matrix for the course B-MAT 507 : Practical- V

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 507.1	3	3	3	3
B-MAT 507.2	3	3	3	3
B-MAT 507.3	2	2	3	2
B-MAT 507.4	2	2	3	2
Average	**2.5**	**2.5**	**3**	**2.5**

CO-PO matrix for the course B-MAT 507 : Practical- V

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 507.1	3	3	3	3	3	2	2	3	2	--	3
B-MAT 507.2	3	3	3	3	3	3	3	3	2	--	3
B-MAT 507.3	3	3	2	3	2	3	3	3	-	--	3
B-MAT 507.4	3	3	2	3	2	3	3	3	-	--	3
Average	**3**	**3**	**2.5**	**3**	**2.5**	**2.75**	**2.75**	**3**	**2**	**--**	**3**

CO-PSO matrix for the course B-MAT 601: Real Analysis -II

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 601.1	3	3	2	3
B-MAT 601.2	3	3	3	3
B-MAT 601.3	3	3	2	3
B-MAT 601.4	3	3	2	2
Average	**3**	**3**	**2.25**	**2.75**

CO-PO matrix for the course B-MAT 601: Real Analysis -II

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 601.1	3	3	3	3	3	2	2	3	-	--	2
B-MAT 601.2	3	3	3	3	3	3	3	3	2	--	3
B-MAT 601.3	3	3	3	3	3	2	3	3	-	--	2
B-MAT 601.4	3	3	3	2	3	2	2	3	-	--	2
Average	**3**	**3**	**3**	**2.75**	**3**	**2.25**	**2.5**	**3**	**2**	**--**	**2.25**

CO-PSO matrix for the course B-MAT602 : Complex Analysis

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 602.1	3	3	2	3
B-MAT 602.2	3	3	3	3
B-MAT 602.3	3	3	3	3
B-MAT 602.4	3	3	3	3
Average	**3**	**3**	**2.75**	**3**

CO-PO matrix for the course B-MAT 602 : Complex Analysis

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 602.1	3	3	3	3	3	2	3	3	2	-	2
B-MAT 602.2	3	3	3	3	3	3	3	3	2	-	3
B-MAT 602.3	3	3	3	3	3	3	3	3	2	--	3
B-MAT 602.4	3	3	3	2	2	2	2	3	2	-	2
Average	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**2.75**	**3**	**2**	**-**	**2.5**

CO-PSO matrix for the course B-MAT 603: Linear Programming

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 603.1	3	3	3	3
B-MAT 603.2	3	3	3	3
B-MAT 603.3	3	3	3	3
B-MAT 603.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 603: Linear Programming

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 603.1	3	3	3	3	3	3	3	3	2	-	2
B-MAT 603.2	3	3	3	3	3	3	3	3	3	-	3
B-MAT 603.3	3	3	3	3	3	3	3	3	3	-	3
B-MAT 603.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.75**	**-**	**2.75**

CO-PSO matrix for the course B-MAT 604 : Probability and Statistics

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 604.1	3	3	3	3
B-MAT 604.2	3	3	3	3
B-MAT 604.3	3	3	3	3
B-MAT 604.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course B-MAT 604 : Probability and Statistics

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 604.1	3	3	3	3	3	3	3	3	3	-	3
B-MAT 604.2	3	3	3	3	3	3	3	3	3	-	3
B-MAT 604.3	3	3	3	3	2	3	3	3	2	-	3
B-MAT 604.4	3	3	3	3	3	3	3	3	2	-	3
Average	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**3**	**2.5**	**-**	**3**

CO-PSO matrix for the course B-MAT 605: Practical- VI

COs	PSO1	PSO2	PSO3	PSO4
B-MAT 605.1	3	3	3	3
B-MAT 605.2	3	3	3	3
B-MAT 605.3	2	2	3	2
B-MAT 605.4	2	2	3	2
Average	**2.5**	**2.5**	**3**	**2.5**

CO-PO matrix for the course B-MAT 605 : Practical- VI

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
B-MAT 605.1	3	3	3	3	3	3	3	3	3	--	3
B-MAT 605.2	3	3	3	3	3	3	3	3	3	--	3
B-MAT 605.3	3	3	2	3	2	3	3	3	-	--	3
B-MAT 605.4	3	3	2	3	2	3	3	3	-	--	3
Average	**3**	**3**	**2.5**	**3**	**2.5**	**3**	**3**	**3**	**3**	**--**	**3**

Table 4 CO-PO-PSO mapping matrix of Mathematics Subject B.Sc. Programme

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
B-MAT 101	3	3	3	2.75	2.75	3	2.5	3	2.5	-	2.75	3	3	3	3
B-MAT 102	3	3	3	2.75	2.75	2.5	2.25	3	2.5	--	2	3	3	2.75	2.75
B-MAT 103	3	3	3	3	3	3	2.5	3	2.5	-	2.5	3	3	3	3
B-MAT 201	3	3	3	2.75	2.75	2.75	2.5	3	2.75	-	2.5	3	3	3	3
B-MAT 202	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
B-MAT 203	3	3	3	3	3	3	3	3	2	--	3	3	3	3	3
B-MAT 301	3	3	3	3	3	3	3	3	2	-	3	2	3	3	2.75
B-MAT 302	3	3	3	2	3	2	2	3	2	-	2.5	3	3	2.5	2.75
B-MAT 303	3	3	3	3	3	2	3	3	3	--	2.75	3	3	3	3
B-MAT 304	3	3	3	3	3	3	3	3	2	-	3	2	3	3	3
B-MAT 401	3	3	3	2	2.5	2	2.25	3	-	-	2	3	3	2.25	2.5
B-MAT 402	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
B-MAT 403	3	3	3	3	3	3	3	3	3	--	3	2.5	3	3	3
B-MAT 501	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
B-MAT 502	3	3	3	3	3	3	2.5	3	2	-	2.5	3	3	3	3
B-MAT 503	3	3	3	3	3	3	2.5	3	2	-	2.5	3	3	3	2.5
B-MAT 504	3	3	3	3	3	3	3	3	2.75	-	3	3	3	3	3
B-MAT 505	3	3	3	2.5	2.75	2.75	2.75	3	2.5	-	2.5	3	3	3	3
B-MAT	3	3	3	3	3	2.75	3	3	2.5	--	2.75	3	3	3	3

506															
B-MAT 507	**3**	**3**	**2.5**	**3**	**2.5**	**2.75**	**2.75**	**3**	**2**	**--**	**3**	**2.5**	**2.5**	**3**	**2.5**
B-MAT 601	**3**	**3**	**3**	**2.75**	**3**	**2.25**	**2.5**	**3**	**2**	**--**	**2.25**	**3**	**3**	**2.25**	**2.75**
B-MAT 602	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**2.75**	**3**	**2**	**-**	**2.5**	**3**	**3**	**2.75**	**3**
B-MAT 603	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.75**	**-**	**2.75**	**3**	**3**	**3**	**3**
B-MAT 604	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**3**	**2.5**	**-**	**3**	**3**	**3**	**3**	**3**
B-MAT 605	**3**	**3**	**2.5**	**3**	**2.5**	**3**	**3**	**3**	**3**	**--**	**3**	**2.5**	**2.5**	**3**	**2.5**

Scheme of the Programme B.A. with Mathematics as one subject

6. Name of the Programme (Course): B.A. with Mathematics

7. Definitions/ Abbreviations:

1 credit=1 Hour Theory Lecture (L) per week
1 credit= 2 Hours Practical (P) per week
1 credit = 25 marks
2 Hours = 3 periods of 45/40 minutes
3 Hours = 4 periods of 45/40 minutes
CC = Core Course
DSC = Discipline Core Course
AECC = Ability Enhancement Compulsory Course
SEC = Skill Enhancement Course
DSE = Discipline Specific Elective Course
GE = Generic Elective

8. One Batch(Practical Group) will consist of 15 students
9. The scheme will be effective from the session 2020-2021 in phased manner.
10. Each End Term Examination will be of three hours.

Credit Distribution for Mathematics subject in the B.A. Programme

	Core Courses (CC)	Ability Enhancement Compulsory Courses (AECC)	Discipline Specific Elective Courses(DSE)	Skill Enhancement Courses(SEC)	Total Credits
Theory	24	-	8	4	36
Practical	8	-	4	-	12
Total	32	-	12	4	48

Semester wise Distribution of Credits in the subject of Mathematics

	First year Credit		Second year Credit		Third year Credit		Total Credits
	1st Sem	2nd Sem	3rd Sem	4th Sem	5th Sem	6th Sem	
Ability Enhancement Compulsory Courses (AECC)	-	-			-	-	-
Core Courses (CC)	8	8	8	8	-	-	32
Discipline Specific Elective Courses(DSE)	-	-	-	-	6	6	12
Skill Enhancement Courses(SEC)	-	-	2	-	2	-	4
Total	8	8	10	8	8	6	48

Contact hours for Mathematics subject in the B.A. Programme

	Core Courses (CC)	Ability Enhancement Compulsory Courses (AECC)	Discipline Specific Elective Courses(DSE)	Skill Enhancement Courses(SEC)	Total hours
Theory	24	-	8	4	36
Practical	16	-	8	-	24
Total	40	-	16	4	60

Program Outcomes (PO) for the B.A. Programme

PO1		
PO2		
PO3		
PO4		
PO5		
PO6		
PO7		
PO8		
PO9		
PO10		
PO11		

Program Specific Outcomes (PSO) for Under Graduate CBCS Programme in the subject of Mathematics

After successful completion of the programme, a student will be able to:

PSO1	Have basic understanding and knowledge in different core areas of Mathematics such as algebra, analysis, calculus, differential equations, mechanics, numerical analysis and in some of the other elective areas. Demonstrate understanding of the concepts /theories/methods from such areas of Mathematics.
PSO2	Have **a** broad background in Mathematics and develop the essential mathematical reasoning, knowledge, skills and aptitude to pursue further studies and research in Mathematics.
PSO3	Communicate mathematics effectively and precisely by written, computational and graphical means.
PSO4	Apply knowledge, understanding, methods, techniques and skills of Mathematics to analyse, evaluate and solve problems of Mathematics and/or the mathematical problems having applications in engineering/science/technology/life sciences/social sciences so as to enhance career prospects in different fields.

Scheme/Structure of the Programme B.A. with Mathematics subject w.e.f. the session 2020-21 in phased manner

Semester-I

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam. Hours
						Ext.	Int.	Total	
AECC-1		AECC Course-I							
Core Course English-I		English							
Core Course Hindi-I		Hindi							
Core Course (Elective 1) -I		CC Elective1-I							
Core Course Mathematics-I	B-MAT 101	Mathematics Theory Course 1	Calculus	3	3	60	15	75	3
	B-MAT102	Mathematics Theory Course 2	Algebra and Number Theory	3	3	60	15	75	3
	B-MAT103	Mathematics Practical Course 1	Practical-I	2	4	40	10	50	3

Semester-II

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam. Hours
						Ext.	Int.	Total	
AECC-2		AECC Course-II							
Core Course English-II		English-II							
Core Course Hindi-II		Hindi-II							
Core Course (Elective 1) -II		Elective1-II							
Core Course Mathematics-II	B-MAT 201	Mathematics Theory Course 3	Advanced Calculus	3	3	60	15	75	3
	B-MAT202	Mathematics Theory Course 4	Differential Equations	3	3	60	15	75	3
	B-MAT203	Mathematics Practical Course 2	Practical-II	2	4	40	10	50	3

Semester-III

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam. Hours
						Ext.	Int.	Total	
SEC-1	B-MAT 301	Mathematics/ Comp. Sc. Theory Course 5	Programming Skills with C	2	2	40	10	50	3
Core Course English-III		English-III							
Core Course Hindi-III		Hindi-III							
Core Course (Elective 1) - III		Elective1-III							
Core Course Mathematics-III	B-MAT 302	Mathematics Theory Course 6	Real Analysis - I	3	3	60	15	75	3
	B-MAT303	Mathematics Theory Course 7	Mechanics –I	3	3	60	15	75	3
	B-MAT304	Mathematics Practical Course 3	Practical –III	2	4	40	10	50	3

Semester-IV

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam. Hours
						Ext.	Int.	Total	
SEC-2		SEC Course-II							
Core Course English-IV		English-IV							
Core Course Hindi-IV		Hindi-IV							
Core Course (Elective 1) – IV		Elective1-IV							
Core Course Mathematics-IV	B-MAT 401	Mathematics Theory Course 8	Abstract Algebra	3	3	60	15	75	3
	B-MAT402	Mathematics Theory Course 9	Numerical Analysis	3	3	60	15	75	3
	B-MAT403	Mathematics Practical Course 4	Practical IV	2	4	40	10	50	3

Semester-V

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam Hours
						Ext.	Int.	Total	
Skill Enhancement Course - Mathematics	B-MAT 501	Mathematics Theory Course 10	Vector Calculus	2	2	40	10	50	3
	B-MAT 502		Special Functions						
GE-1		Generic Elective-I							
DSE-1		DSE Elective1-I							
Discipline Specific Elective-Mathematics-I	B-MAT 503	Mathematics Theory Course 11	Linear Algebra	2	2	40	10	50	3
	B-MAT 504		Partial Differential Equations and Integral Transforms						
	B-MAT 505	Mathematics Theory Course 12	Analytical Geometry	2	2	40	10	50	3
	B-MAT 506		Mechanics –II						
	B-MAT 507	Mathematics Practical Course 5	Practical –V	2	4	40	10	50	3

Semester-VI

Course	Course Code	Subject	Course Nomenclature	Credits	Teaching Hours/ week	Marks			Duration of Exam Hours
						Ext.	Int.	Total	
SEC-4		Skill Enhancement Course-IV							
GE-2		Generic Elective-II							
DSE-3		DSE Elective1-II							
Discipline Specific Elective Mathematics-II	B-MAT 601	Mathematics Theory Course 13	Real Analysis -II	2	2	40	10	50	3
	B-MAT 602		Complex Analysis						
	B-MAT 603	Mathematics Theory Course 14	Linear Programming	2	2	40	10	50	3
	B-MAT 604		Probability and Statistics						
	B-MAT 605	Mathematics Practical Course 6	Practical -VI	2	4	40	10	50	3

B-MAT 101: Calculus

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	3	3	15	60	75	3 Hours
B.A.	3	3	15	60	75	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Calculate the limit of functions, examine the continuity of functions, understand differentiability of different type of functions, successive differentiation of functions and series expansions.
2. Understand concepts of tangents, normals, asymptotes, curvature, evolutes and involutes of a curve; the geometrical meanings of these terms and to solve related problems
3. Determine singular points of a curve and their types. To understand rectification of curves and to apply the reduction formulae.
4. Determine area bounded by curves and volumes and surface area of solids formed by revolution of curves

Unit-I:

ε-δ definition of limit and continuity of a real valued function, basic properties of limits, types of discontinuities. Differentiability of functions. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions

Unit-II:

Tangents and normals (Cartesian and parametric equations). Asymptotes in Cartesian and polar coordinates, intersection of a curve and its asymptotes. Curvature and radius of curvature of curves in Cartesian, polar and parametric forms. Newton's method. Radius of curvature for pedal curves. Centre of curvature. Circle of curvature. Evolutes and involutes.

Unit-III:

Tests for concavity and convexity. Points of inflexion. Multiple points. Cusps, nodes & conjugate points.

Reduction formulae. Rectification.

Unit-IV:

Quadrature, Sectorial area. Area bounded by closed curves. Volumes and surfaces of solids of revolution. Theorems of Pappu's and Guilden.

Recommended Text Books:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

B-MAT 102: Algebra and Number theory

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**3**	**3**	**15**	**60**	**75**	**3 Hours**
B.A.	**3**	**3**	**15**	**60**	**75**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Determine rank of a matrix, eigen values, eigen vectors, characteristic equation and characteristic polynomial of square matrices. Understand unitary and orthogonal matrices and to solve related problems.
2. Find solution of homogeneous and non-homogeneous system of linear equations using matrices. Determine relation between roots and coefficients of a general polynomial equation.
3. Identify multiple roots. Application of Descarte's rule of sign. Solve cubic and biquadratic equations.
4. Understand the basic concepts of number theory and their applications in problem solving. Prove Fermat and Wilson's theorems and their applications.

Unit–I:

Rank of a matrix. Row rank and column rank of a matrix. Eigen values, eigen vectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix. Unitary and Orthogonal Matrices.

Unit–II:

Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations.

Relations between the roots and coefficients of general polynomial equation in one variable. Solutions of polynomial equations having conditions on roots.

Unit–III:

Common roots and multiple roots. Nature of the roots of an equation Descarte's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions.

Unit–IV:

Divisibility, Greatest Common Divisor(GCD), Least Common Multiple (LCM). Prime numbers, Fundamental Theorem of Arithmetic. Linear Congruences, Fermat's theorem. Wilson's theorem and its converse. Linear Diophantine equations in two variables. Greatest integer function [x]. The number of divisors and the sum of divisors of a natural number n (The functions d(n) and σ(n)).

Recommended Text Books:

1. A.I. Kostrikin (1984). *Introduction to Algebra*. Springer Verlag.
2. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7^{th} edition). Pearson Education Pvt. Ltd. India.
3. S. H. Friedberg, A. L. Insel and L.E. Spence (2004). *Linear Algebra*, Prentice Hall of India Pvt. Ltd.
4. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and its Applications* (5^{th} edition). Pearson Education Pvt. Ltd. India.
5. Gareth A. Jones & J. Mary Jones (2005). *Elementary Number Theo*ry. Springer.
6. Neville Robbins (2007). *Beginning Number Theory* (2^{nd} edition). Narosa.
7. I. Niven (2012). *An Introduction to the Theory of Numbers* (5^{th} edition). John Wiley & Sons.
8. H.S. Hall and S.R. Knight (2016). *Higher Algebra*, Arihant Publications.
9. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)

B-MAT 103: PRACTICAL-I

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**4**	**10**	**40**	**50**	**3 Hours**

Note: This course has two components, Problem Solving and Practicals using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration. The examinee will be required to solve one problem from the part (a) and to execute one problem successfully from the part (b). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Handle practical problems of tracing of curves when equations are given in Cartesian, polar coordinates or in parametric form.
2. Solve practical problems of finding length of given curves, calculating volume of solids generated by revolution of curves and solving cubic and biquadratic equations.
3. Have hand on experience to find derivative and integral of different functions and to solve algebraic equations by using built in functions of MAXIMA software.
4. Attain skills to find inverse, eigen values of matrices and to solve system of linear equations by using built in functions of MAXIMA software.

a) **Problem Solving-** Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems of curve tracing when equation is given in Cartesian coordinates.
2. Problems of curve tracing when equation is given in parametric form.
3. Problems of curve tracing when equation is given in polar coordinates.
4. Problem solving of determination of length of a curve expressed in Cartesian coordinates.
5. Problem solving of determination of length of a curve expressed in polar coordinates.

6. Problems of determination of volume of solids generated by revolution of curves expressed in Cartesian coordinates.
7. Problems of determination of volume of solids generated by revolution of curves expressed in polar coordinates.
8. Problems of determination of volume of solids generated by revolution of curves expressed in parametric form.
9. Problems of solving cubic equations by Cardon's method.
10. Problems of solving biquadratic equations by Ferrari' method.

b) **Practicals with Free and Open Source Software (FOSS) Tools-** The following practicals will be done using MAXIMA Software and record of those will be maintained in the practical Note Book:

1. To simplify expression, factor expression, expand expression and to do trigonometric simplification and complex simplification by making use of MAXIMA.
2. To find derivatives of functions using MAXIMA.
3. To find indefinite and definite integrals of different functions using MAXIMA.
4. To find roots of algebraic equations using MAXIMA.
5. To find the value of a determinant using MAXIMA.
6. To compute inverse of a square matrix using MAXIMA.
7. To find Eigen values and Eigen vectors of a square matrix using MAXIMA.
8. To solve system of linear equations using MAXIMA.

B-MAT 201: Advanced Calculus

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**3**	**3**	**15**	**60**	**75**	**3 Hours**
B.A.	**3**	**3**	**15**	**60**	**75**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand and to prove Rolle's Theorem, mean value theorems and their geometrical interpretations. To determine indeterminate forms.
2. Learn conceptual variations while advancing from one variable to several variables in calculus, limit and continuity, partial differentiation of such functions. To understand composite functions, homogeneous functions and to solve related problems.
3. Understand differentiability of real valued functions of two variables and to prove associated results. To determine maximum and minimum of functions of two variables and to apply multivariable calculus in optimization problems.
4. Evaluate double and triple integrals. To learn about Dirichlet integrals, Beta and Gamma functions and to solve related problems.

Unit-I:

Mean value theorems: Rolle's Theorem and Lagrange's mean value theorem and their geometrical interpretations, Cauchy mean value theorem. Taylor's Theorem with various forms of remainders, Darboux intermediate value theorem for derivatives. Indeterminate forms.

Unit-II:

Functions of several variables, Level curves and surfaces, Limits and continuity. Partial differentiation. Total Differentials; Composite functions & implicit functions. Chain rule. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions.

Taylor's theorem for functions of two or more variables.

Unit-III:

Differentiability of real valued functions of two variables. Schwarz and Young's theorem. Implicit function theorem. Extrema of functions of two and more variables; Maxima, Minima critical points, Method of Lagrange multipliers. Constrained optimization problems

Unit-IV:

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates. Jacobian. Change of order of integration. Triple integral over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates. Dirichlet integrals. Beta and Gamma functions.

Recommended Text Books:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.
7. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer India Pvt. Limited.
8. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.

B-MAT 202: Differential Equations

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**3**	**3**	**15**	**60**	**75**	**3 Hours**
B.A.	**3**	**3**	**15**	**60**	**75**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: The course will enable the students to:

1. Understand the basic concepts of ordinary differential equations and to learn various techniques of finding exact solutions of certain solvable first order differential equations. and.
2. Develop the skills of solving homogeneous and non-homogeneous second order linear ordinary differential equations with constant coefficients and with variable coefficients.
3. Understand total differential equations and basic concepts of partial differential equations. To learn methods and techniques for solving linear PDEs of first order.
4. Apply theory of PDEs to determine integral surfaces through a given curve and to find orthogonal surfaces. To understand compatible systems and Charpit method, Jacobi method methods for solving PDEs. To learn techniques of solving second order PDEs.

Unit-I:

Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, equations reducible to homogeneous, Linear differential equations and equations reducible to linear form. Exact differential equations, Integrating factor.

First order higher degree equations solvable for *x*, *y* and *p*. Clairaut's form and singular solutions. Orthogonal trajectories of one-parameter families of curves in a plane.

Unit-II:

Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, linear non-homogeneous differential equations. Linear differential equation of second order with variable coefficients. Method of reduction of order, method of undetermined coefficients, method of variation of parameters. Cauchy-Euler equation.

Unit-III:

Solution of simultaneous differential equations, total differential equations.

Genesis of Partial differential equations (PDE), Concept of linear and non-linear PDEs. Complete solution, general solution and singular solution of a PDE. Linear PDE of first order. Lagrange's method for PDEs of the form: $P(x,y,z)\, p + Q(x,y,z)\, q = R(x,y,z)$, where $p=\partial z/\partial x$ and $q=\partial z/\partial y$.

Unit-IV:

Second Order Partial Differential Equations with Constant Coefficients. Integral surfaces passing through a given curve. Surfaces orthogonal to a given system of surfaces. Compatible systems of first order equations. Charpit's method, Special types of first order PDEs, Jacobi's method. Solutions of second order linear partial differential equations (homogeneous and non-homogeneous) with constant coefficients. Solution of PDEs with variable coefficients reducible to equations with constant coefficients.

Recommended Text Book:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). J. Wiley & Sons
2. B. Rai & D. P. Choudhury (2006). *Ordinary Differential Equations - An Introduction*. Narosa Publishing House Pvt. Ltd. New Delhi.
3. Shepley L. Ross (2007). *Differential Equations* (3rd edition). Wiley.
4. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.
5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.

B-MAT 203: PRACTICAL-II

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**4**	**10**	**40**	**50**	**3 Hours**

Note: This course has two components, Problem Solving and Practicals using MAXIMA software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration. The examinee will be required to solve one problem from the part (a) and to execute one problem successfully from the part (b). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Practical problems of checking continuity and differentiability, finding maxima and minima of functions of several variables, evaluating double and triple integrals.
2. Develop skills of solving ODEs and PDEs.
3. Hands-on experience to find partial derivatives, total derivative and to plot graphs of functions by using built in functions of MAXIMA software.
4. Hands-on experience to evaluate double and triple integrals, solve ordinary differential equations by using built in functions of MAXIMA software.

a) **Problem Solving**- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems of finding continuity of functions of several variables.
2. Problems of finding differentiability of functions of several variables.
3. Problems of finding maxima and minima of functions of two variables.
4. Solving optimization problems.
5. Problem solving of determination surface area through application of double integrals in Cartesian and polar coordinates.
6. Problems of determination of volume using triple integrals.
7. Problems of solving differential equations which are reducible to homogeneous.
8. Problems of solving differential equations which are reducible to linear.
9. Problems of solving differential equations by method of undetermined coefficients.
10. Problems of solving different PDEs using Lagrange's method.
11. Problems of solving PDEs with Charpit's method.
12. Problems of solving second order PDEs with variable coefficients which can be reduced to those with constant coefficients.

b) **Practicals with Free and Open Source Software(FOSS) Tools-** The following practicals will be done using MAXIMA Software and record of those will be maintained in the practical Note Book:

1. To find partial derivatives of a function using MAXIMA.
2. To find total differential of a function of several variables using MAXIMA.
3. To find partial derivatives by chain rule and implicit differentiation.
4. To plot a curve in two dimensions, three dimensional plots and level surfaces using MAXIMA.
5. To find exact solutions of first and second order ODEs using ode2 and ic1/ic2 built in functions of MAXIMA.
6. To find exact solutions of first and second order ODEs using desolve and atvalue built in functions of MAXIMA.
7. To evaluate double and triple integrals using MAXIMA.
8. To find numerical solution of a first order ODE using plotdf built in function of MAXIMA.

B-MAT 301: PROGRAMMING SKILLS WITH C

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	2	2	10	40	50	3 Hours
B.A.	2	2	10	40	50	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Familiarize with C programming language. Learn elements of C, data types, constants and variables, operations and operators, statements and expressions. Use these tools for writing C programs.
2. Learn Input/ Output functions in C, to write reading and writing statements in C, decision making statements and structures in C. Apply this knowledge to use as tools in writing C programs.
3. Understand loops and arrays, their types, characteristics and structures. Attain the skill to write C programs which involve arrays and multiple iterations.
4. Learn strings of characters, their declaration, input/ output, operations on strings and functions which handle strings. Learn declaration, types and calling of user defined functions in C.

   Be ready to attain the skills of programming by making use of tools and knowledge mentioned in the Cos 1 to 4.

Unit-I:

Overview of C: Introduction and importance of C, Basic structure of a C program, Executing a C program. Elements of C: C character set, C tokens, Identifiers and keywords, Constants and Variables, Data types, Assignment statement, Symbolic constants.

Operators & Expression: Arithmetic, relational, logical, bitwise, unary, assignment, conditional operators and special operators. Arithmetic expressions, evaluation of arithmetic expression, type casting and conversion, operator hierarchy & associativity.

Unit-II

Input/output: Unformatted & formatted I/O function, Input functions viz. scanf(), getch(), getche(), getchar(), gets(); output functions viz. printf(), putch(), putchar(), puts().

Decision making & branching: Decision making with IF statement, IF…ELSE statement, Nested IF statement, ELSE-IF ladder, SWITCH statement, GOTO statement.

Unit-III:

Decision making & looping: For, while, and do-while loop, jumps in loops, break, continue statement.

Arrays: Definition, types, initialization, processing an array.

Unit-IV:

Character Strings: Declaration and initialization, Reading and writing, Arithmetic Operations on Characters, Putting strings together, Comparison of strings, String handling Functions.

User defined functions: Need for user defined functions, form of C functions, return values and their types, calling a function, category of functions, nesting of functions, Recursion, Functions with arrays, scope of variables in functions, ANSI C functions.

Recommended Text Books:

1. B.W. Kernighan and D.M. Ritchie : The C Programming Language, 2nd Edition
2. V. Rajaraman : Programming in C, Prentice Hall of India, 1994
3. Byron S. Gottfried : Theory and Problems of Programming with C, Tata McGraw-Hill Publishing Co. Ltd., 1998
4. Programming in ANSI C, E. Balagurusamy, Tata McGraw-Hill Publishing Co. Ltd.

B-MAT 302: Real Analysis -I

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**3**	**3**	**15**	**60**	**75**	**3 Hours**
B.A.	**3**	**3**	**15**	**60**	**75**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand basic concepts of real number system and set theory. Preliminary results on neighbourhood of a point, interior and limit points, open sets, closed sets etc.
2. Learn real sequences, their limit, boundedness and convergence. To find convergence and divergence of a sequence. To understand Cauchy sequence, subsequence and to prove related theorems.
3. Understand infinite series and its basic properties. Attain skills to determine convergence of a series of real numbers by applying various tests.
4. Understand absolute and conditional convergence of alternating series and related tests. Learn the basic concepts of pointwise convergence and uniform convergence of sequence and series of functions.

Unit-I:

Finite and infinite sets, countable and uncountable sets, bounded and unbounded sets in $\mathbb{R}$. Least upper bound (supremum), greatest lower bound (infimum) of a set and their properties. The set of real numbers ($\mathbb{R}$) as an ordered field, Least upper bound properties of $\mathbb{R}$**,** Metric property and completeness of $\mathbb{R}$. Archimedean property of $\mathbb{R}$. Neighbourhood of a point, interior points, isolated points, limit points. Open sets, closed sets, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weierstrass theorem.

Unit-II:

Sequences in $\mathbb{R}$, Convergent sequence and its limit, Limit theorems, Bounded and monotonic sequences in $\mathbb{R}$. Cauchy's theorem on limits, Monotone convergence theorem, Limit superior and limit inferior, Cauchy sequence, Cauchy's convergence criterion. Subsequences, Subsequential limits.

Unit-III:

Infinite series: Convergence and divergence of Infinite Series, Comparison Tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series. D-Alembert's ratio test, Raabe's test, Logarithmic test, Abel's test, Cauchy's nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test.

Unit-IV:

Alternating series, Absolute and conditional convergence, Leibniz test, Rearrangements of series. Pointwise and uniform convergence of sequence and series of functions, M_n-test, Weierstrass's M-test. Uniform continuity. Uniform convergence and continuity.

Recommended Text Books:

1. T. M. Apostol (2008). *Mathematical Analysis: A Modern Approach to Advanced Calculus*. Pearson Education.
2. Charalambos D. Aliprantis &) Owen Burkinshaw1998). *Principles of Real Analysis* (3rd edition). Academic Press.
3. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition).Wiley India.
4. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis.* Springer-Verlag.
6. K. A. Ross (2013). *Elementary Analysis***:** *The Theory of Calculus* (2nd edition). Springer.
7. Walter Rudin. *Principles of Mathematical Analysis* (3rd edition), Tata McGraw Hill.

B-MAT 303: Mechanics -I

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	3	3	15	60	75	3 Hours
B.A.	3	3	15	60	75	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand basic concepts of forces, their resultant and moment; couples and their moments. To attain the problem solving skill for scientific problems.
2. Learn the concepts of friction and laws of friction, centre of mass and centre of gravity and to solve problems related to these concepts.
3. Learn fundamentals of dynamics like velocity, acceleration, angular velocity and acceleration, Newton's laws of motion, simple harmonic motion and to develop the skill of solving simple dynamical problems.
4. Understand concepts of work, power, energy and projectile motion and to solve related problems. Learn about Kepler's laws of the planetary motions.

Unit-I:

Composition and resolution of forces, Parallel forces, Couples, Moment of force and a couple about a point and a line.

Unit-II:

Concept of friction, Laws of friction, Problems of equilibrium under forces including friction. Concepts of centre of mass and centre of gravity, Centre of gravity of an uniform arc, plane area and solids of revolution.

Unit-III:

Velocity and acceleration of a particle along a curve: radial and transverse components, tangential and normal components, Relative velocity and acceleration, Angular velocity and acceleration. Newton's laws of motion. Simple harmonic motion and elastic strings.

Unit-IV:

Work, Power and Energy. Projectile motion. Kepler's laws of planetary motion (Statements and articles only).

Recommended Text Books:

1. R. S. Varma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.
2. P.L. Srivastava (1964). *Elementary Dynamics*. Ram Narain Lal, Beni Prasad Publishers Allahabad.
3. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.
4. S.L. Loney (1995). *An Elementary Treatise on Statics,* Radha Publishing House.
5. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
6. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
7. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
8. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics*. Cambridge University Press.

B-MAT 304: PRACTICAL-III

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**4**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 4 questions at the time of practical examination by taking course outcomes (COs) into consideration. The examinee will be required to write two programs and execute one program successfully. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Demonstrate understanding of syntax and structure of simple programs in C.
2. Attain skill of writing codes in the C programming language.
3. Learn to write, enter and executing elementary programs in the programming language C.
4. Have hands-on experience to run and debug programs in C for different mathematical and other practical problems of daily or scientific use.

Note- The following practicals will be done using the programming language C and record of those will be maintained in the practical Note Book:

1. To find greatest and smallest of three numbers.
2. To find the roots of a quadratic equation.
3. To check whether a given year is leap year or not.
4. To check a given number for being palindrome or Armstrong.
5. To generate Fibonacci sequence.
6. To find sum of cosine series and sine series up to n terms.
7. To find sum of any n numbers.
8. To find transpose of a matrix.
9. To find sum and product of two matrices.
10. To find area of circle, triangle and rectangle depending on choice using switch statement.
11. To find factorial of a number using
    (a) iteration (b) function.
12. To find Greatest Common Divisor of two numbers using recursion.
13. Write a function to check a given number for being prime number. Use the same to generate the prime numbers less than or equal to a given number m.
14. To search the element in an array of n elements using

(a) Linear search method
(b) Binary search.

15. To sort given numbers in ascending/descending order using
    (a) selection sort (b) bubble sort
16. To prepare electricity bill.
17. To find gross salary of an employee.
18. To perform following operations on strings:
    (a) Show address of each character in string
    (b) Concatenate two strings
    (c) Compare two strings
    (e) Calculate the length of strings
    (f) Convert all lowercase characters to uppercase
    (g) Convert all uppercase characters to lowercase.
    (h) Calculate number of vowels
    (i) Reverse the string
19. To arrange string data (name of students) in alphabetical order using bubble sort.
20. To calculate the Letter grades and Grade points of a student according to marks obtained in 4 subjects on the basis of following table:

Marks	Grade Point	Letter Grade
85-100	10	O (Outstanding)
75-84	9	A+ (Excellent)
65-74	8	A (Very Good)
55-64	7	B+ (Good)
50-54	6	B (Above Average)
41-49	5	C (Average)
40	4	P (Pass)
<40	0	F (Fail)

B-MAT 401: Abstract Algebra

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	3	3	15	60	75	3 Hours
B.A.	3	3	15	60	75	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: The course will enable the students to:

1. Recognize the mathematical objects called groups, their elementary properties, order of a group, subgroup, cyclic groups and their properties.
2. Understand the notions of cosets, normal subgroups, and quotient groups. Know homomorphisms, isomorphisms and their properties and to prove three isomorphism theorems.
3. Learn about ring, subring, integral domain, field and ideal and related results.
4. Understand quotient rings, Euclidean ring, ring homomorphisms, ring isomorphisms and fundamental isomorphism theorems.

UNIT-I

Definition and examples of a group including Permutation group, quaternion group, Abelian and Non-abelian groups. The Group Z_n of integers under addition modulo n and under multiplication modulo n . Elementary properties of groups. Order of a group. Order of an element of a group . Subgroup and Subgroup tests. Centralizer, Normalizer, Center of a group. Cyclic group and properties of cyclic groups. Cycle notation for permutations. Properties of permutations. Even and odd permutations. Alternating groups.

UNIT –II

Cosets. Index of a subgroup , Lagrange's theorem , Normal subgroup , Quotient groups . Group homomorphism, Group isomorphisms. Cayley's theorem. Properties of isomorphisms. First, Second and Third isomorphism theorems for groups.

UNIT-III

Definition and examples of rings. Commutative and non-commutative rings. Rings from number system ,Z_n ring of integers modulo n , Ring of matrices. Properties of rings. Subrings. Characteristic of a ring. Integral Domain and Field. Examples of fields: Z_n, Q, R and C.

Ideals. Ideal generated by a subset of a ring. Prime and maximal ideals.

UNIT-IV

Quotient ring. Ring homomorphisms. Properties of ring homomorphisms. First, Second and Third Isomorphism theorems for rings. Euclidean ring.

Recommended Text Books:

1. Joseph A. Gallian (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited, Delhi.
2. John B. Fraleigh (2002). *A First Course in Abstract Algebra* (7th ed.). Pearson.
3. M. Artin (2011). *Abstract Algebra* (2nd ed.). Pearson.
4. Rotman, Joseph J. (1995). *An Introduction to The Theory of Groups* (4th ed.). Springer Verlag, New York.
5. Beachy, John A., & Blair, William D. (2006). *Abstract Algebra* (3rd ed.). Waveland Press.

B-MAT 402: Numerical Analysis

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	3	3	15	60	75	3 Hours
B.A.	3	3	15	60	75	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 6 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. Non-programmable scientific calculators will be allowed during examination.

Course Outcomes: This course will enable the students to:

1. Understand errors and their types. Learn techniques to obtain numerical solutions of algebraic and transcendental equations.
2. Attain numerical skills to find solutions of system of linear equations by different methods.
3. Learn different interpolation and extrapolation methods and their applications. Apply numerical methods to obtain derivatives.
4. Understand numerical methods for evaluating integrals and solving differential equations and to develop skill of applying these methods for future use in scientific problems.

Unit-I:

Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence. Numerical methods for solving algebraic and transcendental Equations: Bisection method, false position method, fixed point iteration method, Newton-Raphson method and secant method. Newton's iterative method for finding pth root of a number.

Unit-II:

Numerical methods for solving simultaneous linear equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method). Crout's method, Cholesky Decomposition method. Iterative method; Jacobi's method, Gauss-Seidal method, relaxation method.

Unit-III:

Finite Differences operators and their relations. Interpolation with equal intervals: Gregory–Newton forward and backward difference interpolations. Interpolation with unequal intervals: Newton's divided difference formulae, Lagrange's Interpolation formulae.

Central Differences: Gauss forward and Gauss's backward interpolation formulae. Sterling formula, Bessel's formula.

Piecewise linear interpolation, Cubic spline interpolation.

Numerical Differentiation: First and second derivative of a function using interpolation formulae.

Unit-IV:

Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's one-third and three-eighth rule, Chebychev formula, Gauss Quadrature formula.

Numerical solution of ordinary differential equations: Single step methods- Picard's method. Taylor's series method, Euler's method, Runge-Kutta Methods.

Recommended Text Books:

1. Brian Bradie (2006), *A Friendly Introduction to Numerical Analysis.* Pearson.
2. C. F. Gerald & P. O. Wheatley (2008). *Applied Numerical Analysis* (7th edition), Pearson Education, India.
3. M.K. Jain, S. R. K. Iyengar & R. K. Jain (2012). *Numerical Methods for Scientific and Engineering Computation* (6th edition). New Age International Publishers.
4. Robert J. Schilling & Sandra L. Harris (1999). *Applied Numerical Methods for Engineers Using* MATLAB *and C.* Thomson-Brooks/Cole.
5. S.D. Conte and Carl de Boor (2017). *Elementary Numerical Analysis: An algorithmic Approach*. SIAM.
6. A. Gupta and S.C. Bose (1989). *Introduction to Numerical Analysis*. Academic Publishers.
7. F.B. Hildebrand (1987). *Introduction to Numerical Analysis*. Dover Publications.

B-MAT 403: PRACTICAL-IV

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**4**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 4 questions at the time of practical examination by taking course outcomes (COs) into consideration. The examinee will be required to write two programs and execute one program successfully. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Attain skill of computer programming and to use that a tool for problem solving.
2. Solve scientific problems by applying numerical techniques in C programing language.
3. Write and execute programs of numerical methods in C.
4. Apply knowledge of numerical analysis in investigation of problems and solving them at individual level and as member of a group.

Note- The following practicals will be done using the programming language C and record of those will be maintained in the practical Note Book:

1. To find roots of algebraic and transcendental equations using Bisection method.
2. To find roots of algebraic and transcendental equations using Newton Raphson method.
3. To find roots of algebraic and transcendental equations using Regula Falsi method.
4. To find solution of system of equations using Gauss Elimination method.
5. To find solution of system of equations using Gauss Seidal method.
6. To find inverse of a square matrix using Gauss Jordan method
7. To find approximate value of a function by Newton Forward Interpolation formula.
8. To find approximate value of a function by Newton Backward Interpolation formula.
9. To find approximate value of a function using Lagrange’s Interpolation formula.
10. To fit a curve by Least Squares Approximation method.

11. To find first and second order derivatives using interpolation formulas.
12. To evaluate a definite integral using Trapezoidal Rule.
13. To evaluate a definite integral using Simpson 1/3 rule.
14. To evaluate a definite integral using Simpson 3/8 rule.
15. To solve an ordinary differential equation using Euler’s method.
16. To find solution of an ordinary differential equation using Euler’s modified method.
17. To solve an ordinary differential equation using Runge-Kutta second order and fourth order methods.

B-MAT 501: Vector Calculus

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**2**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand and solve problems related to scalar and vector product of vectors. Learn vector differentiation and directional derivatives and their problem solving.
2. Learn gradient, divergence and curl operators. Apply knowledge and these tools in problem solving.
3. Understand vector identities, Laplacian operator. Learn vector integration and line integral. Solve problems using these concepts.
4. Learn surface and volume integral formulations and their evaluation. Prove Gauss Divergence, Green's and Stoke's theorems. Realize importance of Green, Gauss and Stokes' theorems.

Unit-I:

Scalar and vector product of vectors. Vector differentiation; Scalar Valued point functions, vector valued point functions, derivative along a curve, directional derivatives.

Unit-II:

Gradient of a scalar point function, geometrical interpretation of grad Φ.

Divergence and curl of vector point function, their characteristics and examples.

Unit-III:

Gradient, divergence and curl of sum and product of functions and their related vector identities. Laplacian operator.

Vector integration; Line integral.

Unit-IV:

Surface integral, Volume integral.

Theorems of Gauss, Green & Stokes and problems based on these theorems.

Recommended Text Books:

1. Murray Spiegel and Seymour Lipschutz (2017) *Vector Analysis*, Schaum Outline Series.
2. N. Saran and S.N. Nigam (2001). *Introduction to Vector Analysis*. Pothishala Pvt. Ltd., Allahabad.
3. Shanti Narayan and P.K. Mittal (2003). A Text Book of Vector Calculus. S. Chand.
4. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10^{th} edition). Wiley India.
5. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
6. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas' Calculus* (14^{th} edition). Pearson Education.
7. James Stewart (2012). *Multivariable Calculus* (7^{th} edition). Brooks/Cole. Cengage.
8. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3^{rd} edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

B-MAT 502: Special Functions

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	2	2	10	40	50	3 Hours
B.A.	2	2	10	40	50	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand singular points of a differential equation and to solve such differential equation by power series method. Learn Hypergeometric differential equation, Hypergeometric function and its properties.
2. Know Bessel's differential equation and its solution. Understand recurrence relations, generating function and othogonality of Bessel's function. Understand Bessel integral. Attain skills to make use of Bessel functions in scientific problem solving.
3. Familiarise with Legendre's differential equation and its solution in the form of Legendre functions. Understand recurrence relations, generating function and othogonality of Legendres function, Rodrigues' formula. Apply knowledge in problem solving.
4. Know Hermite's differential equation and its solution in the form of Hermite functions. Understand recurrence relations, generating function and othogonality of Hermite function, Rodrigues' formula. Attain skill to apply these tools for investigation and solution of problems.

Unit-I

Series solution of differential equations – Power series method. Hypergeometric Series. Hypergeometric function, its integral representation. Hypergeometric differential equation and solutions. Contiguous function relations, simple transformations.

Unit-II

Bessel equation and its solution: Bessel functions and their properties-Convergence, Recurrence relations and generating functions. Bessel's Integral. Orthogonality of Bessel functions.

Unit-III

Legendre differentials equation and its solution; Legendre functions and their properties; Recurrence relations and generating functions. Orhogonality of Legendre polynomials. Rodrigues' Formula for Legendre Polynomials, Laplace Integral Representation of Legendre polynomial.

Unit-IV

Hermite differentials equations and its solutions; Hermite function and its properties; Recurrence relations and generating functions. Orhogonality of Hermite polynomials. Rodrigues' Formula for Hermite Polynomial,

Recommended Text Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
2. Shepley L. Ross (2007). *Differential Equations* (3rd edition), Wiley India. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.
3. Earl. D. Ranvillie (1960). *Special Functions*. Macmillan.
4. W.W. Bell (2004). Special Functions for Scientists & Engineers. Dover Books on Mathematics.
5. L.C. Andrews (1992). Special Functions of Mathematics for Engineers, SPIE Press.

B-MAT 503: Linear Algebra

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**2**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand the concepts of vector spaces, subspaces, bases and their properties; linear transformations and their rank and nullity and to use those concepts for problem solving.
2. Learn to determine eigen values, eigen vectors and characteristic polynomial of linear transformations and their further use in investigation and solution of problems.
3. Have knowledge of inner product spaces, orthogonalization and diagonalization of matrices/ linear transformations and to apply that in further learning and for scientific applications.
4. Learn adjoint operation, Hermitian, unitary, normal and triangular forms of linear transformations and related problem solving.

Unit-I:

Vector spaces. Subspaces. Algebra of subspaces. Quotient space. Linear combination of vectors. Linear span. Linear dependence and independence of vectors. Bases and dimension. Dimension of subspaces. Linear transformations. Matrix representation of a linear transformation. Rank and nullity of a linear transformation.

Unit-II:

Transpose of a linear transformation, Eigen vectors and eigen values of a linear transformation, Characteristic polynomial and Cayley–Hamilton theorem, Minimal polynomial.

Unit-III:

Inner product spaces and orthogonality, Cauchy–Schwarz inequality, Gram–Schmidt orthogonalization, Diagonalization of symmetric matrices.

Unit-IV:

Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; Triangular form, Trace and transpose.

Recommended Text Books:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). *Linear Algebra* (4thedition). Prentice-Hall of India Pvt. Ltd.
2. Kenneth Hoffman & Ray Kunze (2015). *Linear Algebra* (2nd edition). Prentice-Hall.
3. I. M. Gel'fand (1989). *Lectures on Linear Algebra.* Dover Publications.
4. Nathan Jacobson (2009). *Basic Algebra* I & II (2nd edition). Dover Publications.
5. Serge Lang (2005). *Introduction to Linear Algebra* (2nd edition). Springer India.
6. Vivek Sahai & Vikas Bist (2013). *Linear Algebra* (2nd Edition). Narosa Publishing House.
7. Gilbert Strang (2014). *Linear Algebra and its Applications* (2nd edition). Elsevier.

B-MAT 504: Partial Differential Equations and Integral Transforms

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	2	2	10	40	50	3 Hours
B.A.	2	2	10	40	50	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Learn classification of second order partial differential equations, their canonical forms, and methods of solving those. Find characteristic equations and curves. Apply this knowledge to solve problems of science and society.
2. Model physical phenomena using partial differential equations such as the Laplace, heat and wave equations and to solve these equations. Learn solving non-linear equations by Monge's method. Apply these methods as a tool for modelling and solving real world problems.
3. Know about Laplace transforms and its properties in detail and to apply those in solving differential equations.
4. Familiarize with Fourier transforms of functions, properties of Fourier transform, inverse Fourier transforms and relation between Laplace and Fourier transforms. Develop skill of applying Fourier transforms to solve differential equations.

Unit-I:

Classification of linear partial differential equations of second order, Hyperbolic, parabolic and elliptic types, Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions. Characteristic equations and characteristic curves of second order partial differential equation.

Unit-II:

Solution of linear hyperbolic equations. Monge's method for solving non-linear second order partial differential equations.

Laplace equation: elementary solutions of Laplace's equation.

Method of separation of variables: Solution of Laplace's equation, Wave equation and Diffusion (Heat) equation in one and two dimensions Cartesian Co-ordinate system.

Unit-III:

Laplace Transforms – Existence theorem for Laplace transforms, Linearity and shifting properties of the Laplace transforms, Laplace transforms of derivatives and integrals, Convolution theorem, Inverse Laplace transforms, solution of differential equations using Laplace transform.

Unit-IV:

Fourier transforms: Linearity and shifting properties, Convolution Theorem, Fourier Transform of Derivatives, Parseval's identity for Fourier transforms. Solving differential Equations using Fourier Transforms.

Recommended Text Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
2. Tyn Myint-U & Lokenath Debnath (2013). *Linear Partial Differential Equation for Scientists and Engineers* (4th edition). Springer India.
3. H. T. H. Piaggio (2004). An Elementary Treatise on *Differential Equations and Their Applications.* CBS Publishers.
4. S. B. Rao & H. R. Anuradha (1996). *Differential Equations with Applications*. University Press.
5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.
6. Murray R. Spiegel (2005). *Laplace Transforms*. Schaum's Outline Series.
7. Ian N. Sneddon (1974). *The Use of Integral Transforms*. McGraw Hill.

B-MAT 505: Analytical Geometry

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**2**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand the concept of a second degree equation representing different conic sections and its classification and properties. Learn terms related to conic sections and their use in problem solving.
2. Know representation of system of conics and confocal conics and related results. Learn general form of equation of a sphere and to solve problems related to intersection of spheres, tangent plane and line, orthogonality, length of tangent and co-axial system of spheres. Apply this knowledge to investigate and solve problems.
3. Learn equations of cones and cylinders and then to solve related problems. Apply knowledge for problem solving and life-long learning.
4. Familiarize with concepts of conicoids and related tangent plane, director sphere, normal, envelop and to make further use thereof.

Unit-I:

General equation of second degree: Classification of conic sections; centre, asymptotes, axes, eccentricity, foci and directrices of conics. Tangent at any point to the conic, chord of contact, pole of line to the conic, director circle of conic. Polar equation of a conic, tangent and normal to the conic.

Unit-II:

System of conics. Confocal conics.

Sphere: General form, Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, tangent plane and line, polar plane and line, orthogonal spheres.

Unit-III:

Cone: Equation of a cone, right circular cone, quadric cone, enveloping cone. Tangent plane and condition of tangency.

Cylinder: Right circular cylinder and enveloping cylinder.

Unit-IV:

Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Paraboloids.

Recommended Text Books:

1. Robert J. T. Bell (1994). *An Elementary Treatise on Coordinate Geometry of Three Dimensions*. Macmillan India Ltd.
2. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. Narosa Publishing House.
3. Shanti Narayan and P.K. Mittal (2007). *Analytical Solid Geometry*. S. Chand.
4. J.H. Kindle (1990). *Analytic Geometry*. Schaum Outline Series
5. Gordon Fuller and Dalton Tarwater (1992). *Analytic Geometry*. Pearson.

B-MAT 506: Mechanics – II

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**2**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand the equilibrium of a body acted upon by forces in plane and the principle of virtual work for a system of coplanar forces acting on a rigid body and central axis. Apply this knowledge to investigate and solve scientific problems.
2. Understand three dimensional force system, central axis, wrenches, null lines and planes.
3. Understand conservative and impulsive forces, and particle motion on a smooth or rough path in a plane. Apply theoretical concepts to problem solving.
4. Understand equation of motion of a body moving under a central force and Kepler's laws of the planetary motions. Solve problems of central orbits and planetary motion.

Unit-I:

Equilibrium of Particle and rigid body acted on by forces in plane. Virtual work.

Unit-II:

Forces in three dimensions. Poinsot's central axis. Wrenches. Null lines and planes.

Unit-III:

Concepts of Conservative forces and Impulsive forces. Motion on smooth and rough plane curves.

Unit-IV:

Equation of motion under a central force, Differential equation of the orbit, (p, r) equation of the orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetary motion and their relation with Newton's laws of motion.

Recommended Text Books:

1. R. S. Varma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.
2. P.L. Srivastava (1964). *Elementary Dynamics*. Ram Narain Lal, Beni Prasad Publishers Allahabad.
3. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.
4. S.L. Loney (1995). *An Elementary Treatise on Statics,* Radha Publishing House.
5. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
6. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
7. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
8. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics*. Cambridge University Press.

B-MAT 507: PRACTICAL -V

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**4**	**10**	**40**	**50**	**3 Hours**

Note: This course has two components, Problem Solving and Practical using LATEX software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration. The examinee will be required to solve one problem from the part (a) and to execute one program successfully from the part (b). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Attain skills to solve practical problems of Vector Spaces.

   OR

1. Attain skills to solve practical problems transforming second order PDEs to canonical form and then solving those and to solve non-linear PDEs.
2. Handle practical problems of orthogonalization and diagonalization of matrices.

   OR

2. Handle practical problems of solving Laplace, heat and wave equations.
3. Understand basic features and commands of typing software LATEX.
4. Have hands-on skills to type a document using LATEX software. Learn LATEX commands to create document and its type, sections; paper size, font type, size and styles; type mathematical and Greek symbols, mathematical equations and item listing.

a) **Problem Solving-** Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

   Linear Algebra;

1. Practical problems to obtain basis by extending a given set of linearly independent set of vectors.

2. Practical problems to determine matrix representation of a linear transformation and to determine its rank and nullity.
3. Practical problems to determine Eigen Values & Eigen Vectors of a Linear Transformation.
4. Practical problems to find Dual of a Vector Space.
5. Practical problems to determine minimal polynomial of a linear transformation.
6. Practical problems to find orthogonal basis using Gram-Schmidt orthogonalisation process.
7. Practical problems to diagonalise symmetric matrices.
8. Practical problems to determine Jordan Canonical Form of a matrix.

OR

PDE and Integral Transforms;

1. Practical problems to reduce PDEs into canonical form and then solving those.
2. Practical problems of finding the characteristics of second order partial differential equations.
3. Practical problems to solve PDEs with Monge's method.
4. Practical problems to solve wave equation (one and two dimensional).
5. Practical problems to solve Laplace equation.
6. Practical problems to solve heat equation.
7. Practical problems to solve differential equations by Laplace transform method.
8. Practical problems to solve differential equations by Fourier transform method.

b) **LATEX Practicals**- Following practicals of typing documents using LATEX software will be done and records of those will be maintained in the practical notebook and the candidates will be asked by the examiner to type a document using more than one of these listed commands at the time of Semester end practical examination:

1. Create a new file in the work directory with the name note1.tex and to write a simple document in latex using following commands:

```
\documentclass [a4paper, 12pt]{article}
\begin{document}
A paragraph of text
\end{document}
```

2. Create a document to write code for a title page using

\title{...}, \author{...}, \date{...}, \today{...}, \maketitle {...} commands and \emph{...}, \texbf{...}, \texit{...} etc. commands.

3. Create a document to write a code to using \section{...}, \subsection{...}, \subsubsection{...}, \paragraph{...}, \subparagraph{…} commands and using environments to left justify, right justify, center and justify text.
4. Create a document to illustrate Latex commands for paper size, font size, font types and styles.
5. Create a document involving the mathematical equations.
   Use of $...$ and $$...$$ symbols and use of Power and Indices(^, _), Fractions(\frac{numerator}{denominator}), Roots(\sqrt{...}, \sqrt[…]{...}), Sums (\sum_{…}^{…}{…}), Product (\prod_{…}^{…}{…}), Integral (\int_a^b f(x) dx) within $...$ or $$...$$ symbols.
5. Use of commands for Greek letters and the commands \Re, \Im, \partial, \infty, \forall, \exists, \prime, \emptyset, \nabla, \surd,\parallel, \angle, \triangle, \backslash, \div, \vee, \wedge, \cap, \cup, \propto, \perp, \cong for Mathematical symbols and operations.
6. Use of \pm, \mp, \setminus, \cdot, \times,\ast, \hat, \bar,\dot, \ddot, \vec, \leq, \geq, \subset, \supset, \subseteq, \supseteq, \in, \neq,\equiv, \sim, \simeq, \approx commands for mathematical symbols and operators.
7. Create a document to produce equations using \begin{equation} … \end{equation} command and involving mathematical symbols, Greek letters and fractions.
8. Create a Latex document to illustrate the effect of enumerate listing and itemize listing.

B-MAT 601: Real Analysis–II

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	2	2	10	40	50	3 Hours
B.A.	2	2	10	40	50	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Learn basic theory of Riemann integration. Learn fundamental theorem and mean value theorem of integral calculus.
2. Understand improper integrals and to have knowledge to test their convergence. Understand integral as a function of a parameter. Apply this knowledge for problem solving.
3. Understand concepts of metric spaces, sub spaces and their properties. Learn open, closed and bounded sets, interior and limit points , Cauchy sequence and completeness.
4. Learn dense sets, compact and separable metric spaces and related results. Learn important theorems viz. Baire's category theorem, Banach contraction principle, Bolzano–Weierstrass property, Heine–Borel theorem. Use this basic knowledge for life - long learning purposes.

Unit-I:

Riemann integral, Integrabililty of continuous and monotonic functions, The Fundamental theorem of integral calculus. Mean value theorems of integral calculus.

Unit-II:

Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Continuity, Differentiability and integrability of an integral of a function of a parameter.

UNIT-III:

Definition and examples of metric spaces, Subspace of a metric space. Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, Limit points and isolated points, Closed sets, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set.

UNIT-IV:

Convergent and Cauchy sequences, Completeness of metric spaces, Cantor's intersection theorem. Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

Recommended Text Books:

1. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
2. R.R. Goldberg : Real analysis, Oxford & IBH publishing Co., New Delhi, 1970
3. D. Somasundaram and B. Choudhary : A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997
4. Shanti Narayan : A Course of Mathematical Analysis, S. Chand & Co., New Delhi
5. E. T. Copson (1988). *Metric Spaces*. Cambridge University Press.
6. P. R. Halmos (1974). *Naive Set Theory*. Springer.
7. P. K. Jain & Khalil Ahmad (2019). *Metric Spaces*. Narosa.
8. S. Kumaresan (2011). *Topology of Metric Spaces* (2nd edition). Narosa.
9. Satish Shirali&Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.
10. MicheálO'Searcoid (2009). *Metric Spaces*. Springer-Verlag.
11. G. F. Simmons (2004). *Introduction to Topology and Modern Analysis*. McGraw-Hill.

B-MAT 602: Complex Analysis

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**2**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Visualize complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complex plane on the Riemann sphere. Know De Moivre's Theorem and its Applications. Learn about trigonometric, circular and hyperbolic functions and their properties.
2. Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy–Riemann equations. Apply knowledge to solve related problems.
3. Learn complex integration and other related concepts. Know and understand Green's theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function.. Application of these results in problem solving.
4. Know and understand Liouville's theorem, fundamental theorem of algebra, Maximum modulus theorem. Application of these results in problem solving. Understand sequences, series and their convergence. Learn about Taylor series, Laurent series. of analytic functions.

Unit-I:

Complex numbers and their representation, algebra of complex numbers; Complex plane, Open set, Domain and region in complex plane; Stereographic projection and Riemann sphere.

De Moivre's Theorem and its Applications. Expansion of trigonometrical functions.

Direct circular and hyperbolic functions and their properties, Logarithm of a complex quantity, Summation of Trigonometric series.

Unit-II:

Complex functions and their limits including limit at infinity; Continuity and differentiability of a complex valued function. Analytic functions; Cauchy–Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability. Analyticity and zeros of exponential, trigonometric and logarithmic functions.

Unit-III:

Complex integration, Green's theorem, Anti-derivative theorem, Cauchy–Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function.

Unit-IV:

Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem and its consequences.

Sequences, series and their convergence, Taylor series and Laurent series of analytic functions.

Recommended Text Books:

1. Lars V. Ahlfors (2017). *Complex Analysis* (3rd edition). McGraw-Hill Education.
2. Joseph Bak & Donald J. Newman (2010). *Complex Analysis* (3rd edition). Springer.
3. James Ward Brown & Ruel V. Churchill (2009). *Complex Variables and Applications* (9th edition). McGraw-Hill Education.
4. John B. Conway (1973). *Functions of One Complex Variable*. Springer-Verlag.
5. E.T. Copson (1970). *Introduction to Theory of Functions of Complex Variable*. Oxford University Press.
6. Theodore W. Gamelin (2001). *Complex Analysis*. Springer-Verlag.
7. George Polya & Gordon Latta (1974). *Complex Variables*. Wiley.
8. H. A. Priestley (2003). *Introduction to Complex Analysis*. Oxford University Press.
9. E. C. Titchmarsh (1976). *Theory of Functions* (2nd edition). Oxford University Press.

B-MAT 603: Linear Programming

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	2	2	10	40	50	3 Hours
B.A.	2	2	10	40	50	3 Hours

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Familiarize with terminology of linear programming problems (LPP) and all other associated concepts. Analyze and solve linear programming problems of real life situations. Obtain solution of linear programming problems with graphical method.
2. Understand the theory of Simplex method to solve linear programming problems, basic feasible solution and criteria of optimality. Learn related problem solving.
3. Learn to apply knowledge of simplex algorithm in solving real life LPP by several methods.
4. Understand dual problems, duality theorem and to solve linear programming problems by making use of duality theorem. Use these tools for science and society.

Unit-I:

Linear Programming Problems, Definition, objective function, constraints, Canonical and Standard forms. Graphical Approach for solving some Linear Programs, limitations of graphical method. Convex and polyhedral sets, Extreme points, Basic solutions, Basic Feasible Solutions,

Unit-II:

Correspondence between basic feasible solutions and extreme points. Theory of simplex method, Concept of initial basic feasible solution, Optimality criterion, Improving a basic feasible solution, Unboundedness.

Unit-III:

Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-*M* method. Relation between maximization and minimization problems, Solving numerical problems using simplex algorithm.

Unit-IV:

Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory.

Recommended Text Books:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). *Linear Programming and Network Flows* (4th edition). John Wiley & Sons.
2. G. Hadley (2002). *Linear Programming*. Narosa Publishing House.
3. Frederick S. Hillier & Gerald J. Lieberman (2015). *Introduction to Operations Research* (10th edition). McGraw-Hill Education.
4. Hamdy A. Taha (2017). *Operations Research*: *An Introduction* (10th edition). Pearson.
5. Paul R. Thie & Gerard E. Keough (2014). *An Introduction to Linear Programming and Game Theory* (3rd edition). Wiley India Pvt. Ltd.

B-MAT 604: Probability and Statistics

Programme	Course Credit (Theory)	Teaching Hours per week	Internal Assessment Marks	External Theory Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**2**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**2**	**10**	**40**	**50**	**3 Hours**

Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course outcomes (COs) into consideration. The compulsory question (Question No. 1) will contain 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Course Outcomes: This course will enable the students to:

1. Understand probability, distribution function, probability density functions and Joint probability distribution function and learn to use those for problem solving.
2. Learn about mathematical expectation, moments, moment generating function uniform, binomial, Bernoulli, geometric and Poisson distributions and their uses in problem solving.
3. Learn Uniform, Gamma, Exponential, Chi-square and Normal continuous distributions, bivariate distribution and marginal distribution.
4. Learn to find correlation coefficient, covariance, linear regression and to solve problems by method of least squares. Apply this knowledge and studied tools in investigation and solution of problems.

Unit-I:

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Joint Probability Distribution function, Joint Density function.

Unit-II:

Mathematical expectation, Moments, Moment generating function, Joint moment generating function, Characteristic function. Discrete distributions**:** Bernoulli, Binomial, Negative binomial, Geometric and Poisson.

Unit-III:

Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Normal; Bivariate normal distribution, Marginal distributions.

Unit-IV:

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares.

Recommended Text Books:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7^{th} edition), Pearson Education.
2. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8^{th}edition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11^{th} edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

B-MAT 605: PRACTICAL -VI

Programme	Course Credit (Practical)	Practical Hours per week	Internal Assessment Marks	External Examination Marks	Maximum Marks	End Term Examination Time
B.Sc.	**2**	**4**	**10**	**40**	**50**	**3 Hours**
B.A.	**2**	**4**	**10**	**40**	**50**	**3 Hours**

Note: This course has two components, Problem Solving and Practical using LATEX software. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration. The examinee will be required to solve one problem from the part (a) and to execute one program successfully from the part (b). Equal weightage will be given to both the parts. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course Outcomes: This course will enable the students to:

1. Attain skills to solve practical Linear Programming Problems using graphical method, simplex method and other methods.

   OR

1. Attain skills to measure a dispersion, find correlation coefficient, regression line and to fit a curve through given data points.
2. Learn tools for solving practical transportation problems using Vogel's method, (**u v**) method and matrix method.

   OR

2. Apply knowledge to solve practical problems related to Binomial, Normal and Poisson distributions.

3. Attain skills to type a document which includes mathematical symbols, expressions, equations, tables and matrices by making use of LATEX software.

4. Have hands-on experience to type a document in LATEX which illustrates abstract, citation, footnotes, hyperlinks and bibliography.

a) **Linear Programming Problem Solving-** Questions related to the following problems will be solved using scientific calculator and record of those will be maintained in the Practical Notebook:

1) To solve a Linear Programming Problem by Simplex method with unique solution or with unbounded solution.
2) To solve a Linear Programming Problem by Two Phase method.
3) To solve a Linear Programming Problem by Big M- Method.
4) To solve a Linear Programming Problem using duality.
5) To obtain an optimal solution by Dual Simplex Method.
6) To determine optimal solution of a transportation problem using Vogel's method.
7) Determine optimal solution of transportation problem using (**u v**) method.
8) Determine an initial basic feasible solution of transportation problem by matrix method.

OR

a) **Problem Solving of Statistics and Probability-** Questions related to the following problems will be solved using scientific calculator and record of those will be maintained in the Practical Notebook:

1) Practical problems based on measures of dispersion (variance, standard deviation and coefficient of variation).
2) To compute Karl Pearson's coefficient of correlation for given bivariate frequency distribution.
3) To obtain the regression lines for given data.
4) Practical problems based on Binomial distribution.
5) Practical problems based on Poisson distribution.
6) Practical problems based on Normal distribution.
7) To fit a straight line for the given data on pairs of observations.
8) Practical problem solving related to expectation of random variables.

b) **LATEX Practicals**- Following practicals of typing documents using LATEX software will be done and records of those will be maintained in the practical notebook and the candidates will be asked by the examiner to type a document using more than one of these listed commands at the time of Semester end practical examination:

1. Create a document with mixed math and text note. Type some mathematical expressions related to limit, continuity, derivative and differential equations using suitable environment for mathematics formulas and also \begin{eqnarray} ...\end{eqnarray} and \begin{equation} ...

   \end {equation} environment.
2. Create a document to typeset arithmetic operations, subscripts, superscripts, accents, operators, binomial coefficients, congruences, delimiters and integrals.
3. Create a document to produce tables using commands:

\begin{tabular}{…}

l for a column of left-aligned text ,

r for a column of right-aligned text,

c for a column of centre-aligned text,

| for a vertical line

and following \begin command, table data is written by using following symbols;

& is placed between columns,

\\ is placed at the end of a row (to start a new one),

\hline inserts a horizontal line.

\cline{1-2} inserts a partial horizontal line between column 1 and column 2,

the command \end{tabular} finishes the table.

4. Create a document including figures by using following commands:

\usepackage{graphicx} (graphic package is used for figures)

\begin{figure}[h!]

\centering

\includegraphics[width=1\textwidth]{ImageFilename}

\caption{My test image}

\label{…}

\end{figure}

5. Create a document using matrix using the following commands:

```
\usepackage {amsmath}
\begin{matrix}
…
\end{matrix}
\begin{pmatrix}
…
\end{pmatrix}
\begin{bmatrix}
…
\end{bmatrix}
\begin{vmatrix}
…
\end{vmatrix}
```

6. Create a document illustrating use of \begin{abstract} ...\end{abstract}, \begin{theorem} ... \end{theorem}, and \begin{definition} ... \end{definition} formats.
7. Create a document illustrating references, citations, footnotes and hyperlinks.
8. Create a document to generate bibliography.

Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)
(“A+” Grade, NAAC Accredited)

SCHEME/STRUCTURE and SYLLABUS

of

Master of Science in Mathematics

CBCS LOCF
With Effect From Academic Session 2020-21

DEPARTMENT OF MATHEMATICS

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119

HARYANA, INDIA

1. **Program Outcomes (POs)**

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

2. **Program Specific Outcomes (PSOs)**
   After successful completion of the programme, a student will be able to:

PSO1	Have deep understanding and knowledge in the core areas of Mathematics and demonstrate understanding and application of the concepts/theories/principles/ methods/ techniques in different areas of pure and applied Mathematics.
PSO2	Have capability to read and understand mathematical texts, demonstrate and communicate mathematical knowledge effectively and unambiguously through oral and/or written expressions and attain skills of computing/programming/using software tools/formulating models.
PSO3	Attain abilities of critical thinking, logical reasoning, investigating problems, analysis, problem solving, application of mathematical methods/techniques, disciplinary knowledge so as to develop skills to solve mathematical problems having applications in other disciplines and/or in the real world.
PSO4	Have strong foundation in basic and applied aspects of Mathematics so as to venture into research in different areas of mathematical sciences, jobs in scientific and various industrial sectors and/or teaching career in Mathematics.

3. **Programme Scheme/ Structure:**

   The M.Sc. Mathematics programme is a two-year programme divided into foursemesters. A student is required to complete at least 116 credits for the completion of the course and the award of degree. Of these, 82 credits have to be earned from Core Courses, 30 from Elective coursesand 4 credits from open elective courses.

	SEMESTER	**SEMESTER**
PART-I (FIRST YEAR)	Semester I	Semester II
PART-II (SECOND YEAR)	Semester III	Semester IV

This Scheme will be effective in phased manner from the session 2020-21 initially for University Teaching Department of Mathematics.

4. **4.1 Course Credit Scheme:**

Semester	Core Courses			Elective Courses			Open Elective Courses			Total Credits
	No. of Courses	Credits (L+T+P+S)	Total Credits	No. of Courses	Credits (L+T)	Total Credits	No. of Courses	Credits (L+T)	Total Credits	
I	7	20+5+2+2	29	Nil	Nil	Nil	Nil		Nil	**29**
II	6	20+5+2+0	27	Nil	Nil	Nil	1	2+0	2	**29**
III	3	8+2+2+0	12	03	12+3	15	1	2+0	2	**29**
IV	4	8+2+2+2	14	03	12+3	15	Nil		Nil	**29**
Maximum Credits including Open Elective offered by the other departments			**82**			**30**			**4***	**116**
							***4 Credits are to be earned from open electives of other Departments or from MOOCs courses**			
Minimum Credits Required			**82**			**30**			**4***	**116**

4.2 Contact hours per weeks for M.Sc. Mathematics CBCS LOCF Programme

	Core Courses (CC)	Elective Courses	Open Elective Courses	Total hours
Theory	56	24	4	84
Tutorial	14	6	-	20
Practical	16	-	-	16
Seminar	4		-	4
Total	90	30	4	**124**

4.3 Duration of Examination Hours

Duration of End Term Theory Examination	3 Hours
Duration of End Term Practical Examination	4 Hours

5. **Structure/Scheme of Examination for M.Sc. Mathematics CBCS LOCF Programme**

Semester	Core Courses	Elective Courses	Open Elective Courses
I	Core Course 1 Abstract Algebra Core Course 2 Complex Analysis Core Course 3 Ordinary Differential Equations Core Course 4 Real Analysis Core Course 5 Topology Core Course 6 Practical-I Core Course 7 Seminar-I		
II	Core Course 8 Advanced Abstract Algebra Core Course 9 Computer Programming with MATLAB Core Course 10 Differential Equations Core Course 11 Measure and Integration Core Course 12 Mechanics of Solids Core Course 13 Practical-II		Open Elective 1 Basic Mathematics-I
III	Core Course 14 Fluid Mechanics Core Course 15 Functional Analysis Core Course 16 Practical-III	Elective 1 Elective 2 Elective 3	Open Elective 2 Basic Mathematics-II
IV	Core Course 17 Mechanics and Calculus of Variations Core Course 18 Partial Differential Equations Core Course 19 Practical-IV Core Course 20 Seminar-II	Elective 4 Elective 5 Elective 6	
Note: **Open Elective Course :** In each of the Semester II and Semester III, one open Elective course is to be opted out of the list of such courses offered at the University/Institute/College level OR one can choose a MOOC course of minimum credit 2 offered at SWAYAM Portal in that semester.			
Note: The open elective courses, Basic Mathematics-I and Basic Mathematics-II, will be offered to the students other than students of M.Sc. Mathematics Programme.			

with effect from the Session 2020-21 in phased manner

Elective 1- A student will opt for one of the following courses:

i.	MMATH21-304	Advanced Topology
ii.	MMATH21-305	Commutative Algebra
iii.	MMATH21-306	Differential Geometry
iv.	MMATH21-307	Elasticity

Elective 2- A student will opt for one of the following courses:

i.	MMATH21-308	Advanced Numerical Analysis
ii.	MMATH21-309	Fuzzy Sets and Applications
iii.	MMATH21-310	Mathematical Statistics
iv.	MMATH21-311	Number Theory

Elective 3- A student will opt for one of the following courses:

i.	MMATH21-312	Algebraic Coding Theory
ii.	MMATH21-313	Financial Mathematics
iii.	MMATH21-314	Integral Equations
iv.	MMATH21-315	Mathematical Modeling

Elective 4 - A student will opt for one of the following courses:

i.	MMATH21-405	Advanced Complex Analysis
ii.	MMATH21-406	Algebraic Number Theory
iii.	MMATH21-407	General Measure and Integration Theory
iv.	MMATH21-408	Mathematical Aspects of Seismology

Elective 5 - A student will opt for one of the following courses:

i.	MMATH21-409	Advanced Discrete Mathematics
ii.	MMATH21-410	Advanced Functional Analysis
iii.	MMATH21-411	Advanced Fluid Mechanics
	MMATH21-412	Boundary Value Problems

Elective 6 - A student will opt for one of the following courses:

	MMATH21-413	Bio-Mathematics
	MMATH21-414	Fourier and Wavelet Analysis
	MMATH21-415	Linear Programming
	MMATH21-416	Non-Commutative Rings

Choice of Elective Courses:

Under each Elective course a student may choose one course from a given basket of four options or amongst the courses actually offered by the Department/Institute/College. In case a particular course is over-subscribed, merit in the previous semester(s) examination(s) or the number of preferencesor the availability of teacher(s) or feasibility of the option will be taken into account to determine course allocations. The decision of the Department/Institute/College shall be final in this regard.

Scheme / Structure of M.Sc. Mathematics CBCS LOCF Programme with effect from the Session 2020-21 in phased manner

Semester - I

Course Code	**Course Type**	**Nomenclature**	**Teaching Hours**			**Credits**	**Maximum Marks**		
			L	**P**	**T/S**		**Ext**	**Int**	**Total**
MMATH20-101	Core	Abstract Algebra	4	0	1	5	80	20	100
MMATH20-102	Core	Complex Analysis	4	0	1	5	80	20	100
MMATH20-103	Core	Ordinary Differential Equations	4	0	1	5	80	20	100
MMATH20-104	Core	Real Analysis	4	0	1	5	80	20	100
MMATH20-105	Core	Topology	4	0	1	5	80	20	100
MMATH20-106	Core	Practical-I	0	4	0	2	40	10	50
MMATH20-107	Core	Seminar-I	0	0	2	2	0	50	50
		Total	**20**	**4**	**7**	**29**	**440**	**160**	**600**

Each End Term Theory Examination will be of three hours duration and End Term Practical Examination will be of four hours duration.

Semester – II

Course Code	Course Type	Nomenclature	Teaching Hours per week			Credits	Maximum Marks		
			L	**P**	**T/S**		**Ext**	**Int**	**Total**
MMATH20-201	Core	Advanced Abstract Algebra	4	0	1	5	80	20	100
MMATH20-202	Core	Computer Programming with MATLAB	4	0	1	5	80	20	100
MMATH20-203	Core	Differential Equations	4	0	1	5	80	20	100
MMATH20-204	Core	Measure and Integration	4	0	1	5	80	20	100
MMATH20-205	Core	Mechanics of Solids	4	0	1	5	80	20	100
MMATH20-206	Core	Practical-II	0	4	0	2	40	10	50
	Open Elective	Open Elective 1 #	-	-	-	2	40	10	50
		# One Open Elective course is to be opted out of the list of such courses offered at the University/Institute level OR A MOOC course offered at SWAYAM Portal in an even semester.							
OEM20-207	Open Elective	Basic Mathematics-I	2	0	0	2*	40*	10*	50*
		(*This open elective course will be offered and credited to the students other than students of M.Sc. Mathematics)							
		Total	**22**	**4**	**5**	**29**	**480**	**120**	**600**

Each End Term Theory Examination will be of three hours duration and End Term Practical Examination will be of four hours duration.

Semester – III

Course Code	Course Type	Nomenclature	Teaching Hours per week			Credits	Maximum Marks		
			L	P	T/S		Ext	Int	Total
Core Papers									
MMATH21-301	Core	Fluid Mechanics	4	0	1	5	80	20	100
MMATH21-302	Core	Functional Analysis	4	0	1	5	80	20	100
MMATH21-303	Core	Practical-III	0	4	0	2	40	10	50
Elective 1		**Any One of the following:**							
MMATH21-304	Elective	Advanced Topology	4	0	1	5	80	20	100
MMATH21-305	Elective	Commutative Algebra	4	0	1	5	80	20	100
MMATH21-306	Elective	Differential Geometry	4	0	1	5	80	20	100
MMATH21-307	Elective	Elasticity	4	0	1	5	80	20	100
Elective 2		**Elective**							
MMATH21-308	Elective	Advanced Numerical Analysis	4	0	1	5	80	20	100
MMATH21-309	Elective	Fuzzy Sets and Applications	4	0	1	5	80	20	100
MMATH21-310	Elective	Mathematical Statistics	4	0	1	5	80	20	100
MMATH21-311	Elective	Number Theory	4	0	1	5	80	20	100
Elective 3		**Elective**							
MMATH21-312	Elective	Algebraic Coding Theory	4	0	1	5	80	20	100

MMATH21 -313	Elective	Financial Mathematics	4	0	1	5	80	20	100
MMATH21 -314	Elective	Integral Equations	4	0	1	5	80	20	100
MMATH21 -315	Elective	Mathematical Modeling	4	0	1	5	80	20	100
	Open Elective	Open Elective 2#	-	-	-	2	40	10	50
		# One Open Elective course is to be opted out of the list of such courses offered at the University/Institute level OR A MOOC course offered at SWAYAM Portal in an odd semester.							
OEM21-316	Open Elective	Basic Mathematics-II *	2	0	0	2*	40*	10*	50*
		(*This open elective paper will be offered and credited to the students other than students of M.Sc. Mathematics)							
		Total	**22**	**4**	**5**	**29**	**480**	**120**	**600**

Each End Term Theory Examination will be of three hours duration and End Term Practical Examination will be of four hours duration.

Semester – IV

Course Code	Course Type	Nomenclature	Teaching Hours per week			Credits	Maximum Marks		
			L	**P**	**T/S**		**Ext**	**Int**	**Total**
Core Papers									
MMATH21 -401	Core	Mechanics and Calculus of Variations	4	0	1	5	80	20	100
MMATH21 -402	Core	Partial Differential Equations	4	0	1	5	80	20	100
MMATH21 -403	Core	Practical – IV	0	4	0	2	40	10	50
MMATH21 -404	Core	Seminar-II	0	0	2	2	0	50	50
Elective 4		**Any One of the following:**							
MMATH21 -405	Elective	Advanced Complex Analysis	4	0	1	5	80	20	100
MMATH21 -406	Elective	Algebraic Number Theory	4	0	1	5	80	20	100
MMATH21 -407	Elective	General Measure and Integration Theory	4	0	1	5	80	20	100
MMATH21 -408	Elective	Mathematical Aspects of Seismology	4	0	1	5	80	20	100
Elective 5		**Any One of the following:**							
MMATH21 -409	Elective	Advanced Discrete Mathematics	4	0	1	5	80	20	100
MMATH21 -410	Elective	Advanced Functional Analysis	4	0	1	5	80	20	100

MMATH21-411	Elective	Advanced Fluid Mechanics	4	0	1	5	80	20	100
MMATH21-412	Elective	Boundary Value Problems	4	0	1	5	80	20	100
Elective 6		**Any One of the following:**							
MMATH21-413	Elective	Bio-Mathematics	4	0	1	5	80	20	100
MMATH21-414	Elective	Fourier and Wavelet Analysis	4	0	1	5	80	20	100
MMATH21-415	Elective	Linear Programming	4	0	1	5	80	20	100
MMATH21-416	Elective	Non-Commutative Rings	4	0	1	5	80	20	100
		Total	**20**	**4**	**7**	**29**	**440**	**160**	**600**

Each End Term Theory Examination will be of three hours duration and End Term Practical Examination will be of four hours duration.

CO-PSO matrix for the course MMATH20-101 (Abstract Algebra)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-101.1	3	2	2	2
MMATH20-101.2	3	2	2	3
MMATH20-101.3	3	2	2	2
MMATH20-101.4	3	2	3	3
Average	**3**	**2**	**2.25**	**2.5**

CO-PO matrix for the course MMATH20-101 (Abstract Algebra)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 20-101.1	3	3	2	3	-	2	2	-	2	-	2
MMATH 20-101.2	3	3	2	3	-	2	2	-	2	-	2
MMATH 20-101.3	3	3	2	3	-	2	2	-	2	-	2
MMATH 20-101.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PSO matrix for the course MMATH20-102 (COMPLEX ANALYSIS)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-102.1	3	3	2	3
MMATH20-102.2	3	2	3	3
MMATH20-102.3	2	3	3	3
MMATH20-102.4	2	3	3	3
Average	**2.5**	**2.75**	**2.75**	**3**

CO-PO matrix for the course MMATH20-102 (COMPLEX ANALYSIS)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-102.1	3	2	3	3	2	2	3	2	3	--	--
MMATH20-102.2	3	2	3	3	2	2	3	2	3	--	--
MMATH20-102.3	3	2	3	3	2	2	3	2	3	--	2
MMATH20-102.4	3	2	3	3	2	2	3	2	3	--	2
Average	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**--**	**2**

CO-PSO matrix for the course MMATH20-103 (Ordinary Differential Equations)

	PSO1	PSO2	PSO3	PSO4
MMATH20-103.1	3	3	3	3
MMATH20-103.2	3	3	3	3
MMATH20-103.3	3	3	3	3
MMATH20-103.4	3	2	2	3
Average	**3**	**2.75**	**2.75**	**3**

CO-PO matrix for the course MMATH20-103 (Ordinary Differential Equations)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-103.1	3	3	3	3	2	2	2	2	3	-	2
MMATH20-103.2	3	3	3	3	3	3	3	3	3	-	3
MMATH20-103.3	3	3	3	3	3	3	3	3	3	--	3
MMATH20-103.4	3	3	3	3	2	2	2	3	3	-	2
Average	**3**	**3**	**3**	**3**	**2.5**	**2.5**	**2.5**	**2.75**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH20-104 (Real Analysis)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-104 .1	3	3	3	3
MMATH20-104 .2	3	2	2	3
MM20-104 .3	3	3	3	3
MM20-104 .4	3	3	3	3
Average	**3**	**2.75**	**2.75**	**3**

CO-PO matrix for the course MMATH20-104 (Real Analysis)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-104 .1	3	3	3	3	3	3	3	3	3	-	2
MMATH20-104 .2	3	3	2	3	2	3	2	2	3	-	-
MMATH20-104 .3	3	3	2	3	2	3	2	2	3	--	-
MMATH20-104 .4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**2.5**	**3**	**2.5**	**3**	**2.5**	**2.5**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH20-105 (Topology)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-105 .1	3	3	3	3
MMATH20-105 .2	3	2	2	3
MMATH20-105 .3	3	2	3	3
MMATH20-105 .4	3	3	2	3
Average	**3**	**2.5**	**2.5**	**3**

CO-PO matrix for the course MMATH20-105 (Topology)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-105 .1	3	3	2	3	2	3	3	3	3	-	2
MMATH20-105 .2	3	3	2	3	2	3	2	2	3	-	-
MMATH20-105 .3	3	3	2	3	2	3	2	2	3	--	-
MMATH20-105 .4	3	3	2	3	2	3	2	2	3	-	2
Average	**3**	**3**	**2**	**3**	**2**	**3**	**2.25**	**2.25**	**3**	**-**	**2**

CO-PSO matrix for the course MMATH20-106 (PRACTICAL-I)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-106.1	3	3	3	2
MMATH20-106.2	3	3	3	3
MMATH20-106.3	2	3	3	3
MMATH20-106.4	2	3	3	3
Average	**2.25**	**3**	**3**	**2.75**

CO-PO matrix for the course MMATH20-106 (PRACTICAL-I)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-106.1	3	3	2	3	3	3	3	--	3	--	3
MMATH20-106.2	3	3	2	3	3	3	3	--	3	--	3
MMATH20-106.3	3	3	2	3	3	3	3	3	3	--	3
MMATH20-106.4	3	3	2	3	3	3	3	3	3	--	3
Average	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**--**	**3**

CO-PSO matrix for the course MMATH20-107 (SEMINAR-I)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-107.1	3	3	2	3
MMATH20-107.2	3	3	3	3
MMATH20-107.3	3	3	3	3
MMATH20-107.4	3	3	2	3
Average	**3**	**3**	**2.5**	**3**

CO-PO matrix for the course MMATH20-107 (SEMINAR-I)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-107.1	3	3	2	2	3	3	2	3	3	1	3
MMATH20-107.2	3	3	2	3	2	3	2	3	3	1	3
MMATH20-107.3	3	2	3	3	3	2	2	2	3	1	3
MMATH20-107.4	3	2	3	3	3	3	2	2	3	1	3
Average	**3**	**2.5**	**2.5**	**2.75**	**2.75**	**2.75**	**2**	**2.5**	**3**	**1**	**3**

CO-PSO matrix for the course MMATH20-201 (Advanced Abstract Algebra)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-201.1	3	2	2	2
MMATH20-201.2	3	2	2	2
MMATH20-201.3	3	2	2	2
MMATH20-201.4	3	2	3	3
Average	**3**	**2**	**2.25**	**2.25**

CO-PO matrix for the course MMATH20-201 (Advanced Abstract Algebra)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 20-201.1	3	3	2	3	-	2	2	-	2	-	2
MMATH 20-201.2	3	3	2	3	-	2	2	-	2	-	2
MMATH 20-201.3	3	3	2	3	-	2	2	-	2	--	2
MMATH 20-201.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PSO matrix for the course MMATH20-202 (COMPUTER PROGRAMMING with MATLAB)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-202.1	2	2	3	3
MMATH20-202.2	3	3	3	3
MMATH20-202.3	2	2	3	3
MMATH20-202.4	3	3	3	3
Average	**2.5**	**2.5**	**3**	**3**

CO-PO matrix for the course MMATH20-202 (COMPUTER PROGRAMMING with MATLAB)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-202.1	3	2	2	2	3	3	3	3	3	--	3
MMATH20-202.2	3	3	3	3	3	3	3	3	3	--	3
MMATH20-202.3	3	3	3	3	3	2	3	3	3	--	3
MMATH20-202.4	3	3	2	3	3	3	3	3	3	--	3
Average	**3**	**2.75**	**2.5**	**2.75**	**3**	**2.75**	**3**	**3**	**3**	**--**	**3**

CO-PSO matrix for the course MMATH20-203 (Differential Equations)

	PSO1	PSO2	PSO3	PSO4
MMATH20-203.1	3	3	3	3
MMATH20-203.2	3	3	3	3
MMATH20-203.3	3	3	3	3
MMATH20-203.4	3	2	3	3
Average	**3**	**2.75**	**3**	**3**

CO-PO matrix for the course MMATH20-203 (Differential Equations)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-203.1	3	2	3	3	3	2	3	3	3	-	3
MMATH20-203.2	3	3	3	3	2	3	3	3	3	-	3
MMATH20-203.3	3	3	3	3	3	3	3	3	3	--	2
MMATH20-203.4	3	3	3	3	3	3	2	2	3	-	2
Average	**3**	**2.75**	**3**	**3**	**2.75**	**2.75**	**2.75**	**2.75**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH20-204 (Measure and Integration)

Cos	PSO1	PSO2	PSO3	PSO4
MMATH20-204 .1	3	3	3	3
MMATH20-204 .2	3	2	3	3
MMATH20-204 .3	3	2	3	3
MMATH20-204 .4	3	3	2	3
Average	**3**	**2.5**	**2.75**	**3**

CO-PO matrix for the course MMATH20-204 (Measure and Integration)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-204 .1	3	3	3	3	2	3	3	3	3	-	2
MMATH20-204 .2	3	3	2	3	2	3	2	3	2	-	2
MMATH20-204 .3	3	3	3	3	2	3	3	3	3	--	2
MMATH20-204 .4	3	3	2	3	2	3	2	3	2	-	2
Average	**3**	**3**	**2.5**	**3**	**2**	**3**	**2.5**	**3**	**2.5**	**-**	**2**

CO-PSO matrix for the course MMATH20-205 (Mechanics of Solids)

	PSO1	PSO2	PSO3	PSO4
MMATH20-205.1	3	3	3	3
MMATH20-205.2	3	3	3	3
MMATH20-205.3	3	2	3	3
MMATH20-205.4	3	3	3	3
Average	**3**	**2.75**	**3**	**3**

CO-PO matrix for the course MMATH20-205 (Mechanics of Solids)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-205.1	3	3	3	3	3	3	3	2	3	-	3
MMATH20-205.2	3	3	3	3	3	3	2	3	3	-	3
MMATH20-205.3	3	3	3	3	3	2	2	3	3	--	3
MMATH20-205.4	3	3	3	3	3	3	3	3	3	-	2
Average	**3**	**3**	**3**	**3**	**3**	**2.75**	**2.5**	**2.75**	**3**	**-**	**2.75**

CO-PSO matrix for the course MMATH20-206 (PRACTICAL-II)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-206.1	3	3	3	2
MMATH20-206.2	3	3	3	3
MMATH20-206.3	2	3	3	3
MMATH20-206.4	2	3	3	3
Average	**2.5**	**3**	**3**	**2.75**

CO-PO matrix for the course MMATH20-206 (PRACTICAL-II)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-206.1	3	3	2	3	3	3	3	--	3	--	3
MMATH20-206.2	3	3	2	3	3	3	3	3	3	--	3
MMATH20-206.3	3	3	2	3	3	3	3	3	3	--	3
MMATH20-206.4	3	3	2	3	3	3	3	3	3	--	3
Average	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**--**	**3**

CO-PSO matrix for the course OEM20-207 (Basic Mathematics-I)

	PSO1	PSO2	PSO3	PSO4
OEM20-207.1	3	2	2	3
OEM20-207.2	3	3	3	3
OEM20-207.3	3	3	3	3
OEM20-207.4	3	3	3	3
Average	**3**	**2.75**	**2.75**	**3**

CO-PO matrix for the course OEM20-207 (Basic Mathematics-I)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEM20-207.1	3	3	2	3	-	2	2	-	3	-	3
OEM20-207.2	3	3	2	3	-	2	3	-	3	-	3
OEM20-207.3	3	3	3	3	-	3	3	-	3	--	3
OEM20-207.4	3	3	3	3	-	3	3	-	3	-	3
Average	**3**	**3**	**2.5**	**3**	**-**	**2.5**	**2.75**	**-**	**3**	**-**	**3**

CO-PSO matrix for the course MMATH21-301 (Fluid Mechanics)

CO	PSO1	PSO2	PSO3	PSO4
MMATH21-301.1	3	3	3	3
MMATH21-301.2	3	3	3	3
MMATH21-301.3	3	2	3	3
MMATH21-301.4	3	3	3	3
Average	**3**	**2.75**	**3**	**3**

CO-PO matrix for the course MMATH21-301 (Fluid Mechanics)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-301.1	3	2	3	3	3	3	3	3	3	-	3
MMATH21-301.2	3	3	3	3	3	3	2	3	3	-	2
MMATH21-301.3	3	3	3	3	2	2	3	3	3	--	3
MMATH21-301.4	3	3	3	3	2	2	2	3	3	-	2
Average	**3**	**2.75**	**3**	**3**	**2.5**	**2.5**	**2.5**	**3**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH21-302 (Functional Analysis)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-302 .1	3	3	3	3
MMATH21-302 .2	3	3	3	3
MMATH21-302 .3	3	3	3	3
MMATH21-302 .4	3	2	2	3
Average	**3**	**2.75**	**2.75**	**3**

CO-PO matrix for the course MMATH21-302 (Functional Analysis)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-302 .1	3	3	3	3	3	3	3	3	3	-	2
MMATH21-302 .2	3	3	2	3	2	3	3	2	3	-	3
MMATH21-302 .3	3	3	3	3	3	3	3	2	3	--	3
MMATH21-302 .4	3	3	3	3	2	3	3	3	3	-	2
Average	**3**	**3**	**2.75**	**3**	**2.5**	**3**	**3**	**2.5**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH21-303 (PRACTICAL-III)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-303.1	3	3	3	3
MMATH21-303.2	3	3	3	3
MMATH21-303.3	2	3	3	2
MMATH21-303.4	2	3	3	3
Average	**2.5**	**3**	**3**	**2.75**

CO-PO matrix for the course MMATH21-303 (PRACTICAL-III)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-303.1	3	3	2	3	3	2	3	3	3	--	3
MMATH21-303.2	3	3	2	3	3	2	3	2	3	--	3
MMATH21-303.3	3	3	2	3	3	3	3	3	3	--	3
MMATH21-303.4	3	3	2	3	3	3	3	3	3	--	3
Average	**3**	**3**	**2**	**3**	**3**	**2.5**	**3**	**2.75**	**3**	**--**	**3**

CO-PSO matrix for the course MMATH21-304 (Advanced Topology)

	PSO1	PSO2	PSO3	PSO4
MMATH21-304 .1	3	2	3	3
MMATH21-304 .2	3	2	2	3
MMATH21-304 .3	3	2	3	3
MMATH21-304 .4	3	2	2	3
Average	**3**	**2**	**2.5**	**3**

CO-PO matrix for the course MMATH21-304 (Advanced Topology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-304 .1	3	3	2	3	2	3	3	3	3	-	2
MMATH21-304 .2	3	3	2	3	2	3	2	2	3	-	2
MMATH21-304 .3	3	3	2	3	2	3	2	2	3	--	-
MMATH21-304 .4	3	3	2	3	2	3	2	2	3	-	-
Average	**3**	**3**	**2**	**3**	**2**	**3**	**2.25**	**2.25**	**3**	**-**	**2**

CO-PSO matrix for the course MMATH21-305 (Commutative Algebra)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-305.1	3	2	2	2
MMATH21-305.2	3	2	2	2
MMATH21-305.3	3	2	2	2
MMATH21-305.4	3	2	2	2
Average	**3**	**2**	**2**	**2**

CO-PO matrix for the course MMATH21-305 (Commutative Algebra)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-305.1	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-305.2	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-305.3	3	3	2	3	-	2	2	-	2	--	2
MMATH 21-305.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PSO matrix for the course MMATH21-306 (DIFFERENTIAL GEOMETRY)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-306.1	3	3	3	3
MMATH21-306.2	3	2	3	3
MMATH21-306.3	3	2	2	3
MMATH21-306.4	3	3	3	3
Average	**3**	**2.5**	**2.75**	**3**

CO-PO matrix for the course MMATH21-306 (DIFFERENTIAL GEOMETRY)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-306 .1	3	3	3	3	3	3	3	3	3	--	3
MMATH21-306 .2	3	3	3	3	3	3	3	3	3	--	3
MMATH21-306 .3	3	3	2	3	2	3	3	3	3	--	2
MMATH21-306 .4	3	3	3	3	2	2	2	3	3	--	2
Average	**3**	**3**	**2.75**	**3**	**2.5**	**2.75**	**2.75**	**3**	**3**	**--**	**2.5**

CO-PSO matrix for the course MMATH21-307 (ELASTICITY)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-307.1	3	3	2	3
MMATH21-307.2	3	2	3	3
MMATH21-307.3	3	3	3	3
MMATH21-307.4	3	3	3	3
Average	**3**	**2.75**	**2.75**	**3**

CO-PO matrix for the course MMATH21-307 (ELASTICITY)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-307.1	3	3	2	3	3	3	3	3	3	--	3
MMATH21-307.2	3	3	2	3	3	3	3	3	3	--	3
MMATH21-307.3	3	3	3	3	2	3	3	3	3	--	3
MMATH21-307.4	3	3	3	3	3	3	3	3	3	--	2
Average	**3**	**3**	**2.5**	**3**	**2.75**	**3**	**3**	**3**	**3**	**--**	**2.75**

CO-PSO matrix for the course MMATH21-308 (ADVANCED NUMERICAL ANALYSIS)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-308.1	3	3	2	3
MMATH21-308.2	3	3	3	3
MMATH21-308.3	3	3	3	3
MMATH21-308.4	3	3	3	3
Average	**3**	**3**	**2.75**	**3**

CO-PO matrix for the course MMATH21-308 (ADVANCED NUMERICAL ANALYSIS)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-308.1	3	3	3	3	2	3	3	3	3	--	3
MMATH21-308.2	3	3	2	3	2	3	3	2	3	--	3
MMATH21-308.3	3	3	3	3	3	3	3	2	3	--	3
MMATH21-308.4	3	3	3	3	3	3	3	3	3	--	3
Average	**3**	**3**	**2.75**	**3**	**2.5**	**3**	**3**	**2.5**	**3**	**--**	**3**

CO-PSO matrix for the course MMATH21-309 (Fuzzy Sets and Applications)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-309.1	3	3	2	3
MMATH21-309.2	3	2	3	3
MMATH21-309.3	3	2	3	3
MMATH21-309.4	3	3	3	3
Average	**3**	**2.5**	**2.75**	**3**

CO-PO matrix for the course MMATH21-309 (Fuzzy Sets and Applications)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-309.1	3	3	3	3	2	3	3	3	3	-	3
MMATH21-309.2	3	3	3	3	2	3	3	3	2	-	3
MMATH21-309.3	3	3	2	3	2	3	2	3	2	--	2
MMATH21-309.4	3	3	3	3	2	3	3	3	3	-	3
Average	**3**	**3**	**2.75**	**3**	**2**	**3**	**2.75**	**3**	**2.5**	**-**	**2.75**

CO-PSO matrix for the course MMATH21-310 (Mathematical Statistics)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-310.1	3	3	3	3
MMATH21-310.2	3	3	3	3
MMATH21-310.3	3	3	3	3
MMATH21-310.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course MMATH21-310 (Mathematical Statistics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-310.1	3	3	2	3	2	3	3	2	3	-	3
MMATH 21-310.2	3	3	2	3	2	3	3	3	3	-	2
MMATH 21-310.3	3	3	2	3	2	3	2	2	3	-	3
MMATH 21-310.4	3	3	2	3	2	3	3	2	3	-	3
Average	**3**	**3**	**2**	**3**	**2**	**3**	**2.75**	**2.25**	**3**	**-**	**2.75**

CO-PSO matrix for the course MMATH21-311 (Number Theory)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-311.1	3	2	2	2
MMATH21-311.2	3	2	2	3
MMATH21-311.3	3	2	2	2
MMATH21-311.4	3	2	2	3
Average	**3**	**2**	**2**	**2.5**

CO-PO matrix for the course MMATH21-311 (Number Theory)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-311.1	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-311.2	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-311.3	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-311.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PSO matrix for the course MMATH21-312 (Algebraic Coding Theory)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-312.1	3	2	3	3
MMATH21-312.2	3	2	3	3
MMATH21-312.3	3	2	3	3
MMATH21-312.4	3	2	3	3
Average	**3**	**2**	**3**	**3**

CO-PO matrix for the course MMATH21-312 (Algebraic Coding Theory)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-312.1	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-312.2	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-312.3	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-312.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PSO matrix for the course MMATH21-313 (FINANCIAL MATHEMATICS)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-313.1	3	3	2	2
MMATH21-313.2	3	2	3	3
MMATH21-313.3	3	3	3	3
MMATH21-313.4	3	3	3	3
Average	**3**	**2.75**	**2.75**	**2.75**

CO-PO matrix for the course MMATH21-313 (FINANCIAL MATHEMATICS)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-313.1	3	3	3	3	2	3	3	2	3	--	2
MMATH21-313.2	3	3	3	3	3	3	3	3	3	--	3
MMATH21-313.3	3	3	3	3	2	3	3	3	3	--	3
MMATH21-313.4	3	3	3	3	2	3	3	3	3	--	3
Average	**3**	**3**	**3**	**3**	**2.25**	**3**	**3**	**3**	**3**	**--**	**2.75**

CO-PSO matrix for the course MMATH21-314: (INTEGRAL EQUATIONS)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-314.1	3	3	2	3
MMATH21-314.2	3	2	3	3
MMATH21-314.3	3	3	2	3
MMATH21-314.4	3	3	3	3
Average	**3**	**2.75**	**2.5**	**3**

CO-PO matrix for the course MMATH21-314: (INTEGRAL EQUATIONS)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-314.1	3	3	3	3	2	2	2	3	3	--	3
MMATH21-314.2	3	3	3	3	2	3	3	3	3	--	2
MMATH21-314.3	3	3	3	3	2	2	2	2	3	--	2
MMATH21-314.4	3	3	3	3	2	3	3	3	3	--	3
Average	**3**	**3**	**3**	**3**	**2**	**2.5**	**2.5**	**2.75**	**3**	**--**	**2.5**

CO-PSO matrix for the course MMATH21-315 (MATHEMATICAL MODELING)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21- 315.1	3	3	2	2
MMATH21- 315.2	3	2	3	3
MMATH21- 315.3	3	3	3	3
MMATH21- 315.4	3	3	3	3
Average	**3**	**2.75**	**2.75**	**2.75**

CO-PO matrix for the course MMATH21-315 (MATHEMATICAL MODELING)

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21- 315.1	3	3	3	3	2	3	3	2	3	--	2
MMATH21- 315.2	3	3	3	3	3	3	3	3	3	--	3
MMATH21- 315.3	3	3	3	3	3	3	3	3	3	--	3
MMATH21- 315.4	3	3	3	3	3	3	3	3	3	--	3
Average	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**3**	**3**	**--**	**2.75**

CO-PSO matrix for the course OEM21-316 (BASIC MATHEMATICS-II)

COs	PSO1	PSO2	PSO3	PSO4
OEM21-316.1	3	3	2	3
OEM21-316.2	3	2	2	3
OEM21-316.3	3	3	3	3
OEM21-316.4	3	3	3	3
Average	**3**	**2.75**	**2.5**	**3**

CO-PO matrix for the course OEM21-316 (BASIC MATHEMATICS-II)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEM21-316.1	3	3	2	3	2	2	2	2	3	--	3
OEM21-316.2	3	3	2	3	3	2	3	3	3	--	3
OEM21-316.3	3	3	3	3	3	2	3	3	3	--	3
OEM21-316.4	3	3	3	3	2	3	3	2	3	--	3
Average	**3**	**3**	**2.5**	**3**	**2.5**	**2.25**	**2.75**	**2.5**	**3**	**--**	**3**

CO-PSO matrix for the course MMATH21-401 (Mechanics and Calculus of Variations)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-401.1	3	3	3	3
MMATH21-401.2	3	3	3	3
MMATH21-401.3	3	2	3	3
MMATH21-401.4	3	3	3	3
Average	**3**	**2.75**	**3**	**3**

CO-PO matrix for the course MMATH21-401 (Mechanics and Calculus of Variations)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-401.1	3	3	3	3	3	3	3	3	3	-	3
MMATH21-401.2	3	3	3	3	2	3	2	3	3	-	3
MMATH21-401.3	3	3	3	3	3	3	2	3	3	--	3
MMATH21-401.4	3	3	2	3	3	3	3	3	3	-	3
Average	**3**	**3**	**2.75**	**3**	**2.75**	**3**	**2.5**	**3**	**3**	**-**	**3**

CO-PSO matrix for the course MMATH21-402 (PARTIAL DIFFERENTIAL EQUATIONS)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-402.1	3	3	3	3
MMATH21-402.2	3	3	3	3
MMATH21-402.3	3	3	3	3
MMATH21-402.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course MMATH21-402 (PARTIAL DIFFERENTIAL EQUATIONS)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-402.1	3	3	3	3	2	3	3	3	3	--	3
MMATH21-402.2	3	3	3	3	2	3	3	3	3	--	3
MMATH21-402.3	3	3	3	3	3	3	3	3	3	--	3
MMATH21-402.4	3	3	3	3	3	3	3	3	3	--	3
Average	**3**	**3**	**3**	**3**	**2.5**	**3**	**3**	**3**	**3**	**--**	**3**

CO-PSO matrix for the course MMATH21-403 (PRACTICAL-IV)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-403.1	3	3	3	3
MMATH21-403.2	3	3	3	3
MMATH21-403.3	2	3	3	2
MMATH21-403.4	2	3	3	3
Average	**2.5**	**3**	**3**	**2.75**

CO-PO matrix for the course MMATH21-403 (PRACTICAL-IV)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-403.1	3	3	2	3	3	2	3	3	3	--	3
MMATH21-403.2	3	3	2	3	3	2	3	2	3	--	3
MMATH21-403.3	3	3	2	3	3	3	3	3	3	--	3
MMATH21-403.4	3	3	2	3	3	3	3	3	3	--	3
Average	**3**	**3**	**2**	**3**	**3**	**2.5**	**3**	**2.75**	**3**	**--**	**3**

CO-PSO matrix for the course MMATH21-404 (SEMINAR-II)

COs	PSO1	PSO2	PSO3	PSO4
MMATH20-404.1	3	3	2	3
MMATH20-404.2	3	3	3	3
MMATH20-404.3	3	3	3	3
MMATH20-404.4	3	3	2	3
Average	**3**	**3**	**2.5**	**3**

CO-PO matrix for the course MMATH21-404 (SEMINAR-II)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-404.1	3	3	2	2	3	3	2	3	3	1	3
MMATH20-404.2	3	3	2	3	2	3	2	3	3	1	3
MMATH20-404.3	3	2	3	3	3	2	2	2	3	1	3
MMATH20-404.4	3	2	3	3	3	3	2	2	3	1	3
Average	**3**	**2.5**	**2.5**	**2.75**	**2.75**	**2.75**	**2**	**2.5**	**3**	**1**	**3**

CO-PSO matrix for the course MMATH21-405 (Advanced Complex Analysis)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-405.1	3	3	3	3
MMATH21-405.2	3	2	2	3
MMATH21-405.3	3	3	3	3
MMATH21-405.4	3	2	2	3
Average	**3**	**2.5**	**2.5**	**3**

CO-PO matrix for the course MMATH21-405 (Advanced Complex Analysis)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-405.1	3	3	2	3	2	3	2	2	3	-	2
MMATH21-405.2	3	3	3	3	3	3	3	3	3	-	2
MMATH21-405.3	3	3	3	3	2	3	3	3	3	--	3
MMATH21-405.4	3	3	2	3	2	3	2	2	3	-	2
Average	**3**	**3**	**2.5**	**3**	**2.25**	**3**	**2.5**	**2.5**	**3**	**-**	**2.25**

CO-PSO matrix for the course MMATH 21-406 (Algebraic Number Theory)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-406.1	3	2	2	2
MMATH21-406.2	3	2	2	2
MMATH21-406.3	3	2	2	2
MMATH21-406.4	3	2	2	3
Average	**3**	**2**	**2**	**2.25**

CO-PO matrix for the course MMATH21-406 (Algebraic Number Theory)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-406.1	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-406.2	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-406.3	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-406.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PSO matrix for the course MMATH21- 407 (General Measure and Integration Theory)

Cos	PSO1	PSO2	PSO3	PSO4
MMATH21- 407.1	3	3	3	3
MMATH21- 407.2	3	2	2	3
MMATH21- 407.3	3	3	3	3
MMATH21- 407.3	3	2	2	3
Average	**3**	**2.5**	**2.5**	**3**

CO-PO matrix for the course MMATH21- 407 (General Measure and Integration Theory)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-407.1	3	3	2	3	2	3	2	2	3	-	2
MMATH21-407.2	3	3	2	3	2	3	2	2	3	-	2
MMATH21-407.3	3	3	2	3	2	3	2	2	3	--	2
MMATH21-407.4	3	3	3	3	2	3	3	2	3	-	2
Average	**3**	**3**	**2.25**	**3**	**2**	**3**	**2.25**	**2**	**3**	**-**	**2**

CO-PSO matrix for the course MMATH21-408 (Mathematical Aspects of Seismology)

	PSO1	PSO2	PSO3	PSO4
MMATH21-408.1	3	3	3	3
MMATH21-408.2	3	3	3	3
MMATH21-408.3	3	3	3	3
MMATH21-408.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course MMATH21-408 (Mathematical Aspects of Seismology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-408.1	3	3	3	3	3	3	3	3	3	-	3
MMATH21-408.2	3	3	3	3	2	2	3	3	3	-	2
MMATH21-408.3	3	3	3	3	3	3	3	3	3	--	3
MMATH21-408.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**2.75**	**2.75**	**3**	**3**	**3**	**-**	**2.75**

CO-PSO matrix for the course MMATH21-409 (Advanced Discrete Mathematics)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-409.1	3	3	2	3
MMATH21-409.2	3	3	2	3
MMATH21-409.3	3	2	2	2
MMATH21-409.4	3	2	2	2
Average	**3**	**2.5**	**2**	**2.5**

CO-PO matrix for the course MMATH21-409 (Advanced Discrete Mathematics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-409.1	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-409.2	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-409.3	3	3	2	3	-	2	2	-	2	-	2
MMATH 21-409.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PSO matrix for the course MMATH21-410 (Advanced Functional Analysis)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-410.1	3	3	3	3
MMATH21-410.2	3	2	3	3
MMATH21-410.3	3	2	2	3
MMATH21-410.4	3	3	3	3
Average	**3**	**2.5**	**2.75**	**3**

CO-PO matrix for the course MM21-410 (Advanced Functional Analysis))

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-410.1	3	3	3	3	3	3	3	3	3	-	3
MMATH21-410.2	3	3	2	3	2	3	2	2	3	-	2
MMATH21-410.3	3	3	2	3	2	3	2	2	3	--	2
MMATH21-410.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**2.5**	**3**	**2.5**	**3**	**2.5**	**2.5**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH21-411 (Advanced Fluid Mechanics)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-411.1	3	3	3	3
MMATH21-411.2	3	2	3	3
MMATH21-411.3	3	3	3	3
MMATH21-411.4	3	2	3	3
Average	**3**	**2.5**	**3**	**3**

CO-PO matrix for the course MMATH21-411 (Advanced Fluid Mechanics)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-411.1	3	3	3	3	3	3	3	3	3	-	3
MMATH21-411.2	3	3	3	3	3	3	2	3	3	-	2
MMATH21-411.3	3	3	3	3	2	2	3	3	3	--	3
MMATH21-411.4	3	3	3	3	3	3	2	3	3	-	2
Average	**3**	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**3**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH21-412 (Boundary Value Problems)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-412.1	3	3	3	3
MMATH21-412.2	3	3	3	3
MMATH21-412.3	3	2	3	3
MMATH21-412.	3	2	3	3
Average	**3**	**2.5**	**3**	**3**

CO-PO matrix for the course MMATH21-412 (Boundary Value Problems)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-412.1	3	3	3	3	2	3	2	3	3	-	2
MMATH21-412.2	3	3	3	3	3	3	3	3	3	-	2
MMATH21-412.3	3	3	3	3	3	3	3	3	3	--	2
MMATH21-412.4	3	3	3	3	3	3	2	3	3	-	2
Average	**3**	**3**	**3**	**3**	**2.75**	**3**	**2.5**	**3**	**3**	**-**	**2**

CO-PSO matrix for the course MMATH21-413 (BIO-MATHEMATICS)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-413.1	3	3	2	2
MMATH21-413.2	3	2	3	3
MMATH21-413.3	3	3	3	3
MMATH21-413.4	3	3	3	3
Average	**3**	**2.75**	**2.75**	**2.75**

CO-PO matrix for the course MMATH21-413 (BIO-MATHEMATICS)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-413.1	3	3	3	3	3	3	3	2	3	--	2
MMATH 21-413.2	3	3	3	3	3	3	3	3	3	--	3
MMATH 21-413.3	3	3	3	3	2	3	3	3	3	--	3
MMATH 21-413.4	3	3	3	3	2	3	3	3	3	--	3
Average	**3**	**3**	**3**	**3**	**2.5**	**3**	**3**	**3**	**3**	**--**	**2.75**

CO-PSO matrix for the course MMATH21-414 (Fourier and Wavelet Analysis)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-414.1	3	2	3	3
MMATH21-414.2	3	2	2	3
MMATH21-414.3	3	3	3	3
MMATH21-414.4	3	3	3	3
Average	**3**	**2.5**	**2.75**	**3**

CO-PO matrix for the course MMATH21-414 (Fourier and Wavelet Analysis)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-414.1	3	3	2	2	3	3	2	2	3	-	2
MMATH21-414.2	3	3	2	2	3	3	2	2	3	-	2
MMATH21-414.3	3	3	3	3	3	3	3	3	3	--	3
MMATH21-414.4	3	3	3	3	3	3	3	3	3	-	3
Average	**3**	**3**	**2.5**	**2.5**	**3**	**3**	**2.5**	**2.5**	**3**	**-**	**2.5**

CO-PSO matrix for the course MMATH21-415 (Linear Programming)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-415.1	3	3	3	3
MMATH21-415.2	3	3	3	3
MMATH21-415.3	3	3	3	3
MMATH21-415.4	3	3	3	3
Average	**3**	**3**	**3**	**3**

CO-PO matrix for the course MMATH21-415 (Linear Programming)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH 21-415.1	3	3	2	3	2	3	3	2	3	-	2
MMATH 21-415.2	3	3	2	3	2	3	3	2	3	-	2
MMATH 21-415.3	3	3	2	3	2	3	3	3	3	-	2
MMATH 21-415.4	3	3	2	3	2	3	3	2	2	-	2
Average	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2.25**	**2.75**	**-**	**2**

CO-PSO matrix for the course MMATH21-416 (Non Commutative Rings)

COs	PSO1	PSO2	PSO3	PSO4
MMATH21-416.1	3	2	2	2
MMATH21-416.2	3	2	2	2
MMATH21-416.3	3	2	2	2
MMATH21-416.4	3	2	2	2
Average	**3**	**2**	**2**	**2**

CO-PO matrix for the course MMATH21-416 (Non Commutative Rings)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH21-416.1	3	3	2	3	-	2	2	-	2	-	2
MMATH21-416.2	3	3	2	3	-	2	2	-	2	-	2
MMATH21-416.3	3	3	2	3	-	2	2	-	2	-	2
MMATH21-416.4	3	3	2	3	-	2	2	-	2	-	2
Average	**3**	**3**	**2**	**3**	**-**	**2**	**2**	**-**	**2**	**-**	**2**

CO-PO-PSO mapping matrix for all the courses of M.Sc. Mathematics Programme

Course Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
MMATH 20-101	3	3	2	3		2	2		2		2	3	2	2.25	2.5
MMATH 20-102	3	2	3	3	2	2	3	2	3		2	2.5	2.75	2.75	3
MMATH 20-103	3	3	3	3	2.5	2.5	2.5	2.75	3		2.5	3	2.75	2.75	3
MMATH 20-104	3	3	2.5	3	2.5	3	2.5	2.5	3		2.5	3	2.75	2.75	3
MMATH 20-105	3	3	2	3	2	3	2.25	2.25	3		2	3	2.5	2.5	3
MMATH 20-106	3	3	2	3	3	3	3	3	3		3	2.25	3	3	2.75
MMATH 20-107	3	2.5	2.5	2.75	2.75	2.75	2	2.5	3	1	3	3	3	2.5	3
MMATH 20-201	3	3	2	3		2	2		2		2	3	2	2.25	2.25
MMATH 20-202	3	2.75	2.5	2.75	3	2.75	3	3	3		3	2.5	2.5	3	3
MMATH 20-203	3	2.75	3	3	2.75	2.75	2.75	2.75	3		2.5	3	2.75	3	3
MMATH 20-204	3	3	2.5	3	2	3	2.5	3	2.5		2	3	2.5	2.75	3
MMATH 20-205	3	3	3	3	3	2.75	2.5	2.75	3		2.75	3	2.75	3	3
MMATH 20-206	3	3	2	3	3	3	3	3	3		3	2.5	3	3	2.75
OEM20-207	3	3	2.5	3		2.5	2.75		3		3	3	2.75	2.75	3
MMATH 21-301	3	2.75	3	3	2.5	2.5	2.5	3	3		2.5	3	2.75	3	3
MMATH 21-302	3	3	2.75	3	2.5	3	3	2.5	3		2.5	3	2.75	2.75	3
MMATH 21-303	3	3	2	3	3	2.5	3	2.75	3		3	2.5	3	3	2.75
MMATH 21-304	3	3	2	3	2	3	2.25	2.25	3		2	3	2	2.5	3
MMATH 21-305	3	3	2	3		2	2		2		2	3	2	2	2
MMATH 21-306	3	3	2.75	3	2.5	2.75	2.75	3	3		2.5	3	2.5	2.75	3
MMATH 21-307	3	3	2.5	3	2.75	3	3	3	3		2.75	3	2.75	2.75	3
MMATH 21-308	3	3	2.75	3	2.5	3	3	2.5	3		3	3	3	2.75	3
MMATH 21-309	3	3	2.75	3	2	3	2.75	3	2.5		2.75	3	2.5	2.75	3
MMATH 21-310	3	3	2	3	2	3	2.75	2.25	3		2.75	3	3	3	3
MMATH 21-311	3	3	2	3		2	2		2		2	3	2	2	2.5
MMATH 21-312	3	3	2	3		2	2		2		2	3	2	3	3

Course Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3	PS O4
MMATH 21-313	3	3	3	3	2.25	3	3	3	3		2.75	3	2.75	2.75	2.75
MMATH 21-314	3	3	3	3	2	2.5	2.5	2.75	3		2.5	3	2.75	2.5	3
MMATH 21-315	3	3	3	3	2.75	3	3	3	3		2.75	3	2.75	2.75	2.75
OEM21-316	3	3	2.5	3	2.5	2.25	2.75	2.5	3		3	3	2.75	2.5	3
MMATH 21-401	3	3	2.75	3	2.75	3	2.5	3	3		3	3	2.75	3	3
MMATH 21-402	3	3	3	3	2.5	3	3	3	3		3	3	3	3	3
MMATH 21-403	3	3	2	3	3	2.5	3	2.75	3		3	2.5	3	3	2.75
MMATH 21-404	3	2.5	2.5	2.75	2.75	2.75	2	2.5	3	1	3	3	3	2.5	3
MMATH 21-405	3	3	2.5	3	2.25	3	2.5	2.5	3		2.25	3	2.5	2.5	3
MMATH 21-406	3	3	2	3		2	2		2		2	3	2	2	2.25
MMATH 21-407	3	3	2.25	3	2	3	2.25	2	3		2	3	2.5	2.5	3
MMATH 21-408	3	3	3	3	2.75	2.75	3	3	3		2.75	3	3	3	3
MMATH 21-409	3	3	2	3		2	2		2		2	3	2.5	2	2.5
MMATH 21-410	3	3	2.5	3	2.5	3	2.5	2.5	3		2.5	3	2.5	2.75	3
MMATH 21-411	3	3	3	3	2.75	2.75	2.5	3	3		2.5	3	2.5	3	3
MMATH 21-412	3	3	3	3	2.75	3	2.5	3	3		2	3	2.5	3	3
MMATH 21-413	3	3	3	3	2.5	3	3	3	3		2.75	3	2.75	2.75	2.75
MMATH 21-414	3	3	2.5	2.5	3	3	2.5	2.5	3		2.5	3	2.5	2.75	3
MMATH 21-415	3	3	2	3	3	3	3	2.25	2.75		2	3	3	3	3
MMATH 21-416	3	3	2	3		2	2		2		2	3	2	2	2

6. **<u>Attainment of COs:</u>**

The attainment of COs can be measured on the basis of the results of internal assessment and semester examination. The attainment is measured on scale of 3 after setting the target for COs attainment. Table 5 shows the CO attainment levels assuming the set target of 60% marks:

Table 5: CO Attainment Levels for internal assessment

Attainment Level	
1 (low level of attainment)	50% of students score more than 60% of marks in class tests of a course.
2 (Medium level of attainment)	60% of students score more than 60% of marks in class tests of a course.
3 (High level of attainment)	70% of students score more than 60% of marks in class tests of a course.

A proper mapping of course outcomes with assessment methods should be defined before measuring the attainment level. The questions in tests for internal assessment are based on COs. Here, it is assumed that class test – I is based on first two COs (e.g. MMATH20-101.1 and MMATH20-101.2) of a course with equal weightage given to both COs. Similarly, class test – II/ Assignment Test is based on next two COs (e.g. MMATH20-101.3 and MMATH20-101.4) of a course with equal weightage given to these two COs. For each internal assessment test, the percentage of students attaining the target level of CO is estimated and average percentage will decide the attainment level of COs. Following steps may be followed for determining the attainment level in internal assessment of a course.

(i) Estimate the %age of students scoring set target (say 60%) or more in the question(s) of test - I based on first CO i.e. MMATH20-101.1
(ii) Estimate the %age of students scoring set target (60%) or more in the question(s) of test -I based on second CO i.e. MMATH20-101.2
(iii) Estimate the %age of students scoring set target (60%) or more in the question(s) of test -II /Assignment Test based on third CO i.e. MMATH20-101.3
(iv) Estimate the %age of students scoring set target (60%) or more in the question(s) of test -II /Assignment Test based on fourth CO i.e. MMATH20-101.4
(v) Take average of the percentages obtained above.
(vi) Determine the attainment level i.e. 3, 2 or 1 as per scale defined in table 5.

Note: In the above steps, it is assumed that internal assessment is based on two tests only. However if internal assessment is based on more than two tests and/or on assignments then same may by incorporated to determine the COs attainment level. There may be more than four COs for a course. The set target may also be different for different COs. These issues may resolved by the staff councils of the departments/institutes.

For determining the attainment levels for end semester examination, it is assumed that questions in the end term examination are based on all COs of the course. Attainment levels for end semester examination of a course can be determined after the declaration of the results.
The CO attainment levels for end semester examination are given in Table 6.

Table 6: CO Attainment Levels for End Semester Examination(ESE)

Attainment Level	
1 (Low level of attainment)	50% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) in ESE of a course.
2 (Medium level of attainment)	60% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) in ESE of a course.
3 (High level of attainment)	70% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) in ESE of a course.

Overall CO Attainment level of a Course:

The overall CO attainment level of a course can be obtained as:

Overall CO attainment level = 50% of CO attainment level in Internal assessment + 50% of CO Attainment level in End semester examination.

The overall COs attainment level can be obtained for all the courses of the program in a similar manner.

6.1 Attainment of POs:

The overall attainment level of POs is based on the values obtained using direct and indirect methods in the ratio of 80:20. The direct attainment of POs is obtained through the attainment of COs. The overall CO attainment value as estimated above and CO-PO mapping value as shown in Table 4 are used to compute the attainment of POs. PO attainment values obtained using direct method can be written as shown in the Table 7.

Table 7: PO Attainment Values using Direct Method

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
MMATH20-101											
MMATH20-102											
MMATH20-103											
MMATH20-104											
MMATH20-105											
MMATH20-106											
MMATH20-107											
MMATH20-201											
MMATH20-202											
MMATH20-203											
MMATH20-204											
MMATH20-205											
MMATH20-206											
OEM20-207											
MMATH21-301											
MMATH21-302											
MMATH21-303											
MMATH21-304											
MMATH21-305											
MMATH21-306											
MMATH21-307											
MMATH21-308											
MMATH21-309											
MMATH21-310											
MMATH21-311											
MMATH21-312											
MMATH21-313											
MMATH21-314											
MMATH21-315											
OEM21-316											
MMATH21-401											
MMATH21-402											
MMATH21-403											
MMATH21-404											
MMATH21-405											
MMATH21-406											
MMATH21-407											
MMATH21-408											
MMATH21-409											
MMATH21-410											
MMATH21-411											
MMATH21-412											
MMATH21-413											
MMATH21-414											
MMATH21-415											
MMATH21-416											
Direct PO attainment	Average of above values	Average of above values	Average of above values	Average of above values	Average of above values	Average of above values	Average of above values	Average of above values	Average of above values	Average of above values	Average of above values

The PO attainment values to be filled in above table can be obtained as follows:

For MMATH20-101-PO1 Cell:

PO1 attainment value = (Mapping factor of MMATH20-101-PO1 from Table 4 × Overall CO attainment value for the course MMATH20-101)/3

For MMATH20-104-PO1 Cell:

PO1 attainment value = (Mapping factor of MMATH20-104 -PO1 from Table 4 × Overall CO attainment value for the course MMATH20-104)/3

Similarly values for each cell of Table 7 can be obtained. The direct attainment of POs is average of individual PO attainment values.

In order to obtain the PO attainment using indirect method, a student exit survey based on the questionnaire of POs may be conducted at end of last semester of the program. The format for the same is given in Table 8. Average of the responses from the outgoing students for each PO is estimated.

The overall PO attainment values are obtained by adding attainment values estimated using direct and indirect methods in the proportion of 80:20 as follows:

Overall attainment value for PO1 =

0.8 × average attainment value for PO1 using direct method (from table 7)

+

0.2 × average response of outgoing students for PO1 (from Table 8)

Similarly overall attainment value can be obtained for each PO.

<u>Table 8 : Questionnaire for indirect measurement of PO attainment</u>
<u>(For outgoing students)</u>

At the end of my degree program I am able to do:

			Please tick any one		
PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study	3	2	1
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis	3	2	1
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large	3	2	1
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems	3	2	1
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.	3	2	1
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions	3	2	1
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices	3	2	1
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices	3	2	1
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life	3	2	1
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work	3	2	1
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects			
		3: Strongly Agree; 2: Agree; 1: Average			

Overall PO attainment values can be written as shown in Table 9:

<u>Table 9: Overall PO attainment Values</u>

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
Direct PO attainment											
Indirect PO attainment											
Overall PO attainment											
Target	2	2	2	2	1	1.5	1.5	1.5	2	-	1.5

The overall PO attainment values obtained above are compared with set target. The set target for each PO may be different and can be finalized by the staff councils of the departments/institutes. If overall PO attainment value is less than the set target value then an action plan may be prepared for improvement in the subsequent academic session.

The overall PSO attainment level based on CO-PSO mapping values and overall CO attainment values can be obtained in a similar manner.

6.2 Attainment of PSOs:

The overall attainment level of PSOs is based on the values obtained using direct and indirect methods in the ratio of 80:20. The direct attainment of PSOs is obtained through the attainment of COs. The overall CO attainment value as estimated above and CO-PSO mapping value as shown in Table 4 are used to compute the attainment of PSOs. PSO attainment values obtained using direct method can be written as shown in the Table 10.

Table 10: PSO Attainment Values using Direct Method

	PSO1	PSO2	PSO3	PSO4
MMATH20-101				
MMATH20-102				
MMATH20-103				
MMATH20-104				
MMATH20-105				
MMATH20-106				
MMATH20-107				
MMATH20-201				
MMATH20-202				
MMATH20-203				
MMATH20-204				
MMATH20-205				
MMATH20-206				
OEM20-207				
MMATH21-301				
MMATH21-302				
MMATH21-303				
MMATH21-304				
MMATH21-305				
MMATH21-306				
MMATH21-307				
MMATH21-308				
MMATH21-309				
MMATH21-310				
MMATH21-311				
MMATH21-312				
MMATH21-313				
MMATH21-314				
MMATH21-315				
OEM21-316				
MMATH21-401				
MMATH21-402				
MMATH21-403				
MMATH21-404				
MMATH21-405				
MMATH21-406				
MMATH21-407				
MMATH21-408				
MMATH21-409				
MMATH21-410				
MMATH21-411				
MMATH21-412				
MMATH21-413				
MMATH21-414				
MMATH21-415				
MMATH21-416				
Direct PSO attainment	Average of above values	Average of above values	Average of above values	Average of above values

The PSO attainment values to be filled in above table can be obtained as follows:

For MMATH20-101-PSO1 Cell:

PSO1 attainment value = (Mapping factor of MMATH20-101-PSO1 from Table 4 × Overall CO attainment value for the course MMATH20-101)/3

For MMATH20-104 -PO1 Cell:

PO1 attainment value = (Mapping factor of MMATH20-104 -PO1 from Table 4 × Overall CO attainment value for the course MMATH20-104)/3

Similarly values for each cell of Table 10 can be obtained. The direct attainment of PSOs is average of individual PSO attainment values.

In order to obtain the PSO attainment using indirect method, a student exit survey based on the questionnaire of PSOs may be conducted at end of last semester of the program. The format for the same is given in Table 11. Average of the responses from the outgoing students for each PSO is estimated.

The overall PSO attainment values are obtained by adding attainment values estimated using direct and indirect methods in the proportion of 80:20 as follows:

Overall attainment value for PSO1 =

0.8 × average attainment value for PSO1 using direct method (from table 10)

+

0.2 × average response of outgoing students for PSO1 (from Table 11)

Similarly overall attainment value can be obtained for each PSO.

Table 11 : Questionnaire for indirect measurement of PSO attainment
(For outgoing students)

At the end of my degree program I am able to do:

		Please tick any one		
PSO1	Have deep understanding and knowledge in the core areas of Mathematics and demonstrate understanding and application of the concepts/theories/principles/ methods/ techniques in different areas of pure and applied Mathematics.	3	2	1
PSO2	Have capability to read and understand mathematical texts, demonstrate and communicate mathematical knowledge effectively and unambiguously through oral and/or written expressions and attain skills of computing/programming/using software tools/formulating models.	3	2	1
PSO3	Attain abilities of critical thinking, logical reasoning, investigating problems, analysis, problem solving, application of mathematical methods/techniques, disciplinary knowledge so as to develop skills to solve mathematical problems having applications in other disciplines and/or in the real world.	3	2	1
PSO4	Have strong foundation in basic and applied aspects of Mathematics so as to venture into research in different areas of mathematical sciences, jobs in scientific and various industrial sectors and/or teaching career in Mathematics.	3	2	1
	3: Strongly Agree; 2: Agree; 1: Average			

Overall PSO attainment values can be written as shown in Table 12:

Table 12: Overall PSO attainment Values

	PSO1	PSO2	PSO3	PSO4
Direct PSO attainment				
Indirect PSO attainment				
Overall PSO attainment				
Target	2	2	2	2

The overall PSO attainment values obtained above are compared with set target. The set target for each PSO may be different and can be finalized by the staff councils of the departments/institutes. If overall PSO attainment value is less than the set target value then an action plan may be prepared for improvement in the subsequent academic session.

MMATH 20-101: ABSTRACT ALGEBRA

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The concept of a group is surely one of the central ideas of Mathematics. The main aim of this course is to introduce Sylow theory and some of its applications to groups of smaller orders. An attempt has been made in this course to strike a balance between the different branches of group theory, abelian groups, nilpotent groups, finite groups, infinite groups and to stress the utility of the subject. A study of modules, submodules, quotient modules, finitely generated modules etc. is also promised in this course. Similar linear transformations, Nilpotent transformations and related topics are also included in the course.

Course Outcomes: This course will enable the students to:

1. Understand concepts of normal subgroup, quotient group, isomorphism, automorphism, conjugacy, G-sets, normal series, composition series, solvable group, nilpotent group and refinement theorem.

2. Learn about cyclic decomposition, alternating group A_n , simplicity of A_n for $n\geq 5$, Sylow's theorem and its applications.

3. Understand concepts of modules, submodules, direct sum, R-homomorphism, quotient module, completely reducible modules, free modules, representation of linear mappings and their ranks.

4. Learn about similar linear transformation, triangular form, nilpotent transformation, primary decomposition theorem, Jordan form, rational canonical form and elementary divisors.

Unit-I:

Normal subgroup, quotient group, normalizer and centralizer of a non-empty subset of a group G, commutator subgroups of a group. first, second and third isomorphism theorems, correspondence theorem, Aut(G), Inn(G), automorphism group of a cyclic group, G-sets, orbit of an element in group G, Cayley's theorem. conjugate elements and conjugacy classes, class equation of a finite group G and its applications, Burnside theorem. normal series, composition series, Jordan Holder theorem, Zassenhaus lemma, Scheier's refinement theorem, solvable group, nilpotent group.
(Chapter 5 and 6 of recommended book at Sr. No. 1, Chapter 5 of recommended book at Sr. No. 2)

Unit-II:
Cyclic decomposition, even and odd permutation, Alternation group A_n, simplicity of the Alternating group A_n ($n\geq 5$). Cauchy's theorem, Sylow's first, second and third theorems and its applications to group of smaller orders. groups of order p^2 and pq (q>p).
(Chapter 7, 8.4 and 8.5 of recommended book at Sr. No 1)

Unit-III:

Modules, submodules, direct sums, finitely generated modules, cyclic module. R-homomorphism, quotient module, completely reducible modules, Schur's lemma, free modules, representation of linear mapping, rank of linear mapping.

(Chapter 14 of recommended book at Sr. No 1)

Unit-IV:

Similar linear transformation, invariant subspaces of vector spaces, reduction of a linear transformation to triangular form, nilpotent transformation, index of nilpotency of a nilpotent transformation. Cyclic subspace with respect to a nilpotent transformations, uniqueness of the invariants of a nilpotent transformation. Primary decomposition theorem. Jordan blocks, Jordan canonical forms, cyclic module relative to a linear transformation, rational canonical form of a linear transformation and its elementary divisors, uniqueness of elementary divisors. (6.4. to 6.7 of recommended book of Sr. No. 3).

Recommended Books:

1 P. B. Bhattacharya, S. K. Jain, S. R. Nagpaul, Basic Abstract Algebra (Second edition), Cambridge University Press, 2012.

2. Surjit Singh and Quazi Zameeruddin : Modern Algebra ,Vikas Publishing House, 1990.

3 I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.

MMATH20-102: COMPLEX ANALYSIS

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: One objective of this course is to develop the parts of the theory that are prominent in applications of the complex numbers. Other objective is to furnish an introduction to applications of residues and conformal mapping. With regard to residues, special emphasis is given to their use in evaluating real improper integrals, finding inverse Laplace transforms, and locating zeros of functions. Conformal mapping find its use in solving boundary value problems that arise in studies of heat conduction, fluid flow and elastodynamics.

Course outcomes: This course will enable the students to:

1. Understand the concepts of limit, continuity, differentiation and integration for functions defined over a complex plane as well as for the elementary functions.
2. Solve the complex integrals of various kinds through the applications of relevant theorems, formulae and power series expansions.
3. Analyse the complex functions with singularities for zeroes and residues at poles and apply the results to solve the improper integrals.
4. Solve complex improper integrals through the indentation, transformation/mapping of integration paths so as to avoid singularities and branch points/cuts.

Unit-I:
Analytic functions; Harmonic functions; Reflection principle;
Elementary functions: Exponential, Logarithmic, Trigonometric, Hyperbolic, Inverse trigonometric , Inverse hyperbolic, Complex exponents;
Complex Integration: Definite integral; Contours; Branch cuts.
(Relevant portions from the book recommended at Sr. No. 1)

Unit-II:
Cauchy-Goursat theorem; Simply/ multiply connected domains;
Cauchy integral formula; Morera's theorem; Liouville's theorem; Fundamental theorem of algebra;
Maximum modulus principle;
Power series: Taylor series; Laurent series; Uniform/ absolute convergence.
(Relevant portions from the book recommended at Sr. No. 1)

Unit-III:
Differentiation, integration, multiplication, division of power series;
Singularities; Poles; Residues; Cauchy's residue theorem; Zeros of an analytic function;
Evaluation of improper integrals; Jordan's lemma.

(Relevant portions from the book recommended at Sr. No. 1)

Unit-IV:

Indented paths; Integration along a branch cut; Definite integrals involving sines and cosines; Winding number of closed curve; Argument principle; Rouche's theorem; Schwarz Lemma ;

Transformations: linear, bilinear (Mobius), sine, z^2, $z^{1/2}$;

Mapping: Isogonal; Conformal; Scale factors; Local inverses; harmonic conjugates.

(Relevant portions from the book recommended at Sr. No. 1)

Recommended Books:

1. Churchill, R.V. and Brown, J.W., Complex Variables and Applications, Eighth edition; McGraw Hill International Edition , 2009.
2. Ahlfors, L.V., Complex Analysis. McGraw-Hill Book Company, 1979.
3. Conway, J.B., Functions of One complex variables Narosa Publishing, 2000.
4. Priestly, H.A., Introduction to Complex Analysis Claredon Press, Orford, 1990.
5. D.Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
6. Mark J.Ablewitz and A.S.Fokas, Complex Variables : Introduction & Applications, Cambridge University Press, South Asian Edition, 1998.
7. E.C.Titchmarsn, The Theory of Functions, Oxford University Press, London.
8. S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

MMATH20-103: ORDINARY DIFFERENTIAL EQUATIONS

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The objectives of this course are to study the existence and uniqueness theory of solutions of initial value problems, to familiarize with system of linear and non-linear, homogeneous and non-homogeneous differential equations with constant or variable coefficients, to study theory of homogeneous and non-homogeneous linear differential equations of higher order in detail and to understand the dependence of solution on initial parameters. The aim of the course is to form a strong foundation in the theory of ordinary differential equations and to learn to apply towards problem solving.

Course Outcomes: This course will enable the students to:

1. Understand concepts of an initial value problem and its exact and approximate solutions, existence of solutions, uniqueness of solutions and continuation of solutions of an initial value problem of order one. Apply the knowledge to prove specified theorems and to solve relevant exercises
2. Learn about system of linear differential equations of first order and its preliminary concepts, homogeneous and non-homogeneous linear systems, existence and uniqueness theory, fundamental matrix, theory of adjoint systems, linear systems with constant coefficients and with periodic coefficients. Attain the skill to obtain fundamental matrix of such a given linear system to demonstrate problem solving.
3. Have deep understanding of theory of linear differential equations of higher order by getting knowledge of basic theory, Wronskian theory and fundamental sets, adjoint equations and standard theorems related to these topics. Apply methods of reduction of order and variation of parameters to solve linear and non-linear differential equations respectively and to solve higher order linear differential equations with constant coefficients.
4. Understand system of differential equations and its existence theory, dependence of solution of an IVP on initial parameters, extremal solutions, upper and lower solutions so as to be able to develop research aptitude in this area.

Unit-I:

Existence and Uniqueness of Solutions:

Existence of solutions; Initial value problem, ε-approximate solution, Equicontinuous set of functions, Ascoli lemma, Cauchy–Peano existence theorem and its corollary

Uniqueness of solutions; Lipschitz condition, Gronwall's inequality, Inequality involving approximate solutions, Method of successive approximations, Picard-Lindelöf theorem.

Continuation of solutions, Maximal interval of existence, Extension theorem.

(Relevant portions from the book of 'Theory of Ordinary Differential Equations' by Coddington and Levinson)

Unit-II:

System of linear differential equations: Preliminary definitions and notations. Linear homogeneous systems; Definition, Existence and uniqueness theorem, Fundamental matrix, Liouville formula, Adjoint systems, Reduction of the order of a homogeneous system.
Non-homogeneous linear systems; Variation of constants formula.
Linear systems with constant coefficients.
Linear systems with periodic coefficients, Floquet theory.
(Relevant portions from the book 'Theory of Ordinary Differential Equations' by Coddington and Levinson)

Unit-III:

Theory of linear differential equations: Linear Differential Equation (LDE) of order n, Basic theory of homogeneous linear equation, Wronskian theory: Definition, necessary and sufficient condition for linear dependence and linear independence of solutions of homogeneous LDE, Abel's Identity, Fundamental sets, More Wronskian theory, Reduction of order.
Non-homogeneous linear differential equation of order n: Variation of parameters.
Adjoint equations, Lagrange's Identity, Green's formula, Self adjoint equation of second order.
Linear differential equation of order n with constant coefficients; Characteristic roots, Fundamental set.
(Relevant portions from the books 'Theory of Ordinary Differential Equations' by Coddington and Levinson and the book 'Differential Equations' by S.L. Ross)

Unit-IV:

System of differential equations; Preliminary concepts, Differential equation of order n and its equivalent system of differential equations, Existence and uniqueness of solutions of system of differential equations.
Dependence of solutions on initial conditions and parameters: Preliminaries, continuity and differentiability of solution of a system of differential equations as a function of initial parameters.
(Relevant portions from the book 'Theory of Ordinary Differential Equations' by Coddington and Levinson)
Extremal solutions: Maximal and Minimal solutions.
Upper and Lower solutions, Comparison theorems, Existence via upper and lower solutions.
Bihari's inequality.
(Relevant portions from the book 'Textbook of Ordinary Differential Equations' by Deo et al.)

Recommended Text Books:

1. Earl A. Coddington and Norman Levinson, *Theory of Ordinary Differential Equations*, McGraw Hill Education , 2017.
2. Sheply L. Ross, *Differential Equations*, Wiley , 3rd Edition, 2007.
3. S.G. Deo, V. Raghavendra, Rasmita Kar, V. Lakshmikantham, *Textbook of Ordinary Differential Equations*, Tata McGraw-Hill , 2006.

Reference books:

1. P. Hartman, *Ordinary Differential Equations*, John Wiley & Sons NY, 1971.

2. G. Birkhoff and G.C. Rota, *Ordinary Differential Equations*, John Wiley & Sons, 1978.
3. G.F. Simmons, *Differential Equations*, Tata McGraw-Hill , 1993.
4. I.G. Petrovski, *Ordinary Differential Equations*, Prentice-Hall, 1966.
5. D. Somasundaram, *Ordinary Differential Equations, A first Course*, Narosa Pub., 2001.

MMATH20-104: REAL ANALYSIS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The course aims to familiarize the learner with Riemann-Stieltjes integral, uniform convergence of sequences and series of functions, functions of several variables and power series.

Course Outcomes: This course will enable the students to:

1. Understand the concept of Riemann-Stieltjes integral along its properties; integration of vector-valued functions with application to rectifiable curves.

2. Understand and handle convergence of sequences and series of functions; construct a continuous nowhere-differentiable function; demonstrate understanding of the statement and proof of Weierstrass approximation theorem.

3. Understand differentiability and continuity of functions of several variables and their relation to partial derivatives; apply the knowledge to prove inverse function theorem and implicit function theorem.

4. Learn about the concepts of power Series, exponential & logarithmic functions, trigonometric functions, Fourier series and Gamma function; apply the knowledge to prove specified theorems.

Unit-I:

Definition and existence of the Riemann-Stieltjes integral, properties of the integral, integration and differentiation, the fundamental theorem of calculus, integration of vector-valued functions, rectifiable curves. (Scope as in Chapter 6 of 'Principles of Mathematical Analysis' by Walter Rudin, Third Edition).

Unit-II:

Sequences and series of functions: Pointwise and uniform convergence of sequences of functions, Cauchy criterion for uniform convergence, Dini's theorem, uniform convergence and continuity, uniform convergence and Riemann integration, uniform convergence and differentiation. (Scope as in Sections 9.1 to 9.3 of Chapter 9 'Methods of Real Analysis' by R.R. Goldberg).

Convergence and uniform convergence of series of functions, Weierstrass M-test, integration and differentiation of series of functions, existence of a continuous nowhere-differentiable function, the Weierstrass approximation theorem (Scope as in Sections 9.4, 9.5, 9.7 of Chapter 9 & Section 10.2 of Chapter 10 of 'Methods of Real Analysis' by R.R. Goldberg).

Unit-III:

Functions of several variables: Linear transformations, the space of linear transformations on R^n to R^m as a metric space, open sets, continuity, derivative in an open subset of R^n, chain rule, partial derivatives, continuously differentiable mappings, the contraction principle, the inverse function theorem, the implicit function theorem. (Scope as in relevant portions of Chapter 9 (up to 9.29) of 'Principles of Mathematical Analysis' by Walter Rudin, Third Edition)

Unit-IV:

Power Series: Uniqueness theorem for power series, Abel's and Tauber's theorem, Taylor's theorem, Exponential & Logarithmic functions, trigonometric functions, Fourier series, Gamma function (Scope as in relevant portions of Chapter 8 of 'Principles of Mathematical Analysis' by Walter Rudin, Third Edition).

Recommended Text Books:

1. Walter Rudin, Principles of Mathematical Analysis (3rd Edition) McGraw-Hill, 2013.

2. R.R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing, 2020

Reference Books:

1. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.

2. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975.

3. A.J. White, Real Analysis; an introduction. Addison-Wesley Publishing Co., Inc., 1968.

4. E. Hewitt and K. Stromberg. Real and Abstract Analysis, Berlin, Springer, 1969.

5. Serge Lang, Analysis I & II, Addison-Wesley Publishing Company Inc., 1969.

6. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi,4th Edition 2010.

7. D. Somasundaram and B. Choudhary, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997

MMATH20-105: TOPOLOGY

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The main objective of this course is to introduce basic concepts of point set topology, basis and sub basis for a topology. Further, to study continuity, homeomorphisms, open and closed maps, product and quotient topologies and introduce notions of filters and compactness of spaces.

Course Outcomes: This course will enable the students to:

1. Know about topological spaces, understand neighbourhood system of a point and its properties, interior, closure, boundary, limit points of subsets, and base and subbase of topological spaces; apply the knowledge to solve relevant exercises.

2. Learn about first and second countable spaces, separable and Lindelof spaces, continuous functions, separation axioms and their properties.

3. Know about quotient topology; demonstrate understanding of the statements and proofs of Embedding theorem and Urysohn's Lemma.

4. Know about filters and compactness in topological spaces and apply the knowledge to prove specified theorems.

Unit-I :

Definition and examples of topological spaces, neighbourhoods, neighbourhood system of a point and its properties, interior point and interior of a set, interior as an operator and its properties, definition of a closed set as complement of an open set, limit point (accumulation point) of a set, derived set of a set, adherent point (closure point) of a set, closure of a set, closure as an operator and its properties, dense sets and separable spaces.

Base for a topology and its characterization, base for neighbourhood system, sub-base for a topology. relative (induced) topology and subspace of a topological space. Alternate methods of defining a topology using properties of neighbourhood system, interior operator, closed sets, Kuratowski closure operator. comparison of topologies on a set, about intersection and union of topologies, the collection of all topologies on a set as a complete lattice.

Unit-II:

First countable, second countable, their relationships and hereditary property. about countability of a collection of disjoint open sets in a separable and a second countable space, Lindelof theorem. Definition, examples and characterizations of continuous functions, composition of continuous functions, open and closed functions, homeomorphism.

Tychonoff product topology, projection maps, their continuity and openness, Characterization of product topology as the smallest topology such that the projections are continuous, continuity of a function from a space into a product of spaces. T_0 , T_1, T_2 spaces, productive property of T_1 and T_2 spaces.

Unit-III :

Regular and T_3 separation axioms, their characterization and basic properties i.e. hereditary and productive properties. quotient topology w.r.t. a map, continuity of function with domain a space having quotient topology, about Hausdorffness of quotient space.

Completely regular and Tychonoff ($T_{3\,1/2}$), spaces, their hereditary and productive properties. Embedding lemma, Embedding theorem, normal and T_4 spaces, Urysohn's Lemma, complete regularity of a regular normal space, Tietze's extension theorem (statement only).

Unit-IV :

Definition and examples of filters on a set, finer filter, ultra filter (u.f.) and its characterizations, Ultra Filter Principle (UFP). image of a filter under a function. convergence of filters: limit point (cluster point) and limit of a filter and relationship between them, Continuity in terms of convergence of filters. Hausdorffness and filter convergence.

Compactness: Definition and examples of compact spaces, compactness in terms of finite intersection property (f.i.p.), continuity and compact sets, compactness and separation properties. regularity and normality of a compact Hausdorff space. compactness and filter convergence, Tychonoff product theorem.

(Scope of the course is as given in chapters 1, 3, 4 & 5 of General Topology by J.L.Kelley).

Recommended Text Book :

1.J.L. Kelley : General Topology, Springer Verlag, New York, 2012.

Reference Books :

1. J. R. Munkres, Toplogy, Pearson Education Asia, 2002.

2. C.W. Patty, Foundation of Topology, Jones & Bertlett, 2009.

3. Fred H. Croom, Principles of Topology, Cengage Learning, 2009.

4. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1983.

5. K. Chandrasekhara Rao, Topology, Narosa Publishing House Delhi,2009.

6. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, 2006.

MMATH20- 106: Practical-I

Course Credit Practical	Practical Hours per week	End Term Examination Time	Maximum Marks		
			Internal Assessment	End Term Examination	Total
2	4	4 Hours	10	40	50

Note: The examiner will set 3 questions at the time of practical examination by taking course outcomes (COs) into consideration. The examinee will be required to write two programs and execute one program successfully. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course objectives: This is a laboratory course and objective of this course is to acquaint the students with the practical use and to train for writing codes in ANSI-C for problem solving. Also, some problem solving techniques based on papers MMATH20-101 to MMATH20-105 will be taught.

Course Outcomes: This course will enable the students to:

1. Solve practical problems related to theory courses undertaken in the Semester-I from application point of view.
2. Know syntax of expressions, statements, structures and to write source code for a program in C.
3. Edit, compile and execute the source program for desired results.
4. Debug, verify/check and to obtain output of results.

List of Programs: The following practicals will be done using the programming language C and record of those will be maintained in the practical Note Book:

1. *Use of nested if.. .else in finding the smallest of four or more numbers.*
2. *To find if a given 4-digit year is a leap year or not.*
3. *To compute AM, GM and HM of three given real values.*
4. *To invert the order of digits in a given positive integral value.*
5. *Use series sum to compute sin(x) and cos(x) for given angle x in degrees. Then, check error in verifying* $sin^2x+cos^2(x) = 1$ *or other such T-identities.*
6. *Verify* $\sum n^3 = \{\sum n\}^2$*, (where n=1, 2,…, m) & check that prefix and postfix increment operator gives the same result.*
7. *Compute simple interest and compound interest for a given amount, time period, rate of interest and period of compounding.*
8. *Program to multiply two given matrices in a user defined function.*
9. *Calculate standard deviation for a set of values {x(j), j = l, 2,..., n} having the corresponding frequencies {f(j), j = l,2,...,n}.*
10. *Write the user-defined function to compute GCD of two given values and use it to compute the LCM of three given integer values.*
11. *Compute GCD of 2 positive integer values using recursion / pointer to pointer.*
12. *Check a given square matrix for its positive definite/ negative definite forms.*
13. *To find the inverse of a given non-singular square matrix.*
14. *To convert a decimal number to its binary representation and vice-versa.*
15. *Use array of pointers for alphabetic sorting of given list of English words.*

MMATH20- 107: Seminar-I

Course Credit	Seminar Hours per week	End Term Examination Time	Maximum Marks		
			Internal Assessment	End Term Examination	Total
2	2	-	50	-	50

Note: There will be no external examination. Evaluation will be done by the internal group incharge.

Course objectives: The objectives of this course are self study, understanding a topic in detail, comprehension of the subject/topic, investigating a problem, knowledge of ethics, effective communication and life-long learning.

Course Outcomes: This course will enable the students to:

1. Identify an area of interest and to select a topic therefrom realizing ethical issues related to one's work and unbiased truthful actions in all aspects of work and to develop research aptitude.
2. Have deep knowledge and level of understanding of a particular topic in core or applied areas of Mathematics, imbibe research orientation and attain capacity of investigating a problem.
3. Obtain capability to read and understand mathematical texts from books/journals/e-contents, to communicate through write up/report and oral presentation.
4. Demonstrate knowledge, capacity of comprehension and precision, capability to work independently and tendency towards life-long learning.

***Note:** Each student will select a topic of one's choice, get approval from the concerned group incharge, give sittings in a library so as to read different books, prepare a seminar document, present before the group and its incharge for not less than an hour. The evaluation of the seminar will be done by the concerned group incharge by taking into account the following:*

i. Subject knowledge.
ii. Degree of difficulty, research aptitude and knowledge updation in choice of the topic.
iii. Contents.
iv. Communication.
v. Response to questions.

MMATH20-201: ADVANCED ABSTRACT ALGEBRA

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: As suggested by the name of the course itself, some of the advanced topics of abstract algebra will be taught to the students in this course including field extensions, finite fields, normal extensions, finite normal extensions as splitting fields. A study of Galois extensions, Galois groups of polynomials, Galois radical extensions shall also be made.

Course Outcomes: This course will enable the students to:

1. Understand concepts of irreducible polynomial, Eisenstein criterion, field extension, algebraic and transcendental extension, algebraically closed field.
2. Have deep understanding of Splitting fields, normal extension, multiple roots, prime field, finite field and separable extension.
3. Learn about automorphism groups, fixed field, Dedekind lemma, fundamental theorem of Galois theory, roots of unity, Cyclotomic polynomial and cyclic extension.
4. Have deep understanding of polynomials solvable by radicals, symmetric functions, ruler and compass construction.

Unit-I:

Irreducible polynomials, Eisenstein criterion, Gauss lemma. Field extension, algebraic and transcendental extension, degree of an extension, algebraic closure and algebraically closed field.

Unit-II:

Splitting field, degree of extension of splitting field. Normal extension, multiple roots, prime field, characterization of prime field, finite field, separable extension.

Unit-III:

Automorphism group, fixed field, Dedekind lemma, Galois groups of polynomials, Galois extension, fundamental theorem of Galois theory, fundamental theorem of algebra, roots of unity. Cylotomic polynomials, Klein's four group, cyclic extension, Frobenius automorphism of a finite field.

Unit-IV:
Solvability of polynomials by radicals over Q. Symmetric functions and elementary symmetric functions. Construction with ruler and compass only.

(Chapter 15, 16, 17 & 18 of recommended book)

Recommended Text Book:
1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 2012.

Reference books:
1. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
2. Surjit Singh and Quazi Zameeruddin, Modern Algebra, Vikas Publishing House, 1990.
3. Patrick Morandi, Field and Galois Theory, Springer 1996.

MMATH20-202: COMPUTER PROGRAMMING with MATLAB

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: This course is designed to train the students in the computer programming. The objective of this course is to develop a skill of writing codes in MATLAB or equivalent Open Source software for solving different types of mathematical problems which arise in the areas of Mathematical/Physical/Life/Social Sciences and Engineering.

Course outcomes: This course will enable the students to:

1. Get familiar with the importance and working of MATLAB as computation platform through the knowledge of characters, variables, operators, functions and expressions as used for elementary operations in matrix algebra along with the editing, load/save data and compilation/execution/quitting of source programs.
2. Learn the process of writing a source program in MATLAB as high-level language making use of the statements for input/output, conditional/non-sequential processing involving functions, arrays and structures.
3. Learn the plotting of the curves and surfaces, which can be edited, modified, accumulated, handled, printed, exported and used to creating movies.
4. Write source programs with objects, variables, expressions, abstract functions, math functions in symbolic form and their subsequent use for the operations/ concepts/ problems in calculus, linear algebra and differential equations.

Unit-I:

Introduction: Basics of programming; Anatomy of a program; Constants; Characters; Variables; Data types; Assignments; Operators; functions; Examples of expressions; Entering long statements; Command line editing. Good programming style.
Working with vectors: Defining a Vector, Accessing elements within a vector, Basic operations on vectors; Mathematical functions; Strings; String functions; Cell array; Creating cell array; Concatenation.
Working with Matrices: Generating matrices; Mathematical operations and functions; Deleting rows /columns; Linear algebra; Arrays; Multivariate data; Scalar expansion; Logical subscripting;
Input and output: Save/Load functions, M-files, The find function; The format function; Suppressing output;

Unit-II:

Flow Control: if and else, switch and case, for loop, while loop, continue, break, try – catch, return.
Data Structures: Multidimensional arrays; Cell arrays, Characters and text; Structures,
Scripts and Functions: Scripts; Functions; Types of functions; Global variables; Passing string arguments to functions; The eval function; Function handles; Function functions; Vectorization; Preallocation.

Unit-III:

Graphics: Plotting process; Graph components; Figure tools; Arranging graphs within a figure; Selecting plot types; Plot editing mode, Using functions to edit graphs; Modifying a graph data source; Modify a graph to enhance the presentation; Printing a graph; Exporting a graph.
Basic Plotting Functions: Creating a plot; Multiple data sets in one graph; Specifying line styles and colors; Plotting lines and markers; Imaginary and complex data; Adding plots to existing graph; Figure windows; Multiple plots in one figure; Controlling the axes; Axis labels and titles; Saving figures.
Mesh and Surface Plots: Visualizing functions of two variables; Reading/writing images.
Printing and Handle Graphics: Using the handle; Graphics object; Setting object Properties; Specifying the axes or figure, Finding the handles of existing objects.
Animations: Erase mode method, Creating movies.

Unit-IV:

Symbolic Math: Symbolic objects; Creating symbolic variables and expressions; The findsym Command; The default symbolic variable; Constructing real and complex variables; Creating abstract functions; Creating symbolic math functions; Creating an M-file.
Calculus: Limits; Differentiation; Integration; Symbolic summation; Taylor series; Examples; Simplifications and substitutions, Variable-precision arithmetic examples.
Linear Algebra: Basic algebraic operations; Linear algebraic operations; Eigenvalues; Jordan canonical form; Singular value decomposition; Eigenvalue trajectories.
Solving Equations: System of algebraic equations, System of differential equations

Recommended Books:

1. *Learning MATLAB*, COPYRIGHT 1984 - 2005 by The MathWorks, Inc.
2. Amos Gilat, *MATLAB An Introduction With Applications* 5ed, Wiley, 2008.
3. C. F. Van Loan and K.-Y. D. Fan., *Insight through Computing: A Matlab Introduction to Computational Science and Engineering*, SIAM Publication, 2009.
4. T. A. Davis and K. Sigmon, *MATLAB Primer* 7th Edition, CHAPMAN & HALL/CRC, 2005.
5. B. R. Hunt, R. L. Lipsman, J. M. Rosenberg, K. R. Coombes, J. E. Osborn, and G. J. Stuck, *A Guide to MATLAB*, Second Edition, Cambridge University Press, 2006.
6. Y.Kirani Singh, B.B. Chaudhari, *MATLAB Programming*, PHI Learning, 2007.
7. K. Ahlersten, *An Introduction to Matlab*, Bookboon.com.
8. Rudra Pratap, *Getting Started with MATLAB*, Oxford University Press, 2010.
9. C. Gomez, C. Bunks and J.-P. Chancelier, *Engineering and Scientific Computing with SCILAB*, Birkhäuser, 2012.
10. A. Quarteroni, F. Saleri and P. Gervasio, *Scientific Computing with MATLAB and Octave*, Springer Nature, 2014.

MMATH20-203: DIFFERENTIAL EQUATIONS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The objectives of this course are to learn about oscillations of second order differential equations, solving boundary value problems, critical points of linear and non-linear system of differential equations and to determine types and stability of those critical points and systems.

Course Outcomes: This course will enable the students to:

1. Understand preliminary, oscillation and Sturm' theory of second order ordinary differential equations and comparison theorems. Apply this knowledge to solve problems of checking second order ODEs for oscillatory, finding common zeros and applying Prüffer transformation.
2. Have good understanding of boundary value problems of second order, their classification and solution. Appreciate the concept of Green's function. Attain skills to solve boundary value problems which find great applications in areas of applied mathematics, science and engineering.
3. Know critical points of linear and non-linear system of differential equations, their types and stability. Understand concepts of potential energy function, limit cycles, semi orbit and limit sets. Apply the gained knowledge to determine type and stability of critical points and check for existence of limit cycles of given systems. Have a foundation to understand area of non-linear analysis of dynamical systems where mathematics and space science connect to each other.
4. Understand stability of linear, quasi-linear and non-linear systems. Learn to apply Lyapunov direct method to determine stability of such systems for investigating and solving problems.

Unit-I:

Linear second order equations: Preliminaries, Superposition principle, Riccati's equation, Prüffer transformation.
Oscillations of second order differential equations: Zero of a solution, Oscillatory and non-oscillatory equations, Abel's formula, Common zeros of solutions and their linear dependence, Sturm separation theorem, Sturm fundamental comparison theorem and its corollaries, Elementary linear oscillations, Comparison theorem of Hille-Wintner, Oscillations of $x'' + a(t)x = 0$.
(Relevant portions from the book 'Differential Equations' by S.L. Ross and the book 'Textbook of Ordinary Differential Equations' by Deo et al.)

Unit-II:

Second order boundary value problems (BVP): Linear problems; periodic boundary conditions, regular linear BVP, singular linear BVP; non-linear BVP,

Sturm-Liouville BVP; Definition, Characteristic values and Characteristic functions. Orthogonality of characteristic functions.

Green's functions: Definition and Properties. Applications of boundary value problems, Picard's theorem.

(Relevant portions from the book 'Differential Equations' by S.L. Ross and the book 'Textbook of Ordinary Differential Equations' by Deo et al.)

Unit-III:

Non-linear Differential Equations: Autonomous systems; Phase plane, Paths and Critical points, Types of critical points; Node, Center, Saddle point, Spiral point, Stability of critical points, Critical points and paths of linear systems; Basic theorems and their applications.

Critical points and paths of non-linear systems; Basic theorems and their applications. Non-linear conservative systems, Potential energy function, Dependence on a parameter.

Limit Cycles and periodic solutions, Benedixson's non-existence criterion, Half-path, Limit set, Statement of Poincaré-Benedixson theorem and its uses.

(Relevant portions from the book 'Differential Equations' by S.L. Ross)

Unit-IV:

Stability of linear and non-linear systems: System of equations with constant coefficients, linear equation with constant coefficients.

Lyapunov Stability: Stability of solution of a differential system, Positive definite and semidefinite functions, Negative definite and semidefinite functions, Decrescent function,

Lyapunov function, Lyapunov's theorems on stability.

Stability of quasi-linear systems. Boundedness of solutions of a second order differential equations.

(Relevant portions from the book 'Textbook of Ordinary Differential Equations' by Deo et al.)

Recommended Text Books:

1. Sheply L. Ross, *Differential Equations*, Wiley , 3rd Edition, 2007.
2. S.G. Deo, V. Raghavendra, Rasmita Kar, V. Lakshmikantham, *Textbook of Ordinary Differential Equations*, Tata McGraw-Hill , 2006.

Reference books:

1. Earl A. Coddington and Norman Levinson, *Theory of Ordinary Differential Equations*, McGraw Hill Education , 2017.
2. P. Hartman, *Ordinary Differential Equations*, John Wiley & Sons NY, 1971.
3. G. Birkhoff and G.C. Rota, *Ordinary Differential Equations*, John Wiley & Sons, 1978.
4. G.F. Simmons, *Differential Equations*, Tata McGraw-Hill , 1993.
5. Mohan C Joshi, *Ordinary Differential Equations, Modern Perspective*, Narosa Publishing House, 2006.

MMATH20-204: MEASURE AND INTEGRATION

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The main objective is to familiarize with Lebesgue outer measure, measurable sets, measurable functions, Lebesgue integration, fundamental integral convergence theorems, functions of bounded variation, differentiation of an integral, absolutely continuous functions and Lp-spaces.

Course Outcomes: This course will enable the students to:
1. Understand the concepts of measurable sets and Lebesgue measure; construct a non-measurable set; apply the knowledge to solve relevant exercises.
2. Know about Lebesgue measurable functions and their properties; and apply the knowledge to prove Egoroff's theorem, Lusin's theorem and F.Riesz theorem.
3. Understand the requirement and the concept of the Lebesgue integral (as a generalization of the Riemann integration) along its properties and demonstrate understanding of the statement and proofs of the fundamental integral convergence theorems.
4. Know about the concepts of differentiation of monotonic function, functions of bounded variations, differentiation of an integral and absolutely continuous functions; apply the knowledge to prove specified theorems.

Unit-I:

Lebesgue outer measure, elementary properties of outer measure, measurable sets and their properties, Lebesgue measure of sets of real numbers, algebra of measurable sets, Borel sets and their measurability, characterization of measurable sets in terms of open, closed, F_σ and G_δ sets, existence of a non-measurable set.

Unit-II:

Lebesgue measurable functions and their properties, the almost everywhere concept, characteristic functions, simple functions, approximation of measurable functions by sequences of simple functions, Borel measurability of a function.

Littlewood's three principles, measurable functions as nearly continuous functions. Lusin's theorem, almost uniform convergence, Egoroff's theorem, convergence in measure, F.Riesz theorem that every sequence which is convergent in measure has an almost everywhere convergent subsequence.

Unit-III:

The Lebesgue Integral: Shortcomings of Riemann integral, Lebesgue integral of a bounded function over a set of finite measure and its properties, Lebsegue integral as a generalization of the Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions.

Integral of a non-negative function, Fatou's lemma, Monotone convergence theorem, integration of series, the general Lebesgue integral, Lebesgue convergence theorem.

Unit-IV:

Differentiation and Integration: Differentiation of monotone functions, Vitali's covering lemma, the four Dini derivatives, Lebesgue differentiation theorem, functions of bounded variation and their representation as difference of monotone functions.

Differentiation of an integral, absolutely continuous functions and their properties, convex functions, Jensen's inequality. The Lp-spaces and their completeness.

Recommended Text Book:

H.L. Royden, Real Analysis (3rd Edition) Prentice-Hall of India, 2008.

Reference Books:

1. G.de Barra, Measure theory and integration, New Age International, 2014.
2. P.R. Halmos, Measure Theory, Van Nostrans, Princeton, 1950.
3. I.P. Natanson, Theory of functions of a real variable, Vol. I, Frederick Ungar Publishing Co., 1961.
4. R.G. Bartle, The elements of integration, John Wiley & Sons, Inc.New York, 1966.
5. K.R. Parthsarthy, Introduction to Probability and measure, Macmillan Company of India Ltd.,Delhi, 1977.
6. P.K. Jain and V.P. Gupta, Lebesgue measure and integration, New Age International (P) Ltd., Publishers, New Delhi, 1986.

MMATH20-205: MECHANICS OF SOLIDS

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: In this course, basic theory of mechanics of solids is introduced. First, the laws of transformations and tensors will be introduced. Mathematical theory of deformations, analysis of strain and analysis of stress in elastic solids will be learnt next. A student will also learn basic equations of elasticity and variational methods. In this course, the students will be exposed to the mathematical theory of elasticity and other techniques which find applications in areas of civil and mechanical engineering and Earth and material sciences. This course will expose a student to Applied Mathematics and will form a sound basis for doing research in the number of areas involving solid mechanics.

Course Outcomes: This course will enable the students to:

1. Understand the concept of tensors as a generalized form of directional entities and to explore their properties through the operations of algebra and calculus. Be familiar with affine transformation and infinitesimal deformation.
2. Understand analysis of strain and stress tensors. Prepare a strong foundation to learn theory of elasticity to solve scientific problems.
3. Relate strain tensor and stress tensor through anisotropic elastic moduli, subjected to reflection/rotational symmetries to define elastic isotropy, and using theorems/ principles to explore the role of these relations in strain energy, compatibility and uniqueness of solution.
4. Learn variational methods to solve boundary value problems in elasticity. Learn to prove standard theorems related to theory of variational problems and to apply these techniques/methods by minimizing the potential / strain / complementary energies to solve scientific problems in mechanics of solids and get exposed to research problems in the field of elasticity.

Unit-I:
Tensor Algebra: Coordinate-transformation, Cartesian Tensors of different order.

Properties of tensors. Isotropic tensors of different orders and relation between them. Symmetric and skew symmetric tensors. Tensor invariants. Deviatoric tensors. Eigen-values and eigen-vectors of a tensor.

Tensor Analysis: Scalar, vector, tensor functions, Comma notation.

Gradient, divergence and curl of a vector / tensor field.

(Relevant portions of Chapters 2 and 3 of book by D.S. Chandrasekharaiah and L.Debnath)

Affine transformation, Infinitesimal affine deformation.

(Relevant portions of Chapter 1 of the book by I.S. Sokolnikoff).

Unit-II:

Analysis of Strain: Strain tensor, Geometrical Interpretation of strain components. Strain quadric of Cauchy. Principal strains, Invariants, General infinitesimal deformation. Examples of strain, Equations of compatibility.

(Relevant portions of Chapter 1 of the book by I.S. Sokolnikoff).
Analysis of Stress : Stress Vector, Stress tensor, Equations of equilibrium, Transformation of coordinates. Stress quadric of Cauchy, Principal stresses. Maximum normal and shear stresses. Mohr's circles. Examples of stress.

(Relevant portions of Chapter 2 of the book by I.S. Sokolnikoff).

Unit-III:

Equations of Elasticity: Generalised Hooke's Law, Anisotropic symmetries, Homogeneous Isotropic media. Elasticity moduli for Isotropic media. Equilibrium and dynamic equations for an isotropic elastic solid. Strain energy function and its connection with Hooke's Law.

Beltrami-Michell compatibility equations. Uniqueness of solution. Clapeyron's theorem. Saint-Venant's principle.

(Relevant portions of Chapter 3 of book by I.S. Sokolnikoff).

Unit-IV:

Variational Methods: Variational problems and Euler's Equations, Theorem of minimum potential energy. Theorem of minimum complementary energy. Reciprocal theorem of Betti and Rayleigh. Ritz method: one and two dimensional cases. Galerkin method. Method of Kantorovich.

(Relevant portions of Chapter 7 of the book by I.S. Sokolnikoff).

Recommended Text Books:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata-McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. D.S. Chandrasekharaiah and Lokenath Debnath, Continuum Mechanics, Academic Press, 2014.

Reference Books:

1. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
2. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
3. Shanti Narayan, Text Book of Cartesian Tensor, S. Chand & Co., 1950.
4. S. Timeshenko and N. Goodier. Theory of Elasticity, McGraw Hill, New York, 1970.
5. I.H. Shames, Introduction to Solid Mechanics, Prentice Hall, New Delhi, 1975.

MMATH20-206: Practical-II

Course Credit Practical	Practical Hours per week	End Term Examination Time	Maximum Marks		
			Internal Assessment	End Term Examination	Total
2	4	4 Hours	10	40	50

Note: The examiner will set 3 questions at the time of practical examination by taking course outcomes (COs) into consideration. The examinee will be required to write two programs and execute one program successfully. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course objectives: This course aims to train the students for practical implementations of the features of MATLAB/SCILAB/Octave programming, which they study as a theory course MMATH20-202. Also, implementation of some problem solving techniques, based on papers MMATH20-201 to MMATH20-205, should be learnt.

Course Outcomes: This course will enable the students to:

1. Solve practical problems related to theory courses undertaken in the Semester-II from application point of view.
2. Know syntax of expressions, statements, data types, structures, commands and to write source code for a program in MATLAB/SCILAB/Octave.
3. Edit, compile/interpret and execute the source program for desired results.
4. Debug, verify/check and to obtain output of results.

List of Programs: The following practicals will be done on the MATLAB/SCILAB/Octave platform and record of those will be maintained in the practical Note Book:

1. Plot a circle for given centre and a point on the boundary. Find its perimeter and area.
2. To compute the arithmetic mean, geometric mean and harmonic mean for the values {x(j), j=l,2,...,n} and the corresponding frequencies {f(j), j=l,2,...,n}.
3. Find the inverse of a given matrix and verify the result by using built-in function.
4. Use switch…case to calculate the income tax on a given income at the existing rates.
5. Write function for the greatest common divisor (gcd) of two given positive integers and use it to find the least common multiple (lcm) of three given positive integer values. Get the result using built-in functions as well.
6. Solve a cubic equation with given coefficients and verify the solution through built-in function.
7. Identify the location of a given point (x,y) i) at origin, ii) on x-axis or y-axis iii) in quadrant I, II, III or IV. Verify through x-y plot.
8. Write functions to calculate sin(x) and cos(x) as series sum of n terms. Use these functions to plot sin(x), cos(x), sin(x) +cos(x), x in [0,2π], for n=2,5,10. Display the deviation of curves from those obtained via built-in functions.
9. For given coefficients (a, b, c, d, e), solve the equation $ax^2+ by^2+2cx+2dy+e=0$ to plot the corresponding conic, viz. parabola/ hyperbola/ ellipse/ circle or else.
10. For given perimeter and number of sides, plot the polygon and calculate its area.

11. Use polar coordinates to plot 4 circles in a plot with common centre but of different radii.
12. For 4 spheres with given centre and radii, plot their surfaces as different subplots in a figure.
13. Least square fitting of a straight line to given set of points on a plane. Compare the plot this line with the plots of least-square fit polynomials of degree 2 to 5.
14. For a given square matrix A, find its eigenvalues (p) after solving the determinant |A-pI| into an algebraic equation.
15. For a given square matrix of order 3, find the eigen-values and eigen-vectors and check the result with the use of built-in function.

Reference Books:

1. B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, *A Guide to MATLAB*, Second Edition, Cambridge University Press, 2006.
2. T. A. Driscoll, *Learning MATLAB*; Society for Industrial and Applied Mathematics ,2009.
3. K. Sigmon and T.A. Davis, *MATLAB Primer 7th Edition*, CRC Press, 2005.

OEM20-207: BASIC MATHEMATICS-I

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
2	0	3 Hours	10	40	50

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 4 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: The main objective of this course is to familiarize the students with some of the topics from Analysis and Algebra, namely, convergence of sequences and series, Fourier series, algebra of matrices, rank of a matrix, systems of linear equations, characteristic roots and characteristic vectors of a square matrix.

Course Outcomes: This course will enable the students to:

1. Understand convergence of sequences and series; attain the skill to handle the convergence of various infinite series.
2. Know about the Fourier series, conditions for Fourier expansion; attain the skill to compute Fourier series of various functions.
3. Know about the algebra of matrices, rank of a matrix; attain the skill to find the rank of matrices.
4. Solve systems of linear equations and find characteristic roots and characteristic vectors of a square matrix.

Unit-I:
Sequences and series: sequences, bounded, convergent and monotonic sequences, infinite series, convergence and divergence of an infinite series, positive term series, geometric series, comparison test for positive term series, Cauchy's root test, D'Alembert's ratio test. Raabe's test, logarithmic test, integral test, Gauss's test. (Scope as in relevant portions of chapters 3 and 4 of the book recommended at Sr. No. 1)

Unit-II:
Fourier Series : Periodic function, Euler's formulae, conditions for Fourier expansion, functions having points of discontinuity, even and odd functions, Fourier series for even and odd functions, half range Fourier series. (Scope as in relevant portions of chapter 1 of the recommended at Sr. No. 2)

Unit-III:
Algebra of matrices: Basic operations on matrices, special type of square matrices: idempotent matrix, nilpotent matrix, involutary matrix, orthogonal matrix, unitary matrix; rank of a matrix (Scope as in relevant portions of chapters 2 and 4 of the book recommended at Sr. No. 3)

Unit-IV:

Systems of linear equations:, system of linear homogeneous equations, systems of linear non-homogeneous equations, matrices of reflection and rotation.

Characteristic roots and characteristic vectors of a square matrix. Characteristic matrix and characteristic equation of a matrix, Cayley-Hamilton theorem (without proof). (Scope as in relevant portions of chapters 6 and 11 of the book recommended at Sr. No. 3)

Recommended Text Books:

1. S.C. Malik and Savita Arora: Mathematical Analysis, New Age International Publishers, 2017.
2. S. Sreenadh, S. Ranganatham, M.V.S.S.N. Prasad and V.R. Basu : Fourier series and integral transforms, S. Chand & Company (Pvt) Ltd., 2014.
3. Shanti Narayan and P.K. Mittal: A text book of matrices, S. Chand & Company (Pvt) Ltd., 2018.

Reference Books:

1. R.G. Bartle and D.R. Sherbert : Introduction to Real Analysis, John Wiley & Sons, 2000.
2. R.R. Goldberg : Methods of Real Analysis, Oxford and IHB Publishing Company, New Delhi, 1970.
3. Seymour Lipschutz and Marc Lipson : Linear Algebra, Third Edition, McGraw Hill Education, 2005.

MMATH21-301: FLUID MECHANICS

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Fluid mechanics is a branch of continuum mechanics which deals with mechanics of fluids (liquids and gases) of ideal and viscous types. Fluid mechanics has a wide range of applications in the areas of mechanical engineering, civil engineering, chemical engineering, geophysics, astrophysics, and biology. This course aims to provide basic concepts, laws and theories of fluid dynamics and to prepare a foundation to understand the motion of fluid and develop concept, models and techniques which enables to solve the two and three dimensional problems of fluid flow and help in advanced studies and research in the broad area of fluid motion.

Course Outcomes: This course will enable the students to:

1. Be familiar with continuum model of fluid flow, classify fluid/flows, Stream, path and streak lines, rotational and irrotational motion. Understand Eulerian and Lagrangian descriptions of fluid motion, law of conservation of mass and boundary surfaces. Attain ability to derive equation of continuity and problem solving.
2. Learn to derive equations of motion, Bernouli equation, vorticity equation corresponding to different problems of fluid dynamics and to solve those equations. Prove theorems on circulation and energy in fluid flow. Make strong foundation for doing research in the area of fluid mechanics and bio-mechanics.
3. Understand motion of sphere in a fluid and fluid flow past a sphere at rest; sources, sinks, doublets and their images. Learn to solve three dimensional flow problems of fluid dynamics.
4. Understand two dimensional flow problems, stream function, axi-symmetric flow, complex potential, source, sink and doublets in two dimensions, Milne-Thomson circle theorem, Blasius theorem. Attain skills to solve fluid flow problems in two dimensions. Get exposure to research problems in fluid dynamics.

Unit-I:

Kinematics of fluid in motion: Real fluids and ideal fluids, Velocity at a point of a fluid. Lagrangian and Eulerian methods. Stream lines, Path lines and Streak lines. Vorticity and Circulation, Vortex lines, Velocity potential, Irrotational and rotational motions. Acceleration at a point of fluid, Local and particle rates of change.

Equation of continuity. Conditions at a rigid boundary, boundary surfaces.

(Relevant portions from the recommended text books at Sr. No. 1 & 2)

Unit-II:

Pressure at a point in a fluid, Conditions at a boundary of two immiscible fluids. Equation of Motion : Lagrange's and Euler's equations of Motion. Bernoulli's equation, Applications of the Bernoulli Equation in one–dimensional flow problems, Steady motion under conservative body forces.

Kelvins circulation theorem, Vorticity equation. Energy equation for incompressible flow. Kinetic energy of irrotational flow. Kelvins minimum energy theorem. Mean value of the velocity potential. Kinetic energy of infinite liquid. Uniqueness theorems.
(Relevant portions from the recommended text books at Sr. No. 1 & 2)

Unit-III:

Axially symmetric flows. Sphere at rest in a uniform stream, Sphere in motion in fluid at rest at infinity. Equation of motion of a sphere. Kinetic energy generated by impulsive motion. Motion of two concentric spheres.

Three-dimensional sources, sinks and doublets. Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surfaces.
(Relevant portions from the recommended text books at Sr. No. 1 & 2)

Unit-IV:

Two-dimensional flows: Use of cylindrical polar coordinates, Stream function, Some fundamental stream functions, Axisymmetric flow, Equations satisfied by Stokes's stream function in irrotational flow, Basic Stokes's stream functions, Boundary conditions satisfied by the stream function.

Irrotational plane flows: Complex potential, Image systems in plane flows. Milne-Thomson circle theorem. Circular cylinder in uniform stream with circulation. Blasius theorem.
(Relevant portions from the recommended text books at Sr. No. 1 & 2)

Recommended Text Books:

1. F. Chorlton, *Text-book of Fluid Dynamics*, CBS Publishers and Distributors Pvt. Ltd., 2018.
2. Michael E. O'Neill and F. Chorlton, *Ideal and Incompressible Fluid Dynamics*, Ellis Horwood, 1986.

Reference Books:

1. G.K. Batchelor, *An Introduciton to Fluid Dynamics*, Cambridge University Press, 2000.
2. A.J. Chorin and A. Marsden, *A Mathematical Introduction to Fluid Dynamics*, Springer-Verlag, New York, 1993.
3. L.D. Landau and E.M. Lifshitz, *Fluid Mechanics*, Pergamon Press, 1987.
4. H. Schlichting, *Boundary Layer Theory*, Springer, 2016.
5. S. W. Yuan, *Foundations of Fluid Mechanics*, Prentice Hall of India Ltd., 1988.
6. A.D. Young, *Boundary Layers*, AIAA Education Series, Washington DC, 1989.
7. W.H. Besant and A.S. Ramsey, *A Treatise on Hydromechanics*, Part-II, CBS Publishers, Delhi, 2006.

MMATH21-302: FUNCTIONAL ANALYSIS

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The main objective is to familiarize with normed linear spaces, Banach spaces, inner product spaces and Hilbert spaces. The four fundamental theorems: Hahn-Banach Theorem, Uniform Boundedness Theorem, Open Mapping Theorem and Closed Graph Theorem are the highlights of the course. We also make an excursion into Hilbert spaces, introducing basic concepts and proving the classical theorems associated with the names of Riesz, Bessel and Parseval, along with classifying operators into self-adjoint, unitary and normal operators.

Course Outcomes: This course will enable the students to:
1. Know about the requirements of a norm; completeness with respect to a norm; understand relation between compactness and dimension of a space; check boundedness of a linear operator and relate to continuity; convergence of operators by using a suitable norm; apply the knowledge to compute the dual spaces.
2. Extend a linear functional under suitable conditions; apply the knowledge to prove Hahn Banach Theorem for further application to bounded linear functionals on C[a,b]; know about adjoint of operators; understand reflexivity of a space and demonstrate understanding of the statement and proof of uniform boundedness theorem.
3. Know about strong and weak convergence; understand open mapping theorem, bounded inverse theorem and closed graph theorem; distinguish between Banach spaces and Hilbert spaces; decompose a Hilbert space in terms of orthogonal complements.
4. Understand totality of orthonormal sets and sequences; represent a bounded linear functional in terms of inner product; classify operators into self-adjoint, unitary and normal operators.

Unit-I:

Normed linear spaces, Banach spaces, finite dimensional normed spaces and subspaces, equivalent norms, compactness and finite dimension, F.Riesz's lemma.

Bounded and continuous linear operators, differentiation operator, integral operator, bounded linear extension, bounded linear functionals, normed spaces of operators, dual spaces with examples. (Scope as in relevant parts of Chapter 2 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Unit-II:

Hahn-Banach theorem for normed linear spaces, application to bounded linear functionals on C[a,b], Riesz-representation theorem for bounded linear functionals on C[a,b], adjoint operator, norm of the adjoint operator.

Reflexive spaces, uniform boundedness theorem and some of its applications to the space of polynomials and Fourier series. (Scope as in relevant parts of sections 4.1 to 4.7 of Chapter 4 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Unit-III:

Strong and weak convergence, open mapping theorem, bounded inverse theorem, closed linear operators, closed graph theorem. (Scope as in relevant parts of sections 4.8, 4.12 and 4.13 of Chapter 4 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Inner product spaces, Hilbert spaces and their examples, Schwarz inequality, continuity of inner product, orthogonal complements and direct sums, minimizing vector, orthogonality, projection theorem, characterization of sets in Hilbert spaces whose space is dense. (Scope as in relevant parts of sections 3.1 to 3.3 of Chapter 3 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Unit-IV:

Orthonormal sets and sequences, Bessel's inequality, series related to orthonormal sequences and sets, total (complete) orthonormal sets and sequences, Parseval's identity, separable Hilbert spaces. (Scope as in relevant parts of sections 3.4 to 3.6 of Chapter 3 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Riesz representation theorem for bounded linear functionals on a Hilbert space, sesquilinear form, Riesz representation theorem for bounded sesquilinear forms on Hilbert spaces. Hilbert-adjoint operator, its existence and uniqueness, properties of Hilbert-adjoint operators, self-adjoint, unitary and normal operators. (Scope is as in relevant parts of sections 3.8 to 3.10 of Chapter 3 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Recommended Text Book:

E.Kreyszig: Introductory Functional Analysis with Applications, Wiley India, 2007.

Reference Books:

1. G.F.Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Book Co.,New York, 1983.
2. C.Goffman and G.Pedrick: First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
3. G.Bachman and L.Narici, Functional Analysis, Dover Publications, 2000.
4. L.A.Lustenik and V.J.Sobolev, Elements of Functional Analysis, Hindustan Publishing Corporation, New Delhi, 1971.
5. J.B.Conway: A Course in Functional Analysis, Springer-Verlag, 1990.
6. P.K.Jain, O.P.Ahuja and Khalil Ahmad: Functional Analysis, Second Edition,New Age International(P) Ltd. & Wiley Eastern Ltd., New Delhi, 2010.

MMATH21-303: Practical-III

Course Credit Practical	Practical Hours per week	End Term Examination Time	Maximum Marks		
			Internal Assessment	End Term Examination	Total
2	4	4 Hours	10	40	50

Note: The examiner will set 3 questions at the time of practical examination by taking course outcomes (COs) into consideration. The examinee will be required to write two programs and execute one program successfully. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course objectives: The objective of this laboratory course is to write codes for numerical methods and to execute those source programs using either of MATLAB/SCILAB/Octave platforms. In addition, hand on experience of using built-in functions, provided in the libraries of these platforms/software, for verification/ supplementing the source program should be realized. Also, some problem solving techniques based on papers MMATH21-301 to MMATH21-302 will be taught.

Course Outcomes: This course will enable the students to:

1. Understand the algorithms for solving listed mathematical problems and to solve practical problems related to core courses undertaken in the Semester-III from application point of view.
2. Write source codes using either of MATLAB/SCILAB/Octave programming.
3. Edit, compile/interpret and execute the source program for desired results.
4. Verify/check results using built-in MATLAB/SCILAB/Octave functions.

List of Programs: The following practicals will be done on the MATLAB/SCILAB/Octave platform and record of those will be maintained in the practical Note Book:

1. Solutions of simultaneous linear equations: Gauss-elimination method and Gauss-Jordan method.
2. Solutions of simultaneous linear equations using Jacobi method and Gauss-Seidel method.
3. Solution of algebraic / transcendental equations using Bisection method and Regula-falsi method.
4. Solution of algebraic / transcendental equations using Secant method and Newton-Raphson method.
5. Inversion of matrices using adjoints; Jordan method.
6. Numerical differentiation: using various differentiation formulas for error reduction.
7. Numerical integration using composite methods based on trapezoidal rule.
8. Numerical integration using composite Simpson1/3 rule and 3/8 rule.
9. Solution of ordinary differential equations Euler method and Modified Euler method.
10. Solution of ordinary differential equations using Runge-Kutta methods.
11. Statistical problems on central tendency (mean, mode, median) and dispersion (standard variation, standard error).

12. Least square method to fit polynomial (curve) of given degree to given data set.
13. Plotting of special functions.

Reference Books:

1. S.R. Otto, J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer-Verlag, London, 2005.
2. William J. Palm III and William Palm, Introduction to MATLAB 7 for Engineers 2nd Edition, The McGraw-Hill Higher Education London, 2003.

MMATH21-304: ADVANCED TOPOLOGY

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The main objective of this course is to familiarize with some advanced topics in topology. Starting from the convergence of sequences in topological spaces and in first axiom topological spaces, we move on to the introduction and convergence of nets in topological spaces followed by canonical way of converting nets to filters and vice versa. The concepts of metrisable spaces and paracompactness also form a part of the course along with some topics from algebraic topology including the fundamental group, Euclidean simplexes, singular simplexes etc.

Course Outcomes: This course will enable the students to:
1. Know about nets in topological spaces; learn canonical way of converting nets to filters and vice versa; understand the concepts of connectedness and local connectedness.
2. Have understanding of metrisable spaces and Urysohn's metrisation theorem; know about locally finite family and its equivalent forms, paracompactness of a metrisable space; apply knowledge to prove Nagata-Smirnov metrisation theorem and Smirnov metrisation theorem.
3. Understand homotopy classes, fundamental group, Euclidean simplexes and related concepts.
4. Learn about singular simplexes homology and relative homology groups; demonstrate understanding of the statement and proof of the excision theorem.

Unit-I:

Convergence of sequences in topological spaces and in first axiom topological spaces, Nets in topological spaces, convergence of nets, Hausdorffness and convergence of nets, Subnets and cluster points, canonical way of converting nets to filters and vice versa, their convergence relations (Scope as in theorems 2-3,5-8 of Chapter 2 of Kelley's book recommended at Sr. No.1)

Connected spaces, connected subspaces of the real line, components and local connectedness (Scope as in relevant portions of sections 23-26 of Chapter 3 of the book by 'Munkres' recommended at Sr. No. 2)

Unit-II:

Definition and examples of metrisable spaces, Urysohn's metrisation theorem. Locally finite family, its equivalent forms, countably locally finite family, refinement, open refinement, closed refinement of a family, existence of countably locally finite open covering of a metrisable space, Nagata-Smirnov metrisation theorem, Paracompactness, normality of a paracompact Hausdorff

space, paracompactness of a metrisable space and of regular Lindelof space, Smirnov metrisation theorem.
(Scope as in theorems 34.1, 39.1-39.2. 40.3, 41.1-41.5 and 42.1 of Chapter 6 of the book by ‘Munkres’ recommended at Sr. No. 2)

Unit-III:
Relation of homotopy of paths based at a point and homotopy classes, product of homotopy classes, Fundamental group, change of base point topological invariance of fundamental group. (scope as in relevant parts of Chapter IV of the book by ‘Wallace’ recommended at Sr. No.3)

Euclidean simplex, its convexity and its relation with its faces, standard Euclidean simplex, linear mapping between Euclidean simplexes of same dimension (scope as in relevant parts of Chapter V of the book by ‘Wallace’ recommended at Sr. No.3)

Unit-IV:
Singular simplexes and group of p-chains on a space, special singular simplex on and its boundary, induced homomorphism between groups of chains, boundary of a singular simplex and a chain, cycles and boundaries on a space, homologous cycles, homology and relative homology groups, induced homomorphism on relative homology groups, induced homomorphism on relative homology groups, topological invariance of relative homology groups, Prisms, homotopic maps and homology groups.
(scope as in relevant parts of Chapter VI of the book by ‘Wallace’ recommended at Sr. No.3)

Join of a point and a chain, Barycentric subdivision operator B, diameter of a Euclidean simplex and a singular simplex, operator H and its relation with B, representation of an element of a relative cycle made up of singular simplexes into members of a given open cover of the space, the excision theorem
(scope as in relevant parts of Chapter VII of the book by ‘Wallace’ recommended at Sr. No.3)

Recommended Text Books:
1.J.L.Kelley, General Topology, Springer Verlag, New York, 2012.
2. J.R.Munkres, Topology, Pearson Education Asia, 2002.
3. A.H.Wallace, Introduction to Algebraic Topology, Dover Publications, 2007

Reference Books:
1. K. Chandrasekhara Rao, Topology, Narosa Publishing House Delhi,2009.
2. Fred H. Croom, Principles of Topology, Cengage Learning, 2009.
3. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, 2006.
4. C.W.Patty, Foundation of Topology, Jones & Bertlett, 2009.
5. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1983.

MMATH21-305: COMMUTATIVE ALGEBRA

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
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<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The course is designed to give an exposure of the concepts in commutative rings and modules defined on commutative rings. The course contains exact sequences of modules, tensor product modules, localisation, primary decomposition of an ideal. This course also contains Integrally closed domains, Noether's normalization theorem, chain conditions on rings and modules, primary decomposition of an ideal in Notherian rings. Structure theorem of Artinian rings.

Course Outcomes: This course will enable the students to:

1. Learn about free modules, projective modules, tensor products and flat modules.
2. Learn about ideals, local rings, localisation and applications.
3. Understand Noetherian modules, primary decomposition, Artinian modules and length of a module.
4. Understand integral elements, integral extensions, integrally closed domains, finiteness of integral closure.

Unit-I:

Free module, submodules, cyclic modules, homomorphism of R-modules, rank of Module. exact sequence, projective modules, Shanuel's lemma, tensor products, finitely generated R-algebra, flat modules.

Unit-II:

Ideals, maximal ideals, prime ideals, nilpotent elements, nil radical, Jacobson radical of R, comaximal, Chinese remainder theorem, extension and contraction of ideal, local rings, Nakayama lemma, localisation and quotients, localisation of localisation, applications, patching up of localisations.

Unit-III:

Noetherian modules, Hilbert's basis theorem, primary ideal, primary decomposition. first and second uniqueness theorem, Artinian modules, structure of Artinian rings, composition series of R-module, Jordan Holder theorem, length of a module.

Unit-IV:
Integral elements, integral closure, integral extensions, lying above, going up theorem, integrally closed domains, going-down theorem, finiteness of integral closure, Noether's normalisation theorem, weak nullstellensatz, Hilbert's nullstellensatz.
(Chapter 1, 2, 3 & 4 of the recommended book)

Recommended Book:
1. N.S.Gopal Krishnan : Commutative Algebra , Orient Blackswan Private Limited, 2017.
Reference books:
1. M.F.Atiyah and I.G.Macdonald : Introduction to Commutative Algebra, Addison-Wesley Publishing Company, 1969.
2. O. Zariski and P. Samuel : Commutative Algebra I, Springer, 1958.

MMATH21-306: DIFFERENTIAL GEOMETRY

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Differential geometry is a discipline that uses the techniques of differential calculus, vector calculus and linear algebra to study problems in geometry and the mathematical analysis of curves and surfaces in space is studied in this course. The objective is to learn about curves in space and other related concepts; surfaces, envelopes, developable surfaces; curves on surfaces; and Geodesics.

Course Outcomes: This course will enable the students to:

1. Understand concepts of curves in space and other related concepts like tangent, principal normal, curvature, binormal, torsion, centre of curvature, spherical curvature, involutes, evolutes, Bertrand curves and to solve related problems
2. Understand and distinguish surfaces and their characteristics, developable surfaces, family of surfaces and curvilinear coordinates. Demonstrate knowledge to solve related problems of geometry.
3. Learn about curves on surfaces, conjugate systems, asymptotic lines, isometric lines, null lines etc. and minimal curves.
4. Derive equations of Gauss and Codazzi, Mainardi-Codazzi relations and Bonnet’s theorem. Understand concepts of geodesics and curves in relation to geodesics and apply knowledge in problem solving.

Unit-I:

Curves: Tangent, principal normal, curvature, binormal, torsion, Serret-Frenet formulae, locus of center of curvature, spherical curvature, locus of centre of spherical curvature, curve determined by its intrinsic equations, helices, spherical indicatrix of tangent, etc., involutes, evolutes, Bertrand curves.

Unit-II:

Envelopes and Developable Surface : Surfaces, tangent plane, normal. One parameter family of surfaces; Envelope, characteristics, edge of regression, developable surfaces. Developables associated with a curve; Osculating developable, polar developable, rectifying developable. Two parameter family of surfaces; Envelope, characteristic points and examples.

Curvilinear Coordinates, First order magnitudes, directions on a surface, the normal, second order magnitudes, derivatives of **n**, curvature of normal section, Meunier’s theorem.

(Relevant portions from the books ‘*Differential Geometry of Three Dimensions*’ by C.E. Weatherburn)

Unit-III:
Curves on a surface : Principal directions and curvatures, first and second curvatures, Euler's theorem, Dupin's indicatrix, the surface z = f(x, y), surface of revolution. Conjugate systems; conjugate directions, conjugate systems. Asymptotic lines, curvature and torsion. Isometric lines; isometric parameters. Null lines, minimal curves.

Unit-IV:
The equations of Gauss and of Codazzi: Gauss's formulae for $\boldsymbol{r}_{11}, \boldsymbol{r}_{12}, \boldsymbol{r}_{22}$, Gauss characteristic equation, Mainardi-Codazzi relations, alternative expression, Bonnet's theorem, derivatives of the angle ω.

Geodesics: Geodesic property, equations of geodesics, surface of revolution, torsion of a geodesic. Curves in relation to Geodesics; Bonnet's theorem, Joachimsthal's theorems, vector curvature, geodesic curvature, Bonnet's formula.
(Relevant portions from the books '*Differential Geometry of Three Dimensions*' by C.E. Weatherburn)

Recommended Text Book:

1. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Radha Publishing House, Calcutta, 1988.

Reference Books:

1. John A. Thorpe, *Elementary Topics in Differential Geometry*, Springer Science & Business Media, 1994.
2. B.O. Neill, *Elementary Differential Geometry*, Academic Press, 1997.
3. Erwin Kreyszig, *Differential Geometry*, Dover Publications, 2013.
4. S. Sternberg, *Lectures on Differential Geometry*, Reprinted by AMS, 2016.
5. Nirmala Prakash, *Differential Geometry*, Tata McGraw-Hill Publishing Company Limited, 1992.
6. R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice-Hall, 1977.

MMATH21-307: ELASTICITY

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: This course is in continuation to the course MMATH20-205 (Mechanics of Solids) being taught as a core paper in second semester. This paper deals with elastostatics problems on extension, torsion, bending and flexure of beams through the application of forces and couples. The techniques used to solve these problems involve the applications of complex analysis (analytic functions, conformal mappings) as well. The boundary value problems arising in plane elasticity are solved for analytical solutions. Some techniques of solving the three-dimensional elastodynamics problems are also discussed.

Course outcomes: This course will enable the students to:

1. Understand concepts of extension and torsion and learn to solve different elastostatics problems of extension and torsion of beams.
2. Learn techniques to make use of complex analysis (analytic functions, conformal mappings) for solving elastostatics problems. Be familiar with flexure of beams of different cross-sections.
3. Understand plane deformation, plain stress and Airy Stress function and attain capability to solve two dimensional problems in elasticity for analytical solutions.
4. Learn techniques for solving some scientifically important elastodynamics problems in three-dimensions and understand vibrations of elastic solids and wave propagation in such solids.

Unit-I:

Extension : Extension of beams by longitudinal forces, Beam stretched by its own weight, Bending of beams by terminal couples.

Torsion : Torsion of a circular shaft, Torsion of cylindrical bars, Torsional rigidity. Torsion and stress functions. Lines of shearing stress. Torsion of elliptic cylinder. Simple torsion problems, effect of grooves.

(Relevant sections 30–37 of Chapter 4 of the book recommended at Sr. No. 1)

Unit-II:

Torsion of rectangular beam, Torsion of triangular prism. Solution of torsion problems by means of conformal mapping. Torsion-membrane analogy, Torsion of hollow beams, Torsion of anisotropic beams. Flexure of beams by terminal loads, Flexure of circular and elliptic beams, Bending of rectangular beams, Bending of circular pipes.

(Relevant sections 38, 44-47, 51-57, 59; Chapter 4 of the book recommended at Sr. No. 1)

Unit-III:

Two dimensional problems : Plane deformation, Generalized plane stress, Plane elastostatic problems, . Airy stress function. General solution of biharmonic equation, Stresses and displacements in terms of complex potentials. The structure of functions $\varphi(z)$ and $\psi(z)$. First and second boundary value problems in plane elasticity. Existence and uniqueness of the solutions. (Relevant sections 65-74 of Chapter 5 of the book recommended at Sr. No. 1)

Unit-IV:
Three dimensional problems: General solutions; Concentrated forces; Deformation of elastic half-space by normal loads; The problem of Boussinesq. Elastic sphere: pressures, harmonics, equilibrium. Betti's Integration method. Vibrations of elastic solids, Wave propagation in infinite regions, Surface waves.
(Relevant sections 90-97, 102-104 of Chapter 6 of the book recommended at Sr. No. 1)

Recommended Books:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
3. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
4. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994.
5. S. Timoshenko and N. Goodier. Theory of Elasticity, McGraw Hill, New York, 1970.
6. I.H. Shames, Introduction to Solid Mechanics, Prentice Hall, New Delhi, 1975.

MMATH21-308: ADVANCED NUMERICAL ANALYSIS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: This course considers the high-end numerical methods, which are often required to get the numerical results from research studies in applied sciences and engineering. The objective of the course is to equip learners with specialized tools for solving transcendental and polynomial equations, system of linear equations, eigen-value problems, numerical differentiation, numerical integration, ordinary/partial differential equations so as to enable them to draw the algorithm of these numerical methods that form the basis to write source programs in any programming language.

Course outcomes: This course will enable the students to:

1. Learn about errors which arise during computation due to roundoff or truncation or number representation and the high-end numerical methods for solving transcendental and polynomial equations.
2. Attain the skills of solving system of linear equations using direct and iterative schemes and analysis of such schemes. Know to apply finite difference schemes/operators for numerical differentiation.
3. Learn advanced numerical methods to evaluate integrals for solving linear/non-linear first/second order IVP/BVP involving ODEs .
4. Understand the finite difference methods for solving parabolic, elliptic and hyperbolic PDEs and attain capability to use such methods in scientific problem solving.

Unit-I

Error Analysis: Errors, Absolute, relative and percentage errors; Significant digits and numerical instability, Propagation of errors in arithmetic operations, Significant errors, Representation of numbers in computer, Normalized floating point representation and its effects.

Solution of Polynomial and Transcendental Equations: Iteration methods; First order, second order and higher order methods, Accelaration of the convergence, Efficiency of a method, Newton-Raphson method for multiple roots, Modified Newton-Raphson method, Muller method and Chebyshev method, Birge-Vieta method, Bairstow method, Graeffe's root squaring method, Solutions of systems of non-linear equations.

Unit-II:

Systems of Linear Equations: Matrix inverse methods, Triangularization method, Cholesky Method, Matrix partition method, Operation count, Ill-conditioned linear systems, Moore-Penrose inverse method, Least square solutions for inconsistent systems. Iteration methods Successive over relaxation (SOR) method, Convergence analysis. Eigen values and eigen vectors, bounds on eigen values, Given's method, Rutishauser method, Householder's method for symmetric matrices, Power method.

Numerical Differentiation based on difference formulae, Richardson's extrapolation method, Cubic spline method, Method of undetermined coefficients.

Unit-III:

Numerical Integration: Weddle's rule, Newton-Cotes method, Gauss-Legendre, Gauss-Chebyshev, Gauss-Laguerre, and Gauss-Hermite integration methods. Composite integration method, Euler-Maclaurin's formula, Romberg Integration, Double integration.

Numerical Solution of Ordinary Differential Equations: Estimation of local truncation error of Euler and single step methods. Bounds of local truncation error and convergence analysis of multistep methods, Predictor-Corrector methods; Adams-Bashforth methods, Adams-Moulton formula, Milne-Simpson method, System of Differential Equations. Finite difference method for solving second order IVPs and BVPs, Shooting method for boundary value problems.

Unit-IV:

Solving Partial Differential Equations: Finite difference approximations to partial derivatives, solving parabolic equations using implicit and explicit formulae, C-N scheme and ADI methods; solving elliptic equations using Gauss-elimination, Gauss-Seidel method, SOR method, and ADI method , solving hyperbolic equations using method of characteristics, explicit and implicit methods, Lax-Wendroff's method.

Recommended Books:

1. Gupta, R. S., *Elements of Numerical Analysis*, Cambridge Univ. Press, 2015.
2. Jain, M. K., Iyengar, S.R.K. and Jain, R.K., *Numerical Methods for Scientific and Engineering Computation*, 6th Edition, New Age International Publishers, 2012.
3. Pal, M., *Numerical Analysis for Scientists and Engineers*, Narosa Publishing House Pvt. Ltd., 2008.
4. Mathews, John H. and Fink Kurtis D., *Numerical Methods Using Matlab*, Fourth edition; PHI Learning Private Ltd., 2009.
5. Gourdin, A. and Boumahrat, M., *Applied Numerical Methods*, PHI Learning Private Ltd., 2004.

MMATH21-309: FUZZY SETS AND APPLICATIONS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Fuzzy sets and fuzzy logic are powerful mathematical tools for modeling; and are facilitators for common-sense reasoning in decision making in the absence of complete and precise information. The main objective of this course is to familiarize the students with fuzzy sets, operations on fuzzy sets, fuzzy numbers, fuzzy relations, possibility theory and fuzzy logic.

Course Outcomes: This course will enable the students to:

1. Learn about fuzzy sets; understand fuzzy-set-related notions such as α level sets, convexity, normality, support, etc., their properties and various operations on fuzzy sets.
2. Understand the concepts of t-norms, t-conforms, fuzzy numbers; extend standard arithmetic operations on real numbers to fuzzy numbers.
3. Understand various type of fuzzy relations.
4. Apply fuzzy set theory to possibility theory and Fuzzy logic.

Unit-I:

Fuzzy Sets: Basic definitions, α -cuts, strong α -cuts, level set of a fuzzy set, support of a fuzzy set, the core and height of a fuzzy set, normal and subnormal fuzzy sets, convex fuzzy sets, cutworthy property, strong cutworthy property, standard fuzzy set operations, standard complement, equilibrium points, standard intersection, standard union, fuzzy set inclusion, scalar cardinality of a fuzzy set, the degree of subsethood (Scope as in relevant parts of sections 1.3-1.4 of Chapter 1 of the book by Klir & Yuan).

Additional properties of α cuts involving the standard fuzzy set operators and the standard fuzzy set inclusion, Representation of fuzzy sets, three basic decomposition theorems of fuzzy sets Extension principle for fuzzy sets: the Zedah's extension principle, Images and inverse images of fuzzy sets, proof of the fact that the extension principle is strong cutworthy but not cutworthy (Scope as in relevant parts of Chapter 2 of the book by Klir & Yuan)

Operations on fuzzy sets: types of operations, fuzzy complements, equilibrium of a fuzzy complement, equilibrium of a continuous fuzzy complement, first and second characterization theorems of fuzzy complements (Scope as in relevant parts of sections 3.1 and 3.2 of Chapter 3 of the book by Klir & Yuan).

Unit-II:
Fuzzy intersections (t-norms), standard fuzzy intersection as the only idempotent t-norm, standard intersection, algebraic product, bounded difference and drastic intersection as examples of t-norms, decreasing generator, the Pseudo-inverse of a decreasing generator, increasing generators and their Pseudo-inverses, convertion of decreasing generators and increasing generators to each other, characterization theorem of t-norms(statement only). Fuzzy unions (t-conorms), standard union, algebraic sum, bounded sum and drastic union as examples of t-conorms, characterization theorem of t-conorms (Statement only), combination of operations, aggregation operations (Scope as in relevant parts of sections 3.3 to 3.6 of Chapter 3 of the book by Klir & Yuan).

Fuzzy numbers, relation between fuzzy number and a convex fuzzy set, characterization of fuzzy numbers in terms of its membership functions as piecewise defined functions, fuzzy cardinality of a fuzzy set using fuzzy numbers, arithmetic operations on fuzzy numbers, extension of standard arithmetic operations on real numbers to fuzzy numbers, lattice of fuzzy numbers, (R, MIN, MAX) as a distributive lattice, fuzzy equations, equation A+X = B, equation A.X = B (Scope as in relevant parts of Chapter 4 of the book by Klir & Yuan)

Unit-III:
Fuzzy Relations: Crisp and fuzzy relations, projections and cylindrical extensions, binary fuzzy relations, domain, range and height of a fuzzy relation, membership matrices, sagittal diagram, inverse of a fuzzy relation, composition of fuzzy relations, standard composition, max-min composition, relational join, binary relations on a single set, directed graphs, reflexive irreflexive, antireflexive, symmetric, asymmetric, antisymmetric, transitive (max-min transitive), non transitive, antitransitive fuzzy relations. Fuzzy equivalence relations, fuzzy compatibility relations, α -compatibility class, maximal α -compatibles, complete α -cover, reflexive undirected graphs, fuzzy ordering relations, fuzzy upper bound, fuzzy pre ordering, fuzzy weak ordering, fuzzy strict ordering, fuzzy morphisms. Sup-i compositions of Fuzzy relations, Inf-i compositions of Fuzzy relations.
(Scope as in the relevant parts of Chapter 5 of the book by Klir & Yuan)

Unit-IV:
Possibility Theory : Fuzzy measures, continuity from below and above, semicontinuous fuzzy measures, examples and simple properties; Evidence Theory, belief measure, superadditivity, monotonicity, plausibility measure, subadditivity, basic assignment, its relation with belief measure and plausibility measure, focal element of basic assignment, body of evidence, total ignorance, Dempster`s rule of combination, examples; Possibility Theory, necessity measure, possibility measure, implications, possibility distribution function, lattice of possibility distributions, joint possibility distribution. Fuzzy sets and possibility theory, Possibility theory versus probability theory (Scope as in the relevant parts of Chapter 7 of the book by Klir & Yuan)

Fuzzy Logic: An overview of classical logic, about logic functions of two variables, Multivalued logics, Fuzzy propositions,Fuzzy Quantifiers,Linguistic Hedges, Inference from conditional fuzzy propositions, inference from conditional and qualified propositions, inference from unqualified propositions. (Scope as in the relevant parts of Chapter 8 of the book by Klir & Yuan)

Recommended Text Book :

1. G. J. Klir and B. Yuan : Fuzzy Sets and Fuzzy : Logic Theory and Applications, Prentice Hall of India, 2008

Reference Books:

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.

2. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.

3. John Yen, Reza Langari, Fuzzy Logic - Intelligence, Control and Information, Pearson Education, 1999.

4. A.K. Bhargava, Fuzzy Set Theory, Fuzzy Logic & their Applications, S. Chand & Company Pvt. Ltd., 2013.

MMATH21-310: MATHEMATICAL STATISTICS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Mathematical statistics is very useful in all branches of science as well as all branches of social sciences. The concept of mathematical statistics is surely one of the popular branch of applied mathematics. The main aim of this course is to introduce descriptive measures, probability, random distribution, probability models, mathematical expectation, correlation coefficient, discrete probability distributions, continuous probability distributions, sampling probability distributions, stochastic convergence, stochastic independence, statistical inference. An attempt has been made in this course to strike a balance between the different concepts of mathematical statistics.

Course Outcomes: This course will enable the students to:

1. Understand descriptive measures, probability, random variables and distribution functions
2. Understand mathematical expectation, generating functions, law of large numbers, correlation and regression
3. To learn about discrete probability distributions, continuous probability distributions and sampling distributions
4. To learn about large sample theory and statistical inference

Unit-I:

Measures of central tendency, measures of dispersion, measures of skewness, measures of Kurtosis. Probability-Basic terminology, addition theorem of probability, Boole's inequality, conditional probability, Multiplication theorem of probability, independent events. Bayes' theorem. Distribution function, discrete random variable, continuous random variable, two dimensional random variable, transformation of one dimensional random variable, transformation of two dimensional random variable.
(2.1 to 2.17, 3.1 to 3.3, 3.9 to 3.15, 4.2, 5.1 to 5.7 of recommended book)

Unit-II:

Mathematical expectation, expectation of random variable, expectation of function of random variable, properties of expectation and variance , Covariance, Cauchy-schwarz inequality, Jenson inequality, moment generating function, cumulants, characteristic function, Chebychev's Inequality, convergence in probability, weak law of large numbers, scatter diagram, karl pearson's coefficients of Correlation, Linear regression.
(6.1 to 6.7, 7.1 to 7.3 , 7.5 to 7.7, 10.1 to 10.4, 11.1 to 11.2 of recommended book)

Unit-III:

Discrete probability distributions-uniform distributions, Bernoulli distributions, Binomial distributions, Poisson distributions. Continuous probability distribution- Normal distributions, rectangular distributions, triangular distributions, Gamma distributions. Central limit theorem. Sampling distributions- chi square distribution, Student's 't' distribution, F distribution, relation between t and F , relation between F and chi-square.
(8.1 to 8.5, 9.1 to 9.5, 9.13, 15.1 to 15.3, 16.2, 16.5, 16.7, 16.8 of recommended book)

Unit-IV:

Large sample theory- types of sampling, parameter and statistic, test of significance, procedure for testing of hypothesis. Statistical inference- characteristic of estimators, Cramer-Rao inequality, MVU, Rao-Blackwell theorem.
(14.1 to 14.5, 17.1 to 17.3, 17.5 of recommended book)

Recommended Book:

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2014.

Reference book:

1. R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Amerind Pub. Co. Pvt. Ltd. New Delhi, 1972.

MMATH21-311: NUMBER THEORY

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The concept of number theory is surely one of the oldest ideas of Mathematics. The main aim of this course is to introduce arithmetic functions, Diophantine equations, Farey sequences, geometry of numbers, continued fractions. An attempt has been made in this course to strike a balance between different concepts of number theory.

Course Outcomes: This course will enable the students to:

1. Understand concept of greatest integer function, arithmetic function, mobius inversion formula, recurrence function, combinatorial number theory .
2. Find solution of Diophantine equations and rational points on curve.
3. Understand concept of Farey fractions, irrational numbers and geometry of numbers.
4. Have deep understanding of simple continued fractions, approximation to irrational number, Pell's equation.

Unit-I:

Greatest integer function, Arithmetic function, multiplicative function, completely multiplicative function, mobius- inversion formula, recurrence function, combinational number theory.

Unit-II:

Solution of the equation ax+by =c, simultaneous linear equations, Unimodular matrices, Pythagorean triangles, some assorted examples, ternary quadratic forms, rational points on curves.

Unit-III:

Farey sequences, rational approximations, Hurwitz theorem, irrational numbers, Blichfeldt's principle, Minkowski's Convex body theorem, Lagrange's four square theorem.

Unit-IV:

Euclidean algorithm, finite and infinite continued fractions, approximations to irrational numbers, Best possible approximations, Hurwitz theorem, Periodic continued fractions, Pell's equation.

(Chapter 4, 5.1 to 5.6, chapter 6 and 7 of recommended book at Sr. No. 1)

Recommended Book:

1. Ivan Niven, Herbert S. Zuckerman , Hugh L. Montgomery, An Introduction to the Theory of Numbers, John Wiley & Sons (Fifth Edition), 1991.
2. G.H. Hardy and E.M. Wright, An introduction to the theory of numbers, Oxford University Press, 6^{th} Ed, 2008.

MMATH21-312: ALGEBRAIC CODING THEORY

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The course contains systematic study of coding and communication of messages. This course is concerned with devising efficient encoding and decoding procedures using modern algebraic techniques. The course begins with basic results of error detection and error correction of codes, thereafter codes defined by generator and parity check matrices are given. The course also contains polynomial codes, Hamming codes, construction of finite fields and thereafter the construction of BCH codes. Linear codes, MDS codes, Reed-Solomon codes, Perfect codes, Hadamard matrices and Hadamard codes are also the part of the course.

Course Outcomes: This course will enable the students to:
1. Understand group codes, matrix encoding techniques, polynomial codes and Hamming codes.
2. Have deep understanding of finite fields, BCH codes.
3. Learn about linear codes, cyclic codes, self dual binary cyclic codes.
4. Learn about MDS codes, Hadamard matrices and Hadamard codes.

Unit-I:
Group codes, elementary properties, matrix encoding techniques. Generator and parity check matrices, polynomial codes. Vector space and polynomial ring, binary representation of numbers, Hamming codes.
(Chapter 1, 2 & 3 of recommended book at Sr. No. 1)

Unit-II:
Basic properties of finite fields, irreducible polynomial over finite field, roots of unity. (7.1 to 7.3 of recommended book at Sr. No. 2)
Some examples of primitive polynomials, BCH codes. (Chapter 4 of recommended book at Sr. No. 1)

Unit-III:
Linear codes, generator and parity check matrices, dual code of a linear code, Weight distribution of the dual code of a binary linear code, new codes obtained from given codes, cyclic codes, check polynomials, BCH and Hamming codes as cyclic codes, Non-binary Hamming codes, Idempotent , solved examples and invariance property, cyclic codes and group algebras, self dual binary cyclic codes.
(Chapter 5, 6 of recommended book at Sr. No. 1)

Unit-IV:
Necessary and sufficient condition for MDS codes, the weight distribution of MDS codes, an existence problem, Read Solomon codes. Hadamard matrices and Hadamard codes.(Chapter 9 and 11 of recommended book at Sr. No. 1)

Recommended Text Books:

1. L.R. Vermani, Elements of Algebraic Coding Theory, CRC Press, 1996.
2. Steven Roman, Coding and Information Theory, Springer-Verlag, 1992.

MMATH21-313: FINANCIAL MATHEMATICS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: No one can deny the fact that financial markets play a fundamental role in economic growth of nations by helping efficient allocation of investment of individuals to the most productive sectors of the economy. Financial sector has seen enormous growth over the past thirty years in the developed world. This growth has been led by the innovations in products referred to as financial derivatives that require great deal of mathematical sophistication and ingenuity in pricing and in creating an insurance or hedge against associated risks. Hence, this course is for anyone who is interested in the applications of finance, particularly advanced /latest business techniques. Students are required to know elementary calculus (derivatives and partial derivatives, finding maxima or minima of differentiable functions of one or more variables, Lagrange multipliers, the Taylor formula and integrals), probability (random variables and probability (binomial & normal) distributions, expectation, variance and covariance, conditional probability and independence) and linear algebra (systems of linear equations, add, multiply, transpose and invert matrices, and compute determinants).

Course outcomes: This course will enable the students to:

1. Understand the fundamentals of financial mathematics through derivatives, payoff functions, options, trader types, asset price models, random walks/ motion, no-arbitrage and relevant formula/simulation /hypothesis.
2. Use the Black-Scholes analysis for European options, risk neutrality, delta hedging, trading strategy involving options, along with the variations on Black-Scholes models for options on dividend-paying assets, warrants and futures.
3. Solve Black-Scholes equation using Monte-Carlo method, binomial methods, finite difference methods including fast algorithms for solving linear systems and design free boundary value problem, linear complementary problem, fixed domain problem for American option to be solved with projective/implicit methods.
4. Work on exotic options, path-dependent options, derivatives through bond models and interest rate models, convertible bonds and to learn stochastic calculus for its use in Brownian motion, stochastic integrals, stochastic differential equations and diffusion process.

Unit-I:

Fundamentals of Financial Mathematics: Financial Markets, derivatives; Payoff functions, Options, Types of traders Asset Price Models: Discrete/continuous models and their solutions; Random walks; The Brownian motion; Ito’s formula; Simulation of asset price model; Hypothesis of no-arbitrage-opportunities; Basic properties of option prices

Unit-II:

Black-Scholes Analysis: The Black-Scholes Equation; Exact solution for European options; Risk Neutrality; The delta hedging; Trading strategy involving options.

Variations on Black-Scholes models: Options on dividend-paying assets; Warrants; Futures and futures options

Unit-III:

Numerical Methods (Solving B.S equation): Monte Carlo method; Binomial Methods; Finite difference methods; Fast algorithms for solving linear systems;

American Option: free boundary value problem; linear complementary problem; fixed domain problem; Projective/implicit method for American put/call

Unit-IV:

Exotic Options: Binaries; Compounds; Chooser options; Barrier option; Asian/lookback options;

Path-Dependent Options: Average strike options; Lookback Option

Bonds and Interest Rate Derivatives: Bond Models; Interest models; Convertible Bonds

Stochastic calculus: Brownian motion; Stochastic integral; Stochastic differential equation; Diffusion process

Recommended Books:

1. Financial Mathematics: I-Liang Chern Department of Mathematics, National Taiwan University
2. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge Univ. Press.
3. Robert J. Elliott and P. Ekkehard Kopp. Mathematics of Financial Markets, Springer-Verlag, New York Inc.
4. Robert C. Marton, Continuous-Time Finance, Basil Blackwell Inc.
5. Daykin C.D., Pentikainen T. and Pesonen M., Practical Risk Theory for Actuaries, Chapman & Hall.

MMATH21-314: INTEGRAL EQUATIONS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: This course is designed to get acquainted with the concept of integral equations and the methods to find their solutions. A student will learn about integral equations, their classifications, eigen values and eigen functions, method of successive approximations, iterative methods, resolvent kernel. Fredholm three theorems are main part of the first section. In the second section, symmetric kernels, Riesz-Fisher theorem, Hilbert-Schmidt, solution of a symmetric integral equation, Abel's integral equation and Cauchy type singular integral equation are learnt.

Course outcomes: This course will enable the students to:

1. Understand the concept of integral equations to identify different constituents to classify them and to apply the eigen-system method for solving the Fredholm type with separable kernel.
2. Derive procedures to for iterative methods to solve integral equations of both Fredholm and Volterra types without restricting the kernel to be separable and proving specific theorems of Fredholm's theory.
3. Design methods for solving the integral equations with symmetric kernel as linear/bilinear expansions over an orthonormal system of functions and to prove various theorems to analyse these methods. Apply the knowledge to solve problems.
4. Learn the use of numerical method for finding an eigenvalue and the analytical methods to solve the singular integral equations from Cauchy-type to Hilbert-type, which involve Cauchy's principal value, closed/open contours and the Riemann-Hilbert problem.

Unit-I:

Definition of Integral Equations and their classifications. Eigen values and Eigen functions. Special kinds of Kernel, Convolution Integral. The inner or scalar product of two functions. Reduction to a system of algebraic equations. Fredholm alternative, Fredholm theorem, Fredholm alternative theorem, an approximate method.
(Relevant portions from the chapters 1 and 2 of the book recommended at Sr. No. 1).

Unit-II:

Method of successive approximations, Iterative scheme for Fredholm and Volterrra Integral equations of the second kind. Conditions of uniform convergence and uniqueness of series solution. Some results about the resolvent Kernel. Application of iterative scheme to Volterra integral equations of the second kind. Classical Fredholm's theory, the method of solution of Fredholm equation, Fredholm's First theorem, Fredholm's second theorem, Fredhom's third theorem.
(Relevant portions from the chapters 3 and 4 of the book recommended at Sr. No. 1).

Unit-III:

Symmetric Kernels, Complex Hilbert space. An orthonormal system of functions, Riesz-Fisher theorem, A complete two-Dimensional orthonormal set over the rectangle $a \le s \le b, c \le t \le d$. Fundamental properties of Eigenvalues and Eigenfunctions for symmetric Kernels. Expansion in eigen functions and Bilinear form. Hilbert-Schmidt theorem and some immediate consequences.

Definite Kernels and Mercer's theorem. Solution of a symmetric Integral Equation. Approximation of a general ℓ_2-Kernel (not necessarily symmetric) by a separable Kernel. The operator method in the theory of integral equations.

(Relevant portions from the chapter 7 of the book recommended at Sr. No. 1).

Unit-IV:

Rayleigh-Ritz method for finding the first eigenvalue. The Abel Intergral Equation. Inversion formula for singular integral equation with Kernel of the type h(s)-h(t), $0<\alpha<1$, Cauchy's principal value for integrals solution of the Cauchy-type singular integral equation, closed contour, unclosed contours and the Riemann-Hilbert problem. The Hilbert-Kernel, solution of the Hilbert-Type singular Intergal equation.

(Relevant portions from the chapter 8 of the book recommended at Sr. No. 1).

Recommended Books:

1. Ram P. Kanwal, *Linear Integral Equations: Theory & Techniques*, Springer Science & Business Media, 2012.
2. S.G. Mikhlin, *Linear Integral Equations* (translated from Russian) ,Hindustan Book Agency, 1960.
3. F.G Tricomi, *Integral Equations,* Courier Corporation, 1985.
4. Abdul J. Jerri, *Introduction to Integral Equations with Applications*, Wiley-Interscience, 1999.
5. Ian N. Sneddon, *Mixed Boundary Value Problems in potential theory*, North Holland Publishing Co., 1966.
6. Ivar. Stakgold, *Boundary Value Problems of Mathematical Physics* Vol.I, II, Society for Industrial and Applied Mathematics, 2000.

MMATH21- 315: MATHEMATICAL MODELING

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: A mathematical model is a description of a system (device or a phenomenon) using mathematical concepts and language. The process of developing a mathematical model is defined as mathematical modeling. A mathematical model may help to explain a system and to study the effects of different components, and to make predictions about the system. During this course, the students will learn basic concepts of mathematical modeling and to construct mathematical models for population dynamics, epidemic spreading, economics, medicine, arm-race, battle, genetics and other areas of physical/life/social sciences. The course also aims to let the students learn mathematical modeling through ordinary/partial differential equations and probability generating function.

Course outcomes: This course will enable the students to:

1. Understand the need/techniques/classification of mathematical modeling through the use of first order ODEs and their qualitative solutions through sketching.
2. Learn to develop mathematical models using systems of ODEs to analyse/predict population growth, epidemic spreading for their significance in economics, medicine, arm-race or battle/war.
3. Attain the skill to develop mathematical models involving linear ODEs of order two or more and difference equations, for their relevance in probability theory, economics, finance, population dynamics and genetics.
4. Develop mathematical models through PDEs for mass-balance, variational principles, probability generating function, traffic flow problems alongwith relevant initial & boundary conditions.

Unit-I:

Mathematical modeling: need, techniques, classification and illustrative examples; Mathematical modeling through ordinary differential equations of first order; qualitative solutions through sketching.

Unit-II:

Mathematical modeling in population dynamics, epidemic spreading and compartment models; mathematical modeling through systems of ordinary differential equations; mathematical modeling in economics, medicine, arm-race, battle.

Unit-III:

Mathematical modeling through ordinary differential equations of second order. Higher order (linear) models. Mathematical modeling through difference equations: Need, basic theory;

mathematical modeling in probability theory, economics, finance, population dynamics and genetics.

Unit-IV:

Mathematical modeling through partial differential equations: simple models, mass-balance equations, variational principles, probability generating function, traffic flow problems, initial & boundary conditions.
(Scope of the syllabus is from relevant portions of Chapters 1 to 6 of the book recommended at Sr. No. 1)

Recommended Book

1. J.N. Kapur: *Mathematical Modelling*, New Age International Ltd., 1988.
2. M. Adler, *An Introduction to Mathematical Modelling*, HeavenForBooks.Com, 2001.
3. S.M. Moghadas, M.J.-Douraki, *Mathematical Modelling: A Graduate Text Book*, Wiley, 2018.
4. E.A. Bender, *An Introduction to Mathematical Modeling*, Dover Publication, 2000.

OEM21-316: BASIC MATHEMATICS-II

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>2</td><td>0</td><td>3 Hours</td><td>10</td><td>40</td><td>50</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 4 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks. Use of non-programmable scientific calculator will be allowed in the examination.

Course objectives: This course has been designed to introduce numerical methods to the students of the faculty of sciences. The students will come to learn different popular numerical methods for solving transcendental and polynomial equations, system of linear equations, curve fitting, numerical differentiation, numerical integration, solution of ordinary differential equations. After successful completion of the course, a student will be able to draw the algorithm for the use of numerical methods in source programs of any programming language.

Course outcomes: This course will enable the students to:

1. Learn the use of numerical methods for solving transcendental and polynomial equations and direct methods for solving system of linear equations.
2. Solve system of linear equations through iterative methods and knowledge of using various interpolation methods for fitting polynomials to a data-set / function.
3. Understand finite difference schemes/operators for numerical differentiation and attain ability to apply numerical methods for solving definite integrals.
4. Learn numerical techniques for solving linear first order IVP involving ODEs .

Unit-I:

Solution of Polynomial and Transcendental Equations: Bisection method, secant method, Regula-Falsi method, Newton-Raphson method.

Solution of Systems of Linear Equations: Gauss elimination method, Gauss-Jordan method, Triangularization method.

Unit-II:

Iterative methods for Solving Systems of Linear Equations: Jacobi method, Gauss-Seidel iteration method.

Curve fitting: Least-square approximation for fitting a straight line and polynomials of given degree.

Unit-III:

Numerical Differentiation: Methods based on Newton's forward difference formula, Newton's forward difference formula and Sterling's formula.

Numerical Integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Romberg integration, Newton-Cotes integration formula.

Unit-IV:

Solution of Differential Equations: Initial value problem; Taylor series method, Picard method of successive approximation, Euler's method, Runge-Kutta methods of second order and fourth order.

Recommended Books

1. Sastry, S.S., *Introductory Methods of Numerical Analysis***,** Fifth edition, PHI learning , 2012.
2. Jain, M. K., Iyengar, S.R.K.| and Jain, R.K., *Numerical Methods for Scientific and Engineering Computation*, *6th Edition***,** New Age International Publishers, 2012.
3. Rajaraman, V., *Computer Oriented Numerical Methods***,** Fourth edition, PHI learning, 2018.
4. Gourdin, A. and Boumahrat, M., *Applied Numerical Methods*, PHI Learning Private Ltd., 1996.

MMATH21-401: MECHANICS AND CALCULUS OF VARIATIONS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

NOTE : The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt five questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Analytical mechanics deals with motion of a system as a whole not as individual particles and takes in to account the constraints of the system to solve problems. This course let the students to understand basic concepts of analytical mechanics, calculus of variations, degrees of freedom, generalized coordinates, Lagrangian mechanics, Hamiltonian mechanics, principles of least action and Hamilton-Jacobi theory.

Course Outcomes: This course will enable the students to:

1. Understand moments and products of inertia, kinetic energy of a rigid rotating body, Laws of conservation of momentum, angular momentum and energy. Demonstrate knowledge to solve related problems of mechanics.
2. Learn about three dimensional rigid body dynamics and generalized coordinates.
3. Understand Lagrange's equation for potential forces, Variational principles, Hamiltonian, Canonical transformations and Hamilton Jacobi equation.
4. Understand concepts calculus of variations and to solve variational problems of different forms of functionals.

Unit-I:

Moments and products of inertia, The theorems of parallel and perpendicular axes, Angular momentum of a rigid body about a fixed point and about fixed axes, Principal axes.

Kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid – equimomental system, Coplanar distributions, General motion of a rigid body.

Problems illustrating the laws of motion, Problems illustrating the law of conservation of angular momentum, Problems illustrating the law of conservation of energy, Problems illustrating impulsive motion.

(Relevant portions from the book 'Textbook of Dynamics' by F. Chorlton).

Unit-II:
Euler's dynamical equations for the motion of a rigid body about a fixed point, Further properties of rigid motion under no forces, Some problems on general three-dimensional rigid body motion, The rotating earth.
Note on dynamical systems, Preliminary notions, Generalized coordinates and velocities, Virtual work and generalized forces, Derivation of Lagrange's equations for a holonomic system, Case of conservative forces, Generalized components of momentum and impulse. Lagranges equations for impulsive forces, Kinetic energy as a quadratic function of velocities. Equilibrium configurations for conservative holonomic dynamical systems, Theory of small oscillations of conservative holonomic dynamical systems.
(Relevant portions from the book 'Textbook of Dynamics' by F. Chorlton).

Unit-III:
Lagrange's equations for potential forces, Variational principles in Mechanics: Hamilton's principle, The principle of least action. Hamiltonian and canonical equations of Hamilton. Basic integral invariant of Mechanics. Canonical transformations, Hamilton Jacobi equation.
(Relevant portions from the text book recommended at Sr. No. 2).

Unit-IV:
Functional and its variation, Euler's (Euler-Lagrange) equations, Variational problems for functionals depending on one independent and one dependent variable(s) and its (i) first derivative (ii) higher derivatives with fixed end conditions, Variational problems for functionals depending on n functions of a single independent variable and functional depending on a function and its n derivatives, Functionals dependent on functions of several independent variables. Variational problems in parametric form. Natural boundary conditions and transition conditions, Invariance of Euler's equation. Conditional extremum. Variational problem with moving boundaries. Some basic problems in calculus of variations: shortest distance, minimum surface of revolution, Brachistochrone problem, isoperimetric problem and geodesic problems.
(Relevant portions from the text books recommended at Sr. No. 3 & 4).

Recommended Text Books:

1. F. Chorlton, *Text Book of Dynamics* 2nd Ed, CBS, 2002.
2. F. Gantmacher, *Lectures in Analytical Mechanics*, Mir Publishers, 1975.
3. Francis B. Hilderbrand, *Methods of Applied Mathematics* , Dover Publications, 1992.
4. A.S. Gupta, *Calculus of Variations with Applications*, PHI Learning Pvt. Ltd., 1996.

Reference Books:

1. H. Goldstein, C.P. Poole and J.L. Safko, *Classical Mechanics* (3rd edition), Pearson, 2011.
2. I.M. Gelfand and S.V. Fomin, *Calculus of Variations*, Dover Publications, 2012.
3. S.K. Sinha, *Classical Mechanics*, Alpha Science International Limited, 2009.
4. Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press, 2008.

MMATH21-402: PARTIAL DIFFERENTIAL EQUATIONS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: The learning objective of this paper is to study partial differential equations (PDE) which are used to describe a wide variety of phenomena such as sound, heat, electrostatics, electrodynamics, fluid dynamics, elasticity and mechanics. During this course, a student will learn about partial differential equations including definition, classifications, analytical theory and methods of solutions of IVP, transport equations, Laplace's equation, Poisson's equation and heat equations, Green's function and method of solving PDEs by Green's function approach. Other component of the learning objective is to study Wave equation, solutions of wave equation in different forms, Kirchhoff's and Poisson's formula, solution of non-homogeneous wave equation, solution of Laplace, heat and wave equations by method of separation of variables, similarity solutions and by using Fourier and Laplace transforms.

Course outcomes: This course will enable the students to:

1. Classify the PDE of different orders into elliptic/ parabolic/ hyperbolic types and work on the methods to solve homogeneous and non-homogeneous elliptic equations.
2. Understand the role of Green's function in solving PDE and work on the methods/principle used to derive formulas for solutions of homogeneous and non-homogeneous parabolic/heat equations.
3. Use various methods to solve the homogeneous and non–homogeneous wave equations, one to three dimensional, in different coordinate systems. Capacity to apply those techniques/methods to numerous problems that arise in science, engineering and other disciplines.
4. Learn to solve non-linear first order PDEs through complete integrals, envelopes, characteristics and solve Laplace, heat and wave equations using method of separation of variables and using integral transforms.

Unit-I:

Partial Differential Equations (PDE) of k^{th} order: Definition, examples and classifications. Initial value problems. Transport equations homogeneous and non-homogeneous, Radial solution of Laplace's Equation: Fundamental solutions, harmonic functions and their properties, Mean value Formula.

Poisson's equation and its solution, strong maximum principle, uniqueness, local estimates for harmonic functions, Liouville's theorem, Harnack's inequality.

(Relevant portions from the recommended text books given at Sr. No. 1 & 2)

Unit-II:
Green’s function and its derivation, representation formula using Green’s function, symmetry of Green’s function, Green’s function for a half space and for a unit ball. Energy methods: uniqueness, Drichlet’s principle.

Heat Equations: Physical interpretation, fundamental solution. Integral of fundamental solution, solution of initial value problem, Duhamel’s principle, non-homogeneous heat equation, Mean value formula for heat equation, strong maximum principle and uniqueness. Energy methods.
(Relevant portions from the recommended text books given at Sr. No. 1 & 2)

Unit-III:
Wave equation- Physical interpretation, solution for one dimentional wave equation, D’Alemberts formula and its applications, Reflection method, Solution by spherical means Euler-Poisson_Darboux equation. Kirchhoff’s and Poisson’s formula (for n=2, 3 only).

Solution of non –homogeneous wave equation for n=1,3. Energy method. Uniqueness of solution, finite propagation speed of wave equation.
(Relevant portions from the recommended text books given at Sr. No. 1 & 2)
Unit-IV:
Non-linear first order PDE- complete integrals, envelopes, Characteristics of (i) linear, (ii) quasilinear, (iii) fully non-linear first order partial differential equations. Hamilton Jacobi equations.
Other ways to represent solutions: Method of Separation of variables for the Hamilton Jacobi equations, Laplace, heat and wave equations. Similarity solutions (plane waves, traveling waves, solitons, similarity under scaling).

Fourier Transform, Laplace Transform, Convertible non-linear into linear PDE, Cole-Hop Transform, Potential functions, Hodograph and Legendre transforms. Lagrange and Charpit methods.
(Relevant portions from the recommended text books given at Sr. No. 1 & 2)
Recommended Text Books:
1. L.C. Evans, *Partial Differential Equations*, Graduate Studies in Mathematics, American Mathematical Society, 2014.
2. Ian N. Sneddon, *Elements of Partial Differential Equations*, Dover Publications, 2006.
Reference Books:
1. T. Amarnath, *An Elementary Course in Partial Differential Equations*, Jones & Bartlett Publishers, 2009.
2. P. Parsad and R. Ravindran, *Partial Differential Equations*, New Age / International Publishers, 2005.
3. John F. *Partial Differential Equations*, Springer-Verlag, New York, 1971.

MMATH21-403: Practical-IV

Course Credit Practical	Practical Hours per week	End Term Examination Time	Maximum Marks		
			Internal Assessment	End Term Examination	Total
2	4	4 Hours	10	40	50

Note: The examiner will set 3 questions at the time of practical examination by taking course outcomes (COs) into consideration. The examinee will be required to write two programs and execute one program successfully. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.

Course objectives: The objective of this course is to make the students familiar with the R programming. This course also focuses on the statistical analysis of data structures using the programming and visualization features of R language**.** Also, some problem solving techniques based on papers MMATH21-401 to MMATH21-402 will be taught.

Course Outcomes: This course will enable the students to:

1. Solve practical problems related to core courses undertaken in the Semester-IV from application point of view.
2. Understand the basics of R programming language including data types, variables, operators, expressions, input/output statements, control structures and functions.
3. Understand built in functions and tools of general use in R and know how to use those.
4. Learn entering, plotting, manipulation and interpretation of data using statistical functions of R.

List of Programs: The following practicals will be done on the R platform/software package and record of those will be maintained in the practical Note Book:

1. Starting R, entering data, storing data as a vector.
2. Entering data into R;
   i. Using c
   ii. Using scan
   iii. Using scan with file
   iv. Editing your data
   v. Reading in tables of data
   vi. Spreadsheet data
3. Practical examples illustrating templates of functions, for loops and conditional expressions in R.
4. Find mean, variance and standard deviation using R functions.

5. Practical examples with univariate data:
    i. Categorical data; Using tables, factors, bar chart, pie chart
    ii. Numerical data; measures of center and spread
    iii. Stems and leaf charts, histograms, boxplots, frequency polygons using R functions
6. Comparison of bivariate data with plots.
7. Program to fit linear regression line.
8. Program to find Spearman's rank correlation coefficient.
9. Practical examples of plotting graphs using points, abline, lines, plot and curve R functions.
10. Practical examples of storing, accessing and manipulating multivariate data in data frames.

11. Generate random numbers using uniform, normal, binomial, exponential distributions.

12. To estimate confidence interval using p-test.
13. To estimate confidence interval using t-test.
14. To estimate confidence interval using z-test.
15. Hypothesis testing by mean and median.

Reference Books:

1. John Verzani, *Using R for Introductory Statistics*, Chapman and Hall/CRC, 2014.
2. John Verzani, simple R-*Using R for Introductory Statistics*, lecture notes in pdf format, open source.

MMATH21- 404: Seminar-II

Course Credit	Seminar Hours per week	End Term Examination Time	Maximum Marks		
			Internal Assessment	End Term Examination	Total
2	2	-	50	-	50

Note: There will be no external examination. Evaluation will be done by the internal group incharge.

Course objectives: The objectives of this course are self study, understanding a topic in detail, comprehension of the subject/topic, investigating a problem, knowledge of ethics, effective communication and life-long learning.

Course Outcomes: This course will enable the students to:

1. Identify an area of interest and to select a topic therefrom realizing ethical issues related to one's work and unbiased truthful actions in all aspects of work and to develop research aptitude.
2. Have deep knowledge and level of understanding of a particular topic in core or applied areas of Mathematics, imbibe research orientation and attain capacity of investigating a problem.
3. Obtain capability to read and understand mathematical texts from books/journals/e-contents, to communicate through write up/report and oral presentation.
4. Demonstrate knowledge, capacity of comprehension and precision, capability to work independently and tendency towards life-long learning.

Note: *Each student will select a topic of one's choice from emerging areas of Mathematics, get approval from the concerned group incharge, give consulting library so as to read different books/e-resources, prepare a seminar document , present before the group and its incharge for not less than an hour. The evaluation of the seminar will be done by the concerned group incharge by taking into account the following:*

i. Subject knowledge.
ii. Degree of difficulty, research aptitude and knowledge updation in choice of the topic.
iii. Contents.
iv. Communication.
v. Response to questions.

MMATH21- 405: ADVANCED COMPLEX ANALYSIS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The main objective of this course is to understand the notion of logarithmically convex function and its fusion with maximum modulus theorem, the spaces of continuous, analytic and meromorphic functions, Runge's theorem and topics related with it, introduce harmonic function theory leading to Dirichlet's problem, theory of range of an entire function leading to Picard and related theorems.

Course Outcomes: This course will enable the students to

1. Understand the basics of logarithmically convex functions that helps in extending maximum modulus theorem; learn about spaces of continuous, analytic and meromorphic functions.
2. Be familiar with Riemann mapping theorem, Weierstrass' factorization theorem, Gamma functions and its properties.
3. Understand Runge's theorem; know harmonic function theory on a disk; apply the knowledge in solving Dirichlet's problem; know about Green's function.
4. Know how big the range of an entire function is ; prove Picard and related theorems.

Unit-I:

Convex functions and Hadamard's three circles theorem, Phragmen-Lindelöf theorem.
Spaces of continuous functions, Arzela-Ascoli theorem, Spaces of analytic functions, Hurwitz's theorem, Montel's theorem, Spaces of meromorphic functions.

Unit-II:

Riemann mapping theorem, Weierstrass' factorization theorem, Factorization of sine function, Gamma function and its properties, functional equation for gamma function, Bohr-Mollerup theorem, Reimann-zeta function, Riemann's functional equation, Euler's theorem.

Unit-III:

Runge's theorem, Simply connected regions, Mittag-Leffler's theorem. Analytic continuation, Power series method of analytic continuation , Schwarz reflection principle. Monodromy theorem and its consequences.

Harmonic functions, Maximum and minimum principles, Harmonic function on a disk, Harnack's theorem, Sub-harmonic and super-harmonic functions, Dirichlet's problems, Green's function.

Unit-IV:

Entire functions :Jensen's formula, Poisson–Jensen formula. The genus and order of an entire function, Hadamard's factorization theorem.

The range of an analytic function : Bloch's theorem, Little-Picard theorem, Schottky's theorem, Montel-Carathedory theorem, Great Picard theorem.

Recommended Text Book:

J. B.Conway, Functions of one complex variable, Narosa Publishing House, 2002.

Reference Books :

1. Ahlfors, L.V., Complex Analysis, Mc. Graw Hill Co., Indian Edition, 2017.
2. Churchill, R.V. and Brown, J.W., Complex Variables and Applications McGraw Hill Publishing Company, 1990.
3. Priestly, H.A., Introduction to Complex Analysis Claredon Press, Orford, 1990.
4. Liang-shin Hann & Bernard Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
5. D.Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
6. Mark J.Ablewitz and A.S.Fokas, Complex Variables : Introduction & Applications, Cambridge University Press, South Asian Edition, 1998.
7. E.C.Titchmarsh, Theory of Functions, Oxford University Press, London, 1939.
8. S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.
9. D.C. Ullrich, Complex Made Simple, American Mathematical Society, 2008.
10. L. Hahn, B. Epstein, Classical Complex Analysis, Jones and Bartlett, 1996.
11. W. Rudin, Real and Complex Analysis, Third Edition, Tata McGraw-Hill, 2006.

MMATH21-406: ALGEBRAIC NUMBER THEORY

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The concept of ALGEBRAIC NUMBER THEORY is surely one of the recent ideas of mathematics. The main aim of this course is to introduce Norm and trace, Ideals in the ring of algebraic number field, Dedekind domains, Fractional ideals, Chinese Remainder theorem, Different of an algebraic number field, Hurwitz constant, Ideal class group, Minkowski's bound and Quadratic reciprocity.

Course Outcomes: This course will enable the students to:

1. Understand concept of integral bases and discriminant of algebraic number field, ring of algebraic integers and ideal in the ring of algebraic integers
2. Learn about integrally closed domains, Dedekind domain, fractional ideals and unique factorization , different of an algebraic number field, Dedekind theorem
3. Learn about Hurwitz's lemma, Hurwitz constant, finiteness of the ideal class group, class number of an algebraic number field, Diophantine equations, minkowski's bound
4. Understand Legendre symbol, gauss sums, law of quadratic reciprocity, quadratic field, primes in special progression, class number of quadratic fields

Unit-I:

Norm and trace of algebraic numbers and algebraic integers, Bilinear map on algebraic number field K. Integral basis and discriminant of an algebraic number field, Index of an element of K, Ring O_k of algebraic integers of an algebraic number field K. Ideals in the ring of algebraic number field K.

Unit-II:

Integrally closed domains. Dedekind domains. Fractional ideals of K. Factorization of ideals as a product of prime ideals in the ring of algebraic integers of an algebraic number field K. G.C.D. and L.C.M. of ideals in O_k. Chinese Remainder theorem, order of ideal in prime ideal, ramification degree of prime ideals, different of an algebraic number field K, Dedekind theorem.

Unit-III:
Euclidean rings. Hurwitz Lemma and Hurwitz constant. Equivalent fractional ideals. Ideal class group. Finiteness of the ideal class group. Class number of the algebraic number field K. Diophantine equations, Minkowski's bound.

Unit-IV:
Legendre Symbol, Jacobi symbol, Gauss sums, Law of quadratic reciprocity, Quadratic fields, Primes in special progression, class number of quadratic fields.
(Chapter 4, 5, 6 & 7 of recommended book)

Recommended Book:

1. Jody Esmonde and M.Ram Murty, Problems in Algebraic Number Theory, Springer Verlag, 1998.

Reference books:

1. Paulo Ribenboim: Algebraic Numbers, Wiley-Interscience, 1972.
2. R. Narasimhan and S. Raghavan: Algebraic Number Theory, Mathematical Pamphlets-4, Tata Institute of Fundamental Research,1966.

MMATH21-407: GENERAL MEASURE AND INTEGRATION THEORY

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The main objective of this course is to familiarize with general theory of measure and integration, in particular, with measurable functions, sequences of measurable functions, integrable functions, product measures, finite signed measures and integration over locally compact spaces.

Course Outcomes: This course will enable the students to:

1. Understand the concept of measure defined on a ring of sets, its properties; extension, uniqueness and completeness of measures; measurable spaces, measurable and simple functions.
2. Have deep understanding of the concepts of convergence in measure, almost uniform convergence; apply the knowledge to prove Egoroff's theorem, Riesz-Weyl theorem; learn about integrable functions, indefinite integrals; demonstrate understanding of the statement and proof of the monotone convergence theorem.
3. Understand the concepts of product measures; apply the knowledge to prove Fubini's theorem; understand signed measures; demonstrate understanding of the statement and proof of the Jordan-Hahn decomposition, Radon-Nikodym theorem.
4. Know about the concepts of Baire sets, Baire measures, regularity of measures on locally compact spaces; apply the knowledge to prove Riesz-Markoff representation theorem related to the representation of a bounded linear functional on the space of continuous functions.

Unit-I:

Measures, some properties of measures, outer measures, extension of measures, uniqueness of extension, completion of a measure, the LUB of an increasingly directed family of measures.(Scope as in the Sections 3-6, 9-10 of Chapter 1 of the book 'Measure and Integration' by S.K. Berberian).

Measurable spaces, measurable functions, combinations of measurable functions, limits of measurable functions, localization of measurability, simple functions (Scope as in Chapter 2 of the book 'Measure and Integration' by S.K. Berberian).

Unit-II:

Measure spaces, almost everywhere convergence, convergence in measure, almost uniform convergence, Egoroff's theorem, Riesz-Weyl theorem (Scope as in Chapter 3 of the book 'Measure and Integration' by S.K. Berberian).

Integrable simple functions, non-negative integrable functions, integrable functions, indefinite integrals, the monotone convergence theorem, mean convergence (Scope as in Chapter 4 of the book 'Measure and Integration' by S.K. Berberian)

Unit-III:
Product Measures: Rectangles, Cartesian product of two measurable spaces, sections, the product of two finite measure spaces, the product of any two measure spaces, product of two σ-finite measure spaces, Fubini's theorem. (Scope as in Chapter 6 (except section 42) of the book 'Measure and Integration' by S.K. Berberian)

Finite Signed Measures: Absolute continuity, finite singed measure, contractions of a finite signed measure, purely positive and purely negative sets, comparison of finite measures, Lebesgue decomposition theorem, a preliminary Radon-Nikodym theorem, Jordan-Hahn decomposition of a finite signed measure, domination of finite signed measures, the Radyon-Nikodym theorem for a finite measure space, the Radon-Nikodym theorem for a σ - finite measure space (Scope as in Chapter 7 (except Section 53) of the book 'Measure and Integration' by S.K.Berberian).

Unit-IV:
Integration over locally compact spaces: continuous functions with compact support, G_δ's and F_σ's, Baire sets, Baire-sandwich theorem, Baire measures, Borel sets, Regularity of Baire measures, Regular Borel measures, Integration of continuous functions with compact support, Riesz-Markoff representation theorem (Scope as in relevant parts of the sections 54-57, 60, 62, 66 and 69 of Chapter 8 of the book 'Measure and Integration' by S.K.Berberian)

Recommended Text Book:
S.K. Berberian: Measure and Integration, American Mathematical Society, Reprint edition, 2011.

Reference Books:
1. H.L.Royden, Real Analysis (3rd Edition) Prentice-Hall of India, 2008.
2. G.de Barra, Measure theory and integration, New Age International,2014.
3. P.R.Halmos: Measure Theory, Springer New York, 2013.
4. I.K.Rana: An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
5. R.G.Bartle: The Elements of Integration, John Wiley and Sons, Inc. New York, 1966.

MMATH21-408: MATHEMATICAL ASPECTS OF SEISMOLOGY

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Seismology is the study of earthquakes and deals with the generation and propagation of seismic waves. This course has been designed to study applications of mathematics in the field of seismology and will first introduce about the interior of the Earth and basic concepts related to earthquakes viz. causes, observation and location of earthquakes, magnitude and energy etc. The students will learn the mathematical representation of waves, solutions of wave equation in different forms and wave phenomena in detail; elastic waves, their reflection and refraction; mathematical models for the propagation of surface waves and source problems.

Course Outcomes: This course will enable the students to:

1. Understand introductory concepts of earthquakes, seismology and wave propagation so as to form a strong foundation to learn the subject. Know mathematical representation of progressive waves and wave characteristics. Have knowledge to solve wave equation in different coordinate systems.
2. Learn damping, modulation, inhomogeneity and dispersion of waves, representation of spherical waves and their expansion in terms of plane waves. Learn techniques to solve wave equation in order to obtain D'Alembert, Kirchoff, Poisson and Helmholtz formulae which find great importance in energy transport phenomenon in science and engineering.
3. Learn about seismic waves and understand reflection and refraction of seismic waves. Apply knowledge of mathematics and knowledge attained in first two COs to formulate mathematical models having application in seismology and to solve such problems.
4. Understand surface waves and seismic sources (area, line and point). Attain skills to formulate and solve Lamb's problems. Attain knowledge and mathematical tools to pursue research in the area of seismology and to contribute to the science and society.

Unit-I:

Introduction to Seismology: Earthquakes, Causes of earthquakes; Elastic rebound theory, Location of earthquakes, Strength of earthquakes; Earthquake magnitude and intensity, Observation of earthquakes; Seismograms, Seismometers, Earthquake Focal Mechanisms, Energy released by earthquakes, Seismic waves as probes of Earth's interior, Interior of the earth.

General form of progressive waves, Harmonic waves, Plane waves, Wave equation. Principle of superposition, Stationary waves. Special types of solutions: Progressive and Stationary type solutions of wave equation in Cartesian, cylindrical and spherical coordinate systems.

(Relevant articles from the book "*Waves*" by Coulson & Jeffrey)

Unit-II:

Equation of telegraphy. Exponential form of harmonic waves. D'Alembert's formula. Inhomogeneous wave equation, Boundary conditions and mixed problems, Extension of solutions by reflection.

Doppler Effect, Beats, Amplitude modulation, Dispersion, Group velocity, Relation between phase velocity and group velocity, Motion of wave packets.

(Relevant articles from the book "*Waves*" by Coulson & Jeffrey)

Spherical waves. Expansion of a spherical wave into plane waves: Sommerfield's integral. Kirchoff's solution of the wave equation, Poissons's formula, Helmholtz's formula.

(Relevant articles from the book "*Mathematical Aspects of Seismology*" by Markus Bäth).

Unit-III:

Seismic waves: Reduction of equation of motion to wave equations. P and S waves and their characteristics. Polarization of plane P and S waves; Wave potentials. Energy in a plane wave. Snell's law of reflection and refraction. Ray parameter and slowness.

Reflection of plane P and SV waves at a free surface. Partition of reflected energy. Reflection at critical angles.

Reflection and reflection of plane P, SV and SH waves at an interface. Special cases of Liquid-Liquid interface, Liquid-Solid interface and Solid-Solid interface.

(Relevant articles from the book, "*Elastic waves in Layered Media*" by Ewing et al).

Unit-IV:

Surface waves: Rayleigh waves, Love waves and Stoneley waves.

(Relevant articles from the book, "*Elastic waves in Layered Media*" by Ewing et al).

Two dimensional Lamb's problems in an isotropic elastic solid: Area sources and Line Sources in an unlimited elastic solid. A normal force acts on the surface of a semi-infinite elastic solid, tangential forces acting on the surface of a semi-infinite elastic solid.

Three dimensional Lamb's problems in an isotropic elastic solid: Area sources and Point sources in an unlimited elastic solid, Area source and Point source on the surface of semi-infinite elastic solid.

Haskell matrix method for Love waves in multilayered medium.

(Relevant articles from the book "*Mathematical Aspects of Seismology*" by Markus Bäth).

Recommended Books:

1. C.A. Coulson and A. Jeffrey, Waves: A mathematical approach to the common types of wave motion, Longman Higher Education, 1977, Published online by Cambridge University Press, 2016.
2. M. Bath, *Mathematical Aspects of Seismology*, Elsevier Publishing Company, 1968.
3. W.M. Ewing, W.S. Jardetsky and F. Press, *Elastic Waves in Layered Media*, McGraw Hill Book Company, 1957.

Reference Books:

1. P.M. Shearer, Introduction to Seismology, Cambridge University Press,(UK) 1999.
2. Jose Pujol, Elastic Wave Propagation and Generation in Seismology, Cambridge Universty Press, 2003.
3. Seth Stein and Michael Wysession, An Introduction to Seismology, Earthquakes and Earth Structure, Blackwell Publishing Ltd., 2003.
4. Aki, K. and P.G. Richards, Quantitative Seismology: theory and methods, W.H. Freeman, 1980.
5. Bullen, K.E. and B.A. Bolt, *An Introduction to the Theory of Seismology*, Cambridge Universty Press, 1985.
6. C.M.R. Fowler, *The Solid Earth*, Cambridge University Press, 1990.

MMATH21-409: ADVANCED DISCRETE MATHEMATICS

<table>
<tr><td colspan="2">Course Credit</td><td rowspan="2">End Term Examination Time</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>Internal Assessment</td><td>End Term Examination</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>3 Hours</td><td>20</td><td>80</td><td>100</td></tr>
</table>

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The course consists of two sections. In the first section lattices are defined as algebraic structures. This section contains various types of lattices i.e. modular, distributive and complimented lattices.The notion of independent elements in modular lattices is introduced. Boolean algebra has been introduced as an algebraic system. Basic properties of finite Boolean algebra and application of Boolean algebra to switching circuit theory is also given.
Section two contains graph theory. In this section students will be taught connected graphs, Euler's theorem on connected graphs, trees and their basic properties. This section also contains fundamental circuits and fundamental cut-sets, planner graphs, vector space associated with a graph, and the matrices associated with graphs, paths, circuits and cut-sets. The contents of this paper find many applications in computer science and engineering science.

Course Outcomes: This course will enable the students to:
1. Understand concept of lattices, Boolean algebra.
2. Apply lattices to switching circuits.
3. Understand concept of graph, path, circuits, tree, fundamental circuits, cut-set and cut-vertices.
4. Understand concept of planer and dual graph, circuit and cut-set subspace, fundamental circuit matrix, cut- set matrix, path matrix and adjacency matrix.

Unit-I:
Properties of lattice, modular and distributive lattices. Boolean algebra, basic properties, Boolean polynomial, ideals, minimal forms of Boolean polynomials. (Chapter 1 of recommended book at Sr. No. 1)

Unit-II:
Switching circuits, application of lattice to switching circuits.
(2.1 of chapter 2 of recommended book at Sr. No. 1)

Unit-III:
Finite and infinite graphs, Incidence and degree, Isolated vertex, pendant vertex, Null graph, isomosphism, subgraphs, a puzzle with multicolored cubes, walks, paths and circuits. Connected and disconnected graphs, Components of a graph, Euler graphs, Hamiltonian paths and circuits,

The traveling salesman problem. Trees and their properties, pendant vertices in a tree, distance and centers in a tree, rooted and binary tree. Spanning tree, fundamental circuits. Spanning tree in a weighted graph. Cut-sets and their properties. Fundamental circuits and cut-sets. Connectivity and separability. Network flows. (1.1 to 1.5, 2.1 to 2.10, 3.1 to 3.10, 4.1 to 4.6 of recommended book at Sr. No. 2)

Unit-IV:

Planner graphs. Kuratowski's two graphs. Representation of planner graphs. Euler formula for planner graphs. Geometric dual, vector and vector spaces, Vector space associated with a graph. Basis vectors of a graph. Circuit and cut-set subspaces. Intersection and joins of W_C and W_S. Incidence matrix, submatrices of A(G), Circuit matrix, Fundamental circuit matrix, and its rank, Cut-set matrix, path matrix and adjacency matrix .

(5.1 to 5.6, 6.4 to 6.7, 6.9, 7.1 to 7.4, 7.6, 7.8 & 7.9 of recommended book at Sr. No. 2)

Recommended Books:

1. Rudolf Lidl & Gunter Pilz, Applied Abstract Algebra, Springer-Verlag, Second Edition, 1998.
2. Narsingh Deo, Graph Theory with application to Engineering and Computer Science, Prentice Hall of India, 1979.

Reference books:

1. Nathan Jacobson: Lectures in Abstract Algebra Vol. I, D Van Nostrand Company Inc., 1961.
2. L.R.Vermani and Shalini, A course in discrete Mathematical structures, Imperial College Press, London, 2011.

MMATH21-410: ADVANCED FUNCTIONAL ANALYSIS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Spectral theory is one of the main branches of modern functional analysis and its applications. The main objective of this course is to familiarize with some advanced topics in functional analysis which include spectral theory of linear operators in normed spaces, compact linear operators on normed spaces and their spectrum, and spectral theory of bounded self-adjoint linear operators and unbounded linear operators in Hilbert spaces.

Course Outcomes: This course will enable the students to:
1. Undersatnd the spectrum of a bounded operator, spectral properties of bounded linear operators; apply the knowledge to prove spectral mapping theorem for polynomials; be familiar with Banach algebras and its properties.
2. Learn about compact linear operators on normed spaces, their spectral properties and application to operator equations involving compact linear operators.
3. Understand the spectral properties of bounded self-adjoint linear operators; apply the knowledge to prove spectral theorem for bounded self adjoint linear operators and extend the spectral theorem to continuous functions.
4. Understand the basics of unbounded linear operators on Hilbert spaces; adjoints of unbounded linear operators; spectral properties of self-adjoint operators; multiplication and differentiation operators.

Unit-I:
Spectrum of a bounded operator: point spectrum, continuous spectrum and residual spectrum, spectral properties of bounded linear operators, the closedness and compactness of the spectrum of a bounded linear operator on a complex Banach space; further properties of resolvent and spectrum, spectral mapping theorem for polynomials. (Scope as in relevant parts of Sections 7.1 to 7.4 of Chapter 7 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Non-emptiness of the spectrum of a bounded linear operator on a complex Banach space, spectral radius, spectral radius formula, Banach algebras, resolvent set and spectrum of a Banach algebra element, further properties of Banach algebras, spectral radius of a Banach algebra element, non-emptiness of the spectrum of a Banach algebra element. (Scope as in relevant parts of Sections 7.5 to 7.7 of Chapter 7 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Unit –II:
Compact linear operators on normed spaces, compactness criterion, conditions under which the limit of a sequence of compact linear operators is compact, weak convergence and compact operators, separability of range, adjoint of compact operators, Spectral properties of compact linear operators on normed spaces, eigen values of compact linear operators, closedness of the range of T_{λ}, further spectral properties of compact linear operators. (Scope as in relevant parts of Sections 8.1 to 8.4 of Chapter 8 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Operator equations involving compact linear operators, necessary and sufficient conditions for the solvability of various operator equations, further theorems of Fredholm type. Fredholm alternative. (Scope as in relevant parts of Sections 8.5 to 8.7 of Chapter 8 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Unit –III:
Spectral theory of bounded self-adjoint linear operators : spectral properties of bounded self adjoint operators, positive operators, projection operators and their properties. (Scope as in relevant parts of Sections 9.1 to 9.6 of Chapter 9 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Spectral family of a bounded self adjoint linear operator, spectral representation of bounded self-adjoint linear operators, spectral theorem for bounded self-adjoint linear operators, extension of the spectral theorem to continuous functions, properties of the spectral family of a bounded self adjoint operator. (Scope as in relevant parts of Sections 9.7 to 9.11 of Chapter 9 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Unit-IV:
Unbounded linear operators and their Hilbert adjoints, Hellinger-Toeplitz theorem, Hilbert-adjoint, symmetric and self-adjoint linear operators. Closed linear operators and closures, spectral properties of self adjoint linear operators. (Scope as in relevant parts of Sections 10.1 to 10.4 of Chapter 10 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Spectral representation of unitary operators : Wecken's lemma, spectral theorem for unitary operators, spectral representation for self-adjoint linear operators, multiplication and differentiation operators. (Scope as in relevant parts of Sections 10.5 to 10.7 of Chapter 10 of 'Introductory Functional Analysis with Applications' by E.Kreyszig)

Recommended Text Book:
E.Kreyszig: Introductory Functional Analysis with Applications, Wiley India, 2007.

Reference Books:
1. G.F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Book Co.,New York, 1983.
2. R. Bhatia, Notes on Functional Analysis, TRIM series, Hindustan Book Agency, India, 2009.
3. J.E. Conway, A course in Operator Theory, Graduate Studies in Mathematics, Volume 21, AMS, 1999.
4. Martin Schechter, Principles of Functional Analysis, American Mathematical Society, 2004.
5. W. Rudin, Functional Analysis, TMH Edition, 1974.

MMATH21-411: ADVANCED FLUID MECHANICS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: This course deals with mechanics of real (viscous) fluids and objective of this course is to let the students have deep understanding of gas dynamics, dynamics of viscous fluids and boundary layer theory. This is a strong foundation course to pursue research in the areas of Fluid Mechanics, Computational Fluid Dynamics, Bio-Mechanics, Mathematical Modeling and Mathematical Biology.

Course Outcomes: This course will enable the students to:

1. Understand wave motion, including sound, in a gas; Sonic, subsonic, supersonic, isentropic types of flows; shock waves and flow of gas through a nozzle. Capacity to solve simple gas flow problems.
2. Have thorough knowledge of viscous fluids; stress, strain rate and relations between them and equations of motion for viscous fluids.
3. Identify those viscous fluid flow problems whose exact solutions can be found and to learn the methods to solve such problems. Apply the knowledge to solve real world problems.
4. Recognize concepts of dynamical similarity, dimensional analysis, Reynolds number, Wever Number, Mach Number, Froude Number, Eckert Number, Buckingham π-theorem and its applications. Understand the concept of boundary layer and the associated theory. Get exposure to real fluid flow problems of science and engineering.

Unit-I:

Wave motion in a Gas. Speed of sound in a gas. Equation of motion of a Gas. Subsonic, sonic and supersonic flows. Isentropic gas flow, Flow through a nozzle. Shock waves.
(Relevant portions from the recommended text book at Sr. No. 1)

Unit-II:

Stress components in a real fluid. Relation between Cartesian components of stress. Translational motion of fluid element. Rate of strain quadric and principal stresses.

Transformation of rates of strains. Stress analysis in fluid motion. Relations between stress and strain rate.

The co-efficient of viscosity and laminar flow. Newtonian and non-Newtonian fluids. Navier-Stokes equations of motion. Equations of motion in cylindrical and spherical polar coordinates.

(Relevant portions from the recommended text book at Sr. No. 1)

Unit-III:

Some solvable problems in viscous flow: Steady motion between parallel planes, Steady flow through tube of uniform cross-section (Poiseuille Flow), Steady flow between concentric rotating cylinders. Steady viscous flow in tubes of uniform cross-section: Uniqueness theorem; Flow through tubes of uniform elliptic, equilateral triangular and rectangular cross-sections. Diffusion of vorticity. Energy dissipation due to viscosity. Steady flow past a fixed sphere. Unsteady flow over a flat plate. Flow in convergent and divergent chennals.

(Relevant portions from the recommended text book at Sr. No. 1)

Unit-IV:

Dynamical similarity. Dimensional analysis. Buckingham π-theorem and its applications to viscous and compressible fluid flow. Reynolds number, Weber Number, Mach Number, Froude Number, Eckert Number

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Prandtl boundary layer theory, Boundary layer thickness, Boundary layer equation in two-dimensions. The boundary layer flow over a flat plate (Blasius solution). Characteristic boundary layer parameters. Karman integral equations. Karman-Pohlhausen method.

(Relevant portions from the recommended text book at Sr. No. 2)

Recommended Text Books:

1. F. Chorlton, *Text-book of Fluid Dynamics*, CBS Publishers and Distributors Pvt. Ltd., 2018.
2. S. W. Yuan, *Foundations of Fluid Mechanics*, Prentice Hall of India Ltd., 1988.

Reference Books:

1. G.K. Batchelor, *An Introduciton to Fluid Dynamics*, Cambridge University Press, 2000.
2. A.J. Chorin and A. Marsden, *A Mathematical Introduction to Fluid Dynamics*, Springer-Verlag, New York, 1993.
3. L.D. Landau and E.M. Lifshitz, *Fluid Mechanics*, Pergamon Press, 1987.
4. H. Schlichting, *Boundary Layer Theory*, Springer, 2016.
5. A.D. Young, *Boundary Layers*, AIAA Education Series, Washington DC, 1989.
6. W.H. Besant and A.S. Ramsey, *A Treatise on Hydromechanics*, Part-II, CBS Publishers, Delhi, 2006.

MMATH21-412: BOUNDARY VALUE PROBLEMS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each section and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each section and the compulsory question. All questions carry equal marks.

Course Objectives: The objective of this course is to learn to solve the boundary value problems. Boundary value problems find applications in all area of science and engineering. The different techniques to solve boundary value problems and mixed boundary value problems are studied in this course. Such problems can be solved with Green's function approach, Integral transform methods and by using Perturbation techniques. One of the objective to study this course is to expose a student to real world problems that are formulated as boundary value problems.

Course Outcomes: This course will enable the students to:

1. Reduce boundary value problems involving ODEs to the equivalent integral and to solve such problems with Green's function and Modified Green's function approaches. Apply these techniques in problem solving.
2. Learn to find solutions of boundary value problems involving Laplace's equation, Poisson's equation and Helmoltz's equation by using theory of integral equations and Green's function. Attain skill to solve such BVP which arise frequently in different branches of engineering and sciences.
3. Learn to solve the integral equations by integral transform methods. Apply the gained knowledge in solving mixed boundary problems.
4. Understand Perturbation methods and attain capability to apply perturbation techniques in solving different listed boundary value problems of Electrostatics, Hydrodynamics and Elasticity.

Unit-I:

Applications to Ordinary Differential Equations; Initial value problems, Boundary Value Problems. Dirac Delta functions. Green's function approach to reduce boundary value problems of a self-adjoint-differential equation with homogeneous boundary conditions to integral equation forms. Green's function for N^{th}-order ordinary differential equation. Modified Green's function.

(Relevant portions from the Chapter 5 of the book "Linear Integral Equations, Theory and Techniques by R.P.Kanwal").

Unit-II:

Applications to partial differential equations: Integral representation formulas for the solution of the Laplace and Poisson Equations. The Newtonian, single-layer and double-layer potentials, Interior and Exterior Dirichlet problems, Interior and Exterior Neumann problems. Green's function for Laplace's equation in a free space as well as in a space bounded by a ground vessel. Integral equation formulation of boundary value prolems for Laplace's equation. Poisson's Integral formula. Green's function for the space bounded by grounded two parallel plates or an infinite circular cylinder. The Helmholtz equation.

(Relevant portions from the Chapter 6 of the book "Linear Integral Equations, Theory and Techniques by R.P.Kanwal").

Unit-III:

Integral Transform methods: Introduction, Fourier transform. Laplace transform. Convolution Integral. Application to Volterra Integral Equations with convolution-type Kernels. Hilbert transform.

Applications to mixed Boundary Value Problems: Two-part Boundary Value problems, Three-part-Boundary Value Problems, Generalized Three-part Boundary Value problems.

(Relevant portions from the Chapter 9 & 10 of the book "Linear Integral Equations, Theory and Techniques by R.P. Kanwal").

Unit-IV:

Integral equation perturbation methods: Basic procedure, Applications to Electrostatics, Low-Reynolds-Number Hydrodynamics: Steady stokes Flow, Boundary effects on Stokes flow, Longitudinal oscillations of solids in stokes Flow, Steady Rotary Stokes Flow, Rotary Oscillations in Stokes Flow, Rotary Oscillation in Stokes Flow, Oseen Flow-Translation Motion, Oseen Flow-Rotary motion Elasticity, Boundary effects, Rotation, Torsion and Rotary Oscillation problems in elasticity, crack problems in elasticity, Theory of Diffraction.

(Relevant portions from the Chapter 11 of the book "Linear Integral Equations, Theory and Techniques by R.P.Kanwal").

Recommended Books:

1. Ram P. Kanwal, *Linear Integral Equations: Theory & Techniques*, Springer Science & Business Media, 2012.
2. S.G. Mikhlin, *Linear Integral Equations* (translated from Russian) ,Hindustan Book Agency, 1960.
3. F.G Tricomi, *Integral Equations*, Courier Corporation, 1985.
4. Abdul J. Jerri, *Introduction to Integral Equations with Applications*, Wiley-Interscience, 1999.
5. Ian N. Sneddon, *Mixed Boundary Value Problems in potential theory*, North Holland Publishing Co., 1966.
6. Ivar Stakgold, *Boundary Value Problems of Mathematical Physics* Vol.I, II, Society for Industrial and Applied Mathematics, 2000.

MMATH21-413: BIO-MATHEMATICS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course objectives: This paper deals with a widely acceptable fact that many phenomena in life sciences and environment sciences can be modelled mathematically. Biology offers a rich variety of topics that are amenable to mathematical modeling, but some of the genuinely interesting are touched in this paper. It is assumed that students have no knowledge of biology, but they are expected to learn a substantial amount during the course. The ability to model problems using mathematics may not require much of the memorization, but it does require a deep understanding of basic principles and a wide range of mathematical techniques. Students are required to know differential equations and linear algebra. Topics in stochastic modeling are also touched, which requires some knowledge of probability.

Course outcomes: This course will enable the students to:

1. Derive population growth laws/models regulated through logistic equation, involving species competition, Lotka-Volterra predator-prey equations to develop the theory of age-structured populations using both discrete- and continuous-time models for their applications in life cycle of a hermaphroditic worm.
2. Model smaller populations those exhibit stochastic effects so as to analyze births rates in finite populations for their role in mathematical models of infectious disease epidemics and endemics so as to predict the future spread of a disease and to develop strategies for containment and eradication.
3. Learn the mathematical modeling of the evolution/maintenance of polymorphism to understand population genetics, influence of natural selection, genetic drift, mutation, and migration (i.e., evolutionary forces) in changing the Allele frequencies.
4. Derive mathematical models for biochemical reactions, including catalyzed by enzymes, based on the law of mass action, enzyme kinetics, fundamental enzymatic properties (i.e., competitive inhibition, allosteric inhibition, cooperativity) so as to know about DNA chemistry and the genetic code for alignment of DNA/RNA sequences by brute force, dynamic programming or gaps.

Unit-I:

Population Dynamics: The Malthusian growth ; The Logistic equation; A model of species competition; The Lotka-Volterra predator-prey model;

Age-structured Populations : Fibonacci's rabbits; The golden ratio Φ; The Fibonacci numbers in a sunflower; Rabbits are an age-structured population; Discrete age-structured populations; Continuous age-structured populations; The brood size of a hermaphroditic worm.

Unit-II:

Stochastic Population Growth : A stochastic model of population growth; Asymptotics of large initial populations; Derivation of the deterministic model; Derivation of the normal probability distribution; Simulation of population growth.
Infectious Disease Modeling: The SI model; The SIS model; The SIR epidemic disease model; Vaccination ; The SIR endemic disease model ; Evolution of virulence.

Unit-III:

Population Genetics: Haploid genetics; Spread of a favored allele; Mutation-selection balance ; Diploid genetics; Sexual reproduction; Spread of a favored allele; Mutation-selection balance; Heterosis; Frequency-dependent selection; Linkage equilibrium; Random genetic drift.

Unit-IV:

Biochemical Reactions: The law of mass action; Enzyme kinetics; Competitive inhibition; Allosteric inhibition; Cooperativity. Sequence Alignment: DNA ; Brute force alignment; Dynamic programming; Gaps; Local alignments; Software.

Recommended Books:

1. Mathematical Biology, Lecture notes for MATH 4333, (Jeffrey R. Chasnov)
2. Mathematical Biology I. An Introduction, Third Edition, (J.D. Murray)

MMATH21-414: FOURIER AND WAVELET ANALYSIS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Wavelet analysis is a modern supplement to classical Fourier analysis. In some cases Wavelet analysis is much better than Fourier analysis in the sense that fewer terms suffice to approximate certain functions. The main objective of this course is to familiarize with the standard features of Fourier transforms along with more recent developments such as the discrete and fast Fourier transforms and wavelets. We consider the idea of a multiresolution analysis and the course we follow is to go from MRA to wavelet bases.

Course Outcomes: This course will enable the students to:

1. Have an idea of the finite Fourier transform, convolution on the circle group T, the Fourier transform and residues and know about continuous analogue of Dini's theorem and Lipschitz's test.
2. Know about (C,1) summability for integrals, understand the Fejer-Lebesgue inversion theorem, Parseval's identities, the L_2 theory, Plancherel theorem and Mellin transform.
3. Have understanding of the Discrete and Fast Fourier transforms, and Buneman's Algorithm.
4. Understand Multiresolution Analysis, Mother wavelets; construction of scaling function with compact support, Shannon wavelets, Franklin wavelets, frames, splines and the continuous wavelet transform.

Unit-I:

Fourier Transform: The finite Fourier transform, the circle group T, convolution to T, (L (T),+,*) as a Banach algebra, convolutions to products, convolution on T, the exponential form of Lebesgue's theorem, Fourier transform : trigonometric approach, exponential form, Basics/examples.

Fourier transform and residues, residue theorem for the upper and lower half planes, the Abel kernel, the Fourier map, convolution on R, inversion, exponential form, inversion, trigonometric form, criterion for convergence, continuous analogue of Dini's theorem, continuous analogue of Lipschitz's test, analogue of Jordan's theorem.

(Scope as in relevant parts of Chapter 5 of the book "Fourier and Wavelet Analysis" by Bachman, Narici and Beckenstein)

Unit-II:
(C,1) summability for integrals, the Fejer-Lebesgue inversion theorem,the continuous Fejer Kernel, the Fourier map is not onto, a dominated inversion theorem, criterion for integrability of

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Approximate identity for L_1(R), Fourier Sine and Cosine transforms, Parseval's identities, the L_2 theory, Parseval's identities for L_2, inversion theorem for L_2 functions, the Plancherel theorem, A sampling theorem, the Mellin transform, variations.

(Scope as in relevant parts of Chapter 5 of the book "Fourier and Wavelet Analysis" by Bachman, Narici and Beckenstein)

Unit-III:
Discrete Fourier transform, the DFT in matrix form, inversion theorem for the DFT, DFT map as a linear bijection, Parseval's identities, cyclic convolution, Fast Fourier transform for N=2 , Buneman's Algorithm, FFT for N=RC, FFT factor form. (Scope as in relevant parts of Chapter 6 of the book "Fourier and Wavelet Analysis" by Bachman, Narici and Beckenstein)

Unit-IV:
Wavelets : orthonormal basis from one function , Multiresolution Analysis, Mother wavelets yield Wavelet bases, Haar wavelets, from MRA to Mother wavelet, Mother wavelet theorem, construction of scaling function with compact support, Shannon wavelets, Riesz basis and MRAs, Franklin wavelets, frames, splines, the continuous wavelet transform. (Scope as in relevant parts of Chapter 7 of the book "Fourier and Wavelet Analysis" by Bachman, Narici and Beckenstein)

Recommended Text Book :
1. G. Bachman, L. Narici and E. Beckenstein : Fourier and Wavelet Analysis, Springer, 2000

Reference Books :
1. Hernandez and G. Weiss : A first course on wavelets, CRC Press, New York, 1996
2. C. K. Chui: An introduction to Wavelets, Academic Press,1992
3. I. Daubechies : Ten lectures on wavelets, CBMS_NFS Regional Conferences in Applied Mathematics, 61, SIAM, 1992
4. V. Meyer, Wavelets, algorithms and applications SIAM, 1993
5. M.V. Wickerhauser: Adapted wavelet analysis from theory to software, Wellesley,MA, A.K. Peters, 1994
6. D. F. Walnut: An Introduction to Wavelet Analysis, Birkhauser, 2002
7. K. Ahmad and F.A. Shah: Introduction to Wavelets with Applications, World Education Publishers, 2013

MMATH21-415: LINEAR PROGRAMMING

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: Real life systems can have dozens or hundreds of variables, or more, which may not be handled through standard algebraic techniques. Such systems are used every day in the organization and allocation of resources and are generally handled through linear programming based on "optimization techniques". Linear programming deals with the problems of maximizing or minimizing a linear function subject to linear constraints in the form of equalities or inequalities. The general process for solving linear-programming exercises is to graph the constraints to form a walled-off area called "feasibility region". Then, corners of this feasibility region are tested to find the highest (or lowest) value of the outcome (or resources).

Course Outcomes: This course will enable the students to:

1. Learn background for linear programming, theory of simplex method, detailed development and computational aspects of the simplex method.
2. Discuss simplex method in detail, resolution of the degeneracy problem .
3. Discuss revised simplex method.
4. Understand duality theory and its ramifications, transportation problem.

Unit-I:

Simultaneous linear equations, Basic solutions, Linear transformations, Point sets, Lines and hyperplanes, Convex sets, Convex sets and hyperplanes, Convex cones, Restatement of the LP problem, Slack and surplus variables, Preliminary remarks on the theory of the simplex method, Reduction of any feasible solution to a basic feasible solution, Definitions and notations regarding LP problems. Improving a basic feasible solution, Unbounded solutions, Optimality conditions, Alternative optima, Extreme points and basic feasible solutions.

The simplex method, Selection of the vector to enter the basis, Degeneracy and breaking ties, Further development of the transformation formulas, The initial basic feasible solution, artificial variables, Inconsistency and redundancy, Tableau format for simplex computations, Use of the tableau format, Conversion of a minimization problem to a maximization problem, Review of the simplex method.

(Chapter 2, 3 & 4 of recommended book)

Unit-II:

The two-phase method for artificial variables, Phase I, Phase II, Numerical examples of the two-phase method, Requirements space, Solutions space, Determination of all optimal solutions, Unrestricted variables, Charnes' perturbation method regarding the resolution of the degeneracy problem.

Selection of the vector to be removed, Definition of b(€). Order of vectors in b(€), Use of perturbation technique with simplex tableau format, Geometrical interpretation of the perturbation method. The generalized linear programming problem, The generalized simplex method, Examples pertaining to degeneracy, An example of cycling.

(Chapter 5, 6 of recommended book)

Unit-III:

Revised simplex method: Standard Form I, Computational procedure for Standard Form I, Revised simplex method: Standard Form II, Computational procedure for Standard Form II, Initial identity matrix for Phase I, Comparison of the simplex and revised simplex methods,

The product form of the inverse of a non-singular matrix.

(Chapter 7 of recommended book)

Unit-IV:

Alternative formulations of linear programming problems, Dual linear programming problems, Fundamental properties of dual problems, Other formulations of dual problems, Complementary slackness, Unbounded solution in the primal, Dual simplex algorithm, Alternative derivation of the dual simplex algorithm, Initial solution for dual simplex algorithm, The dual simplex algorithm; an example, geometric interpretations of the dual linear programming problem and the dual simplex algorithm. A primal dual algorithm, Examples of the primal-dual algorithm.

Transportation problem, properties of matrix A, the simplex method and transportation problem, simplification resulting from all $y_{ij}^{\alpha\beta}$= ±1 or 0, the transportation problem tableau, bases in the transportation tableau, the stepping stone algorithm, an example. (Chapter 8 & 9.1 to 9.8 of recommended book)

Recommended Text Book:

1. G. Hadley, Linear Programming, Narosa Publishing House, 2002.

Reference book:

1. S.I. Gauss, Linear Programming: Methods and Applications, 4th Ed., McGraw-Hill, New York, 1975.

MMATH21-416: NON-COMMUTATIVE RINGS

Course Credit		End Term Examination Time	Maximum Marks		
L	T		Internal Assessment	End Term Examination	Total
4	1	3 Hours	20	80	100

Note: The examiner will set 9 questions in all, selecting two questions from each unit and one compulsory question. The compulsory question (Question No. 1) will contain 8 parts, without any internal choice, covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions carry equal marks.

Course Objectives: The course has been designed to give an exposure of the advanced ring theory. Course contains some special example of rings i.e. differential polynomial rings, group rings, skew group rings, triangular rings, Hurwitz's rings of integral quaternion's, DCC and ACC in triangular rings, Dedekind finite rings, simple and semi-simple modules, projective and injective modules. Nil radical and Jacobson radical of matrix rings are also part of the course. The course also contains sub-direct product of rings and commutativity theorems of Jacobson-Herstein and Herstein-Kaplansky. Finally theory of finite division rings is given.

Course Outcomes: This course will enable the students to:

1. Understand basic terminology and examples of non-commutative rings, simple and semi-simple modules and rings, Wedderburn-Artin Theorem, Schur's Lemma, Minimal ideals, Amitsur Theorem on non-inner derivations.
2. Understand Jacobson radical of a ring R, Jacobson semi-simple rings, Hopkins-Levitzki Theorem. Jacobson radical of the matrix ring, Amitsur Theorem on radicals, Nakayama's Lemma, Von Neumann regular rings, E. Snapper's Theorem.
3. Understand Prime and semi-prime ideals and rings. Lower and upper nil radical of a ring R . Amitsur theorem on nil radical of polynomial rings, Brauer's Lemma, Levitzki theorem , Density Theorem, Structure theorem for left primitive rings.
4. To learn about Subdirectly reducible and irreducible rings, Birchoff's Theorem, G.Shin's Theorem, Commutativity Theorems , Division rings, Wedderburn's Little Theorem, Herstein's Lemma and theorem, Jacobson and Frobenius Theorem, Cartan-Brauer-Hua Theorem.

Unit-I:

Basic terminology and examples of non-commutative rings i.e. Hurwitz's ring of integral quaternions, Free k-rings. Rings with generators and relations. Hilbert's Twist, Differential polynomial rings, Group rings, Skew group rings, Triangular rings, D.C.C. and A.C.C. in triangular rings. Dedekind finite rings. Simple and semi-simple modules and rings. Spliting homomorphisms. Projective and Injective modules.

Ideals of matrix ring M_n (R). Structure of semi simple rings. Wedderburn-Artin Theorem Schur's Lemma. Minimal ideals. Indecomposable ideals. Inner derivation δ. δ-simple rings. Amitsur Theorem on non-inner derivations.

Unit-II:

Jacobson radical of a ring R.Annihilator ideal of an R-module M. Jacobson semi-simple rings. Nil and Nilpotent ideals. Hopkins-Levitzki Theorem. Jacobson radical of the matrix ring M_n (R). Amitsur Theorem on radicals. Nakayama's Lemma. Von Neumann regular rings. E. Snapper's Theorem. Amitsur Theorem on radicals of polynomial rings.

Unit-III:

Prime and semi-prime ideals. m-systems. Prime and semi-prime rings. Lower and upper nil radical of a ring R Amitsur theorem on nil radical of polynomial rings. Brauer's Lemma. Levitzki theorem on nil radicals. Primitive and semi-primitive rings. Left and right primitive ideals of a ring R. Density Theorem. Structure theorem for left primitive rings.

Unit-IV:

Sub-direct products of rings. Subdirectly reducible and irreducible rings. Birchoff's Theorem. Reduced rings. G.Shin's Theorem. Commutativity Theorems of Jacobson, Jacobson-Herstein and Herstein Kaplansky. Division rings. Wedderburn's Little Theorem. Herstein's Lemma. Jacobson and Frobenius Theorem. Cartan-Brauer-Hua Theorem. Herstein's Theorem.

(1.1 to 1.26, 2.1 to 2.9, 3.1 to 3.19, 4.1 to 4.27, 5.1 to 5.10, 10.1 to 10.30, 11.1 to 11.20, 12.1 to 12.11 and 13.1 to 13.26 of recommended book).

Recommended Book:

1. T.Y. Lam : A First Course in Noncommutive Rings, Springer-Verlag, 1990.

Reference book:

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Nomenclature for B.Tech. Degree in Emerging Areas of Electronics and Communication Engineering

1. B.Tech. (Hons.) Electronics and Communication Engineering with Specialization in Artificial Intelligence and Machine Learning
2. B.Tech. (Hons.) Electronics and Communication Engineering with Specialization in Internet of Things (IoT)
3. B.Tech. (Hons.) Electronics and Communication Engineering with Specialization in Blockchain
4. B.Tech. (Hons.) Electronics and Communication Engineering with Specialization in Robotics
5. B.Tech. (Hons.) Electronics and Communication Engineering with Specialization in Data Science
6. B.Tech. (Hons.) Electronics and Communication Engineering with Specialization in Cyber Security
7. B.Tech. Electronics and Communication Engineering with Minor Degree in 3D Printing
8. B.Tech. Electronics and Communication Engineering with Minor Degree in Electric Vehicles
9. B.Tech. Electronics and Communication Engineering with Minor Degree in Energy Engineering
10. B.Tech. Electronics and Communication Engineering with Minor Degree in Mechatronics
11. B.Tech. Electronics and Communication Engineering with Minor Degree in Computer Science and Biology
12. B.Tech. Electronics and Communication Engineering with Minor Degree in Drug Engineering
13. B.Tech. Electronics and Communication Engineering with Minor Degree in Genome Engineering and Technology

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Nomenclature for B.Tech. Degree in Emerging Areas of Computer Science and Engineering

1. B.Tech. (Hons.) Computer Science and Engineering with Specialization in Artificial Intelligence and Machine Learning
2. B.Tech. (Hons.) Computer Science and Engineering with Specialization in Blockchain
3. B.Tech. (Hons.) Computer Science and Engineering with Specialization in Data Science
4. B.Tech. (Hons.) Computer Science and Engineering with Specialization in Internet of Things (IoT)
5. B.Tech. (Hons.) Computer Science and Engineering with Specialization in Cyber Security
6. B.Tech. Computer Science and Engineering with Minor Degree in 3D Printing
7. B.Tech. Electronics and Communication Engineering with Minor Degree in Electric Vehicles
8. B.Tech. Computer Science and Engineering with Minor Degree in Energy Engineering
9. B.Tech. Computer Science and Engineering with Minor Degree in Robotics
10. B.Tech. Electronics and Communication Engineering with Minor Degree in Mechatronics
11. B.Tech. Computer Science and Engineering with Minor Degree in Computer Science and Biology
12. B.Tech. Computer Science and Engineering with Minor Degree in Drug Engineering
13. B.Tech. Computer Science and Engineering with Minor Degree in Genome Engineering and Technology

Nomenclature for B.Tech. Degree in Emerging Areas of Mechanical Engineering

1. B.Tech. (Hons.) Mechanical Engineering with Specialization in 3D Printing
2. B.Tech. (Hons.) Mechanical Engineering with Specialization in Electric Vehicles
3. B.Tech. (Hons.) Mechanical Engineering with Specialization in Energy Engineering
4. B.Tech. (Hons.) Mechanical Engineering with Specialization in Robotics
5. B.Tech. (Hons.) Mechanical Engineering with Specialization in Mechatronics
6. B.Tech. Mechanical Engineering with Minor Degree in Artificial Intelligence and Machine Learning
7. B.Tech. Mechanical Engineering with Minor Degree in Blockchain
8. B.Tech. Mechanical Engineering with Minor Degree in Data Science
9. B.Tech. Mechanical Engineering with Minor Degree in Internet of Things (IoT)
10. B.Tech. Mechanical Engineering with Minor Degree in Cyber Security
11. B.Tech. Mechanical Engineering with Minor Degree in Computer Science and Biology
12. B.Tech. Mechanical Engineering with Minor Degree in Drug Engineering
13. B.Tech. Mechanical Engineering with Minor Degree in Genome Engineering and Technology

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Nomenclature for B.Tech. Degree in Emerging Areas of Biotechnology

1. B.Tech. (Hons.) Biotechnology with Specialization in Computer Science and Biology
2. B.Tech. (Hons.) Biotechnology with Specialization in Drug Engineering
3. B.Tech. (Hons.) Biotechnology with Specialization in Genome Engineering and Technology
4. B.Tech. Biotechnology with Minor Degree in Artificial Intelligence and Machine Learning
5. B.Tech. Biotechnology with Minor Degree in Blockchain
6. B.Tech. Biotechnology with Minor Degree in Data Science
7. B.Tech. Biotechnology with Minor Degree in Internet of Things (IoT)
8. B.Tech. Biotechnology with Minor Degree in Cyber Security
9. B.Tech. Biotechnology with Minor Degree in 3D Printing
10. B.Tech. Biotechnology with Minor Degree in Electric Vehicles
11. B.Tech. Biotechnology with Minor Degree in Energy Engineering
12. B.Tech. Electronics and Communication Engineering with Minor Degree in Mechatronics
13. B.Tech. Biotechnology with Minor Degree in Robotics

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Table 1: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Artificial Intelligence and Machine Learning

Artificial Intelligence and Machine Learning (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/AI-1	Artificial Intelligence : Search Methods For Problem solving
	SPMD/AI-2	**OR** An Introduction to Artificial Intelligence
2.	SPMD/AI-3	Artificial Intelligence: Knowledge Representation and Reasoning
3.	SPMD/AI-4	Programming, Data Structures and Algorithms in Python
	SPMD/AI-5	**OR** Python for Data Science
4.	SPMD/AI-6	Introduction to Machine Learning
5.	SPMD/AI-7	Deep Learning
	SPMD/AI-8	**OR** Deep Learning for Computer Vision
6.	SPMD/AI-9	Reinforcement Learning
7.	SPMD/AI-10	AI: Constraint Satisfaction
8.	SPMD/AI-11	Computer Vision
9.	SPMD/AI-12	Natural Language Processing
	SPMD/AI-13	**OR** Applied Natural Language Processing
10.	SPMD/AI-14	Practical Machine Learning with Tensorflow
11.	SPMD/AI-15	Introduction to Data Analytics
	SPMD/AI-16	**OR** Data Science for Engineers
12.	SPMD/AI-17	Learning Analytics Tools
13.	SPMD-1	Design Thinking - A Primer
14.	SPMD-2	Ethics in Engineering Practice

Table 2: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Internet of Things (IoT)

Internet of Things (IoT) (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/IoT-1	Introduction to Industry 4.0 and Industrial Internet of Things
	SPMD/IoT-2	**OR** Introduction to Internet of Things
2.	SPMD/IoT-3	Electronic Systems for Sensor Applications
3.	SPMD/IoT-4	Optical Fiber Sensors
	SPMD/IoT-5	**OR** Optical Sensors
4.	SPMD/IoT-6	Introduction to Machine Learning
5.	SPMD/IoT-7	Selection of Nanomaterials for Energy Harvesting and Storage Application
6.	SPMD/IoT-8	Python for Data Science
7.	SPMD/IoT-9	Deep Learning
	SPMD/IoT-10	**OR** Deep Learning for Computer Vision
8.	SPMD/IoT-11	Reinforcement Learning
9.	SPMD/IoT-12	Cloud computing
	SPMD/IoT-13	**OR** Google Cloud Computing Foundations
10.	SPMD/IoT-14	Modern Application Development
11.	SPMD/IoT-15	Introduction to Data Analytics
	SPMD/IoT-16	**OR** Data Science for Engineers
12.	SPMD/IoT-17	Computer Networks and Internet Protocol
13.	SPMD/IoT-18	Introduction to Database Systems
14.	SPMD-1	Design Thinking – A Primer
15.	SPMD-2	Ethics in Engineering Practice

Table 3: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Blockchain

Blockchain (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/BL-1	Introduction to Blockchain Technology and Applications
	SPMD/BL-2	**OR** Blockchain Architecture Design and Use Cases
2.	SPMD/BL-3	Introduction to Internet of Things
3.	SPMD/BL-4	Information Security – 5 – Secure Systems Engineering
4.	SPMD/BL-5	Introduction to Machine Learning
5.	SPMD/BL-6	Ethical Hacking
6.	SPMD/BL-7	GPU Architectures and Programming
7.	SPMD/BL-8	Computer Networks and Internet Protocol
8.	SPMD/BL-9	Cloud computing
	SPMD/BL-10	**OR** Google Cloud Computing Foundations
9.	SPMD/BL-11	Foundations of Cryptography
10.	SPMD/BL-12	Information Theory and Coding
11.	SPMD/BL-13	Introduction to Database Systems
12.	SPMD/BL-14	Internetwork Security
13.	SPMD-1	Design Thinking – A Primer
14.	SPMD-2	Ethics in Engineering Practice

Table 4: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Robotics

Robotics (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/RB-1	Foundations of Cognitive Robotics
2.	SPMD/RB-2	Introduction to Robotics
	SPMD/RB-3	**OR** Robotics
3.	SPMD/RB-4	Mechanism and Robot Kinematics
4.	SPMD/RB-5	Computer Architecture and Organization
5.	SPMD/RB-6	Power Electronics
6.	SPMD/RB-7	Principle of Hydraulic Machines and System Design
7.	SPMD/RB-8	Programming, Data Structures and Algorithms Using Python
8.	SPMD/RB-9	Control Systems
9.	SPMD/RB-10	Fundamentals of Artificial Intelligence
10.	SPMD/RB-11	Introduction to Machine Learning
11.	SPMD/RB-12	Dynamical System and Control
12.	SPMD/RB-13	Introduction to Embedded System Design
13.	SPMD/RB-14	Introduction to Internet of Things
	SPMD/RB-15	**OR** Introduction to Industry 4.0 and Industrial Internet of Things
14.	SPMD-1	Design Thinking – A Primer
15.	SPMD-2	Ethics in Engineering Practice

Table 5: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Data Science

Data Science (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/DS-1	Python for Data Science
	SPMD/DS-2	**OR** Programming, Data Structures and Algorithms in Python
2.	SPMD/DS-3	Introduction to Data Analytics
	SPMD/DS-4	**OR** Data Science for Engineers
3.	SPMD/DS-5	Programming, Data Structures and Algorithms in Python
	SPMD/DS-6	**OR** Python for Data Science
4.	SPMD/DS-7	Introduction to Machine Learning
5.	SPMD/DS-8	Deep Learning
	SPMD/DS-9	**OR** Deep Learning for Computer Vision
6.	SPMD/DS-10	Reinforcement Learning
7.	SPMD/DS-11	Artificial Intelligence : Search Methods For Problem solving
	SPMD/DS-12	**OR** An Introduction to Artificial Intelligence
8.	SPMD/DS-13	Artificial Intelligence: Knowledge Representation and Reasoning
9.	SPMD/DS-14	Computer Vision
10.	SPMD/DS-15	Natural Language Processing
	SPMD/DS-16	**OR** Applied Natural Language Processing
11.	SPMD/DS-17	Practical Machine Learning with Tensorflow
12.	SPMD/DS-18	Learning Analytics Tools
13.	SPMD-1	Design Thinking – A Primer
14.	SPMD-2	Ethics in Engineering Practice

Table 6: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Cyber Security

Cyber Security (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/CS-1	Cryptography And Network Security
2.	SPMD/CS-2	Ethical Hacking
3.	SPMD/CS-3	Information Security – 5 – Secure Systems Engineering
4.	SPMD/CS-4	Privacy and Security in Online Social Media
5.	SPMD/CS-5	Information Theory and Coding
6.	SPMD/CS-6	Introduction to Information Security
7.	SPMD/CS-7	Introduction to Cryptology
8.	SPMD/CS-8	Computational Number Theory & Cryptography
9.	SPMD/CS-9	Hardware Security
10.	SPMD/CS-10	Internetwork Security
11.	SPMD/CS-11	Introduction to Machine Learning
12.	SPMD/CS-12	Introduction to Internet of Things
13.	SPMD-1	Design Thinking – A Primer
14.	SPMD-2	Ethics in Engineering Practice

Table 7: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in 3D Printing

3D Printing (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/3D-1	Rapid Manufacturing
2.	SPMD/3D-2	Electronics Equipment Integration and Prototype Building
3.	SPMD/3D-3	Product Design and Development
4.	SPMD/3D-4	The Future of Manufacturing Business: Role of Additive Manufacturing
5.	SPMD/3D-5	Functional and Conceptual Design
6.	SPMD/3D-6	Introduction to Polymer Science
7.	SPMD/3D-7	Innovation by Design
8.	SPMD/3D-8	Design, Technology and Innovation
9.	SPMD-1	Design Thinking – A Primer
10.	SPMD-2	Ethics in Engineering Practice

Table 8: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Electric Vehicles

Electric Vehicles (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/EV-1	Fundamentals of Electric Vehicles: Technology & Economics
2.	SPMD/EV-2	Fundamentals of Electrical Engineering
3.	SPMD/EV-3	Electrical Machines
4.	SPMD/EV-4	Physics of Materials
	SPMD/EV-5	**OR** Powder Metallurgy
5.	SPMD/EV-6	Introduction to CFD
6.	SPMD/EV-7	Structural Analysis of Nanomaterials
7.	SPMD/EV-8	Ecology and Environment
8.	SPMD/EV-9	Dynamic Behavior of Materials
9.	SPMD/EV-10	Welding of Advanced High Strength Steels for Automotive Applications
10.	SPMD/EV-11	Dynamical System and Control
11.	SPMD-1	Design Thinking - A Primer
12.	SPMD-2	Ethics in Engineering Practice

Table 9: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Energy Engineering

Energy Engineering (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/EE-1	Fundamentals of Conduction and Radiation
	SPMD/EE-2	**OR** Fundamentals of Convective Heat Transfer
2.	SPMD/EE-3	Energy Conservation and Waste Heat Recovery
3.	SPMD/EE-4	Ecology and Environment
4.	SPMD/EE-5	Energy Economics and Policy
5.	SPMD/EE-6	Bioenergy
	SPMD/EE-7	**OR** Waste to Energy Conversion
6.	SPMD/EE-8	Non-Conventional Energy Resources
	SPMD/EE-9	**OR** Technologies for Clean and Renewable Energy Production
7.	SPMD/EE-10	Selection of Nanomaterials for Energy Harvesting and Storage Application
8.	SPMD/EE-11	Solar Energy Engineering and Technology
9.	SPMD-1	Design Thinking - A Primer
10.	SPMD-2	Ethics in Engineering Practice

Table 10: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Mechatronics

Mechatronics (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/ME-1	Power Electronics
2.	SPMD/ME-2	Semiconductor Optoelectronics
	SPMD/ME-3	**OR** Semiconductor Devices and Circuits
3.	SPMD/ME-4	Digital Circuits
4.	SPMD/ME-5	Analog Electronic Circuits
5.	SPMD/ME-6	Control Systems
	SPMD/ME-7	**OR** Control Engineering
6.	SPMD/ME-8	Introduction to Internet of Things
7.	SPMD/ME-9	Introduction to Fuzzy Set Theory, Arithmetic and Logic
	SPMD/ME-10	**OR** Switching Circuits and Logic Design
8.	SPMD/ME-11	Microcontrollers and Applications
9.	SPMD/ME-12	Introduction to Embedded System Design
10.	SPMD/ME-13	Introduction to Robotic
11.	SPMD/ME-14	Optical Fiber Sensors
12.	SPMD/ME-15	Automation in Manufacturing
13.	SPMD-1	Design Thinking - A Primer
14.	SPMD-2	Ethics in Engineering Practice

Table 11: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Computer Science and Biology

<table>
<tr><th colspan="3">Computer Science and Biology
(Minimum credits to be earned are EIGHTEEN-TWENTY)</th></tr>
<tr><td colspan="3">Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.</td></tr>
<tr><th>Sr. No.</th><th>Code</th><th>Subject Nomenclature</th></tr>
<tr><td>1.</td><td>SPMD/CB-1</td><td>Computational Systems Biology</td></tr>
<tr><td>2.</td><td>SPMD/CB-2</td><td>Introduction to Database Systems</td></tr>
<tr><td rowspan="2">3.</td><td>SPMD/CB-3</td><td>Introduction to Artificial Intelligence</td></tr>
<tr><td>SPMD/CB-4</td><td>OR
Artificial Intelligence Search Methods for Problem Solving</td></tr>
<tr><td>4.</td><td>SPMD/CB-5</td><td>Image Signal Processing</td></tr>
<tr><td>5.</td><td>SPMD/CB-6</td><td>Introduction to Internet of Things</td></tr>
<tr><td rowspan="2">6.</td><td>SPMD/CB-7</td><td>Introduction to Computer Graphics</td></tr>
<tr><td>SPMD/CB-8</td><td>OR
Computer Graphics</td></tr>
<tr><td>7.</td><td>SPMD/CB-9</td><td>MATLAB Programming for Numerical Computation</td></tr>
<tr><td>8.</td><td>SPMD/CB-10</td><td>Programming, Data Structures and Algorithms in Python</td></tr>
<tr><td>9.</td><td>SPMD/CB-11</td><td>Introduction to Machine Learning</td></tr>
<tr><td>10.</td><td>SPMD/CB-12</td><td>Data Mining</td></tr>
<tr><td>11.</td><td>SPMD/CB-13</td><td>Introduction to Dynamical Models in Biology</td></tr>
<tr><td>12.</td><td>SPMD/CB-14</td><td>Biometrics</td></tr>
<tr><td>13.</td><td>SPMD/CB-15</td><td>BioInformatics: Algorithms and Applications</td></tr>
<tr><td>14.</td><td>SPMD/CB-16</td><td>Introduction to Proteogenomics</td></tr>
<tr><td>15.</td><td>SPMD/CB-17</td><td>Foundations of Cryptography</td></tr>
<tr><td>16.</td><td>SPMD/CB-18</td><td>Modern Application Development</td></tr>
<tr><td>17.</td><td>SPMD/CB-19</td><td>Ethical Hacking</td></tr>
<tr><td>18.</td><td>SPMD/CB-20</td><td>Computer Aided Drug Design</td></tr>
<tr><td>19.</td><td>SPMD/CB-21</td><td>Functional Genomics</td></tr>
<tr><td>20.</td><td>SPMD-1</td><td>Design Thinking - A Primer</td></tr>
<tr><td>21.</td><td>SPMD-2</td><td>Ethics in Engineering Practice</td></tr>
</table>

Table 12: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Drug Engineering

Drug Engineering (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/DE-1	Drug Delivery: Principles and Engineering
2.	SPMD/DE-2	Experimental Biotechnology
3.	SPMD/DE-3	Spectroscopic Techniques for Pharmaceutical and Biopharmaceutical Industries
4.	SPMD/DE-4	Environmental Quality Monitoring & Analysis
5.	SPMD/DE-5	Computer Aided Drug Design
6.	SPMD/DE-6	Current Regulatory Requirements for Conducting Clinical Trials in India for Investigational New Drugs/New Drug
7.	SPMD/DE-7	Introduction to Dynamical Models in Biology
8.	SPMD/DE-8	Medical Biomaterials
9.	SPMD/DE-9	Metals in Biology
10.	SPMD/DE-10	Gene Therapy
11.	SPMD/DE-11	Introduction to Cardiovascular Fluid Mechanics
12.	SPMD/DE-12	Optical Sensors
13.	SPMD/DE-13	Nano Structured Materials- Synthesis, Properties, Self-assembly and Applications
14.	SPMD/DE-14	Transport Phenomena in Biological Systems
15.	SPMD/DE-15	Aspects of Biochemical Engineering
16.	SPMD/DE-16	Process Control Design, Analysis and Assessment
17.	SPMD/DE-17	Industrial Biotechnology
18.	SPMD/DE-18	Interactomics
19.	SPMD/DE-19	Health Research Fundamentals
20.	SPMD/DE-20	Computational Systems Biology
21.	SPMD/DE-21	Human Molecular Genetics
22.	SPMD-1	Design Thinking - A Primer
23.	SPMD-2	Ethics in Engineering Practice

Table 13: List of elective subjects for acquiring additional 18-20 credits for B.Tech (Hons.) with Specialization/Minor Degree in Genome Engineering & Technology

Genome Engineering & Technology (Minimum credits to be earned are EIGHTEEN-TWENTY)		
Note: Credit of the subject/s which are counted for earning 160 credits of the degree will not be counted for acquiring Hons. with Specialization/Minor Degree.		
Sr. No.	**Code**	**Subject Nomenclature**
1.	SPMD/GE-1	Introduction to Proteogenomics
2.	SPMD/GE-2	Interactomics: Basics & Applications
3.	SPMD/GE-3	Drug Delivery: Principles and Engineering
4.	SPMD/GE-4	Experimental Biotechnology
5.	SPMD/GE-5	Bioengineering: An Interface with Biology and Medicine
6.	SPMD/GE-6	Functional Genomics
7.	SPMD/GE-7	Protein and Gel Based Proteomics
8.	SPMD/GE-8	Cell Culture Technologies
9.	SPMD/GE-9	Tissue Engineering
10.	SPMD/GE-10	Biomedical Nanotechnology
11.	SPMD/GE-11	Introductory Mathematical Methods for Biologists
12.	SPMD/GE-12	Nanotechnology in Agriculture
13.	SPMD/GE-13	Introduction to Proteomics
14.	SPMD/GE-14	Applications of Interactomics using Genomics and Proteomics Technologies
15.	SPMD/GE-15	Transport Phenomena in Biological Systems
16.	SPMD/GE-16	Proteomics and Genomics
17.	SPMD/GE-17	Medical Biomaterials
18.	SPMD/GE-18	Theromodynamics for Biological Systems: Classical and Statistical Aspect
19.	SPMD/GE-19	Mass Spectrometry Based Proteomics
20.	SPMD/GE-20	Advanced Clinical Proteomics
21.	SPMD/GE-21	Application of Spectroscopic Methods in Molecular Structure Determination
22.	SPMD/GE-22	Gene Therapy
23.	SPMD-1	Design Thinking - A Primer
24.	SPMD-2	Ethics in Engineering Practice

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Guidelines to implement the MOOCs/ SWAYAM online courses in the Institute

In pursuance to the Gazette Notification No. 295 dated 19th July 2016 of University Grants Commission notifying the "UGC (Credit Framework for Online Learning Courses through SWAYAM) Regulations, 2016" for adoption of MOOCs (Massive Open Online Courses) through SWAYAM (Study Web of Active Learning by Young and Aspiring Mind) platform, UIET, KUK has framed the following guidelines for implementation of Online courses in all the Institute:

1. These guidelines shall be called the "Guidelines to implement the SWAYAM/ MOOCs/ other authorized online courses (OAOC), in the Institute".

2. These guidelines shall apply to the transfer of credits of such students who are enrolled as students in any of the department of the Institute.

3. These shall come into force from the date of approval of the Academic Council of the Institute/University.

4. The procedure for adopting Online Learning Courses:

4.1 The Principal Investigator (PI), a Subject Matter Expert entrusted by the National MOOCs Coordinator (NMC) or equivalent agency, will offer the online learning courses for the forthcoming Semester through an institution (called Host Institution). The courses will be made available through the online portal twice a year (for odd semester and even semester).

4.2 Once the list of online learning courses to be offered in the forthcoming Semester is available on SWAYAM/NPTEL (National Programme on Technology Enhanced Learning)/ Authorized Portal Offering Online Courses (APOOC), Head/Faculty Incharge of the Department shall notify a list of courses from SWAYAM/NPTEL portal/APOOC keeping in view the academic requirements of students, subject to the approval of Academic Council of the Institute/University.

4.3 The Head/Faculty Incharge of the Department will recommend the courses of SWAYAM/NPTEL/OAOC to the Authorities of the Institute/University, if:

4.3.1 There is non-availability of suitable teaching staff or running a course in the department.

4.3.2 The facilities for offering the elective papers (courses), sought for by the students are not on offer in the department, but are available on the SWAYAM/NPTEL/APOOC platform.

4.3.3 The courses offered on SWAYAM/NPTEL/APOOC would supplement the teaching-learning process in the department.

4.4 The Head/Faculty Incharge of the Department shall ensure that the physical facilities like laboratories, computer facilities, library etc., as essential for pursuing the courses, are available inadequate measure.

4.5 Every student is required to register for and complete (minimum) one course out of those offered by the department and pay for the certification registration fee on the online platform of the portal meant for it.

4.6 The constituent college/school must designate an Online Course Coordinator (OCC) in the respective department along with a relevant course faculty (for each SWAYAM/NPTEL/OAOC course) who will be responsible to guide the students throughout the course and to facilitate/conduct the Lab/Practical sessions/examinations. The OCC will monitor compliance of these guidelines, keeping the Head/Faculty Incharge apprised of the progress, time to time, and also collect relevant documents from each online course faculty for record purposes, at the end of a course.

5. Evaluation and Certification of SWAYAM/MOOCs/Online courses:

5.1 The Host Institution and the PI shall be responsible for evaluating the students registered for the MOOCs course launched by him/her.

5.2 The evaluation done by the Host Institution shall be based on predefined norms and parameters and shall be on a comprehensive evaluation throughout the length and breadth of course based on specified instruments like discussions, forums, quizzes, assignments, sessional examinations and final examination.

5.3 The examination for certification may be in online mode or a pen & paper mode as decided by PI and Host Institution. This shall be announced by the PI/Host Institution in the overview of the Course at the time it is offered.

5.4 In case, a pen and paper final examination is to be conducted, the same shall be offered through any college/school volunteering to conduct the same. The decision in this respect will be of the PI and the Host Institution.

5.5 After conduct of the examination and completion of the evaluation, the PI through the Host Institution shall award marks/grade as per the evaluation scheme announced.

5.6 The final marks/grade shall be communicated to the students as well as the department/Institute/University generally within four weeks from the date of completion of the final examination.

5.7 The concerned department shall forward the marks/grade to the Office of the Controller of Examinations to incorporate into mark sheet/grade card of the students.

5.8 The Office of the Controller of Examinations shall give the equivalent credit weightage to the students for the credits earned through online learning courses (not more than 20% of courses in any semester). In case the completed course has been selected by the student towards the grant of Minor degree/Hons. in a particular Emerging Area offered by the Institute, it should clearly be specified by the student and verified and communicated to the Office of the Controller of Examinations by the Heads/ Faculty Incharge.

5.9 These marks/grade will be reflected on the student's mark sheet/grade card and may be counted for final award of the degree by the University.

5.10 The courses in which Lab/Practical Component is involved, the concerned department shall evaluate the students for the practical/lab component and the marks/grade obtained by the students be forwarded to the Office of the Controller of Examinations for incorporation into marks sheet/grade card.

5.11 The PI through its Host Institution will send to Department/Institute/University Certificate(s) in respect of all those students who would have successfully completed the MOOCs course. Heads/Faculty Incharge of the concerned department will ensure the award of these certificates to the concerned students.