B.Tech. Biotechnology
Kurukshetra University, Kurukshetra
Scheme of Exams w.e.f. session 2025-2026
SEMESTER-III

S. No.	Course No./ Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of exam (Hours)
						End Semester Exam	Internal assessment	Practical Exam	Total	
1	B24-BTT-201	Biochemistry	3:0:0	3	3	70	30	--	100	3
2	B24- BTT -203	Microbiology	3:0:0	3	3	70	30	--	100	3
3	B24- BTT -205	Molecular Biology	3:0:0	3	3	70	30	--	100	3
4	B24- BTT -207	Green biotechnology and Pollution Abatement	3:0:0	3	3	70	30	--	100	3
5	B24-BTT-209	Genetics and Cell Biology	3:0:0	3	3	70	30	_	100	3
6	B24- BTT -211	Green biotechnology and Pollution Abatement Lab	0:0:3	3	1.5	--	40	60	100	3
7	B24- BTT -213	Molecular Biology Lab	0:0:3	3	1.5	--	40	60	100	3
8	B24- BTT -215	Microbiology Lab	0:0:3	3	1.5	--	40	60	100	3
9	B24- BTT -217	Biochemistry Lab	0:0:3	3	1.5	--	40	60	100	3
10	B24-MAC-201	Environmental Studies	3:0:0	3	1	70	30	--	100	3
11	B24- BTT -219	Seminar	0:0:1	1	0.5	--	100	--	100	---
TOTAL				**31**	**22.5**	**420**	**440**	**240**	**1100**	

B.Tech. Biotechnology
Kurukshetra University, Kurukshetra
Scheme of Exams w.e.f. session 2025-2026
SEMESTER-IV

S. No.	Course No./ Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of exam (Hours)
						End Semester Exam	Internal assessment	Practical Exam	Total	
1	B24-BTT -202	Bioprocess Engineering	3:0:0	3	3	70	30	--	100	3
2	B24- BTT -204	Structural Biology	3:0:0	3	3	70	30	--	100	3
3	B24- BTT-206	Immunology and Diagnostic Techniques	3:0:0	3	3	70	30	--	100	3
4	B24- BTT-208	Recombinant DNA Technology	3:0:0	3	3	70	30	--	100	3
5	B24- BTT-212	Bioprocess Engineering Lab	0:0:3	3	1.5	--	40	60	100	3
6	B24-BTT-214	Immunology and Diagnostic Techniques Lab	0:0:3	3	1.5	--	40	60	100	3
7	B24- BTT-216	Recombinant DNA Technology Lab	0:0:3	3	1.5		40	60	100	3
8	B24- MAC-202	Essence of Indian Traditional Knowledge	2:0:0	2	1	--	100	--	100	3
9	B24- HSM-202	Innovation, Start-up and Entrepreneurship	3:0:0	3	3	70	30	--	100	3
TOTAL				**26**	**20.5**	**350**	**370**	**180**	**900**	

Note: All students have to undertake the industrial training for 6 to 8 weeks after 4th semester which will be evaluated in 5th semester.

B24-BTT-201	Biochemistry (B.Tech Biotechnology) Semester-III						
Lecture	**Tutorial**	**Practical**	**Credit**	**End semester Exam**	**Internal Assessment**	**Total**	**Time**
3	**-**	**-**	**3**	**70**	**30**	**100**	**3 Hrs.**
Purpose	**To introduce the students with basics of Biochemistry**						

Course Outcomes	
CO1	**The students will be able to learn the structure and functions of carbohydrates and proteins**
CO2	**The students will be able to learn structure and functions of lipid and nucleic acids along with basic concepts of enzymes.**
CO3	**The students will be able to write major pathways of carbohydrates and lipid metabolism**
CO4	**The students will be able to write the process of urea cycle and mitochondrial oxidative phosphorylation.**

UNIT-I

1. **Amino acids** : Introduction, classification of amino acids, peptide bond important peptides. Industrial applications of amino acids.
2. **Proteins** classification based on their biological roles. Forces stabilizing protein structure and shape. Different levels of structural organization of proteins. Ramachandran plot, alpha helix, beta plated sheets, domain motif and fold. Protein folding.
3. **Carbohydrates-Structure and functions:** Structures and properties of glucose and fructose, distinguishing features of different disaccharides. Ring structure and mutarotation. Structure and brief introduction of starch, glycogen and cellulose.

UNIT-II

4. **Lipids-Structure and functions:** Classification of lipids based on their biological roles and their general functions. Membrane lipids and brief discussion on fatty acids.
5. **Nucleic Acids-Structure and functions:** Structure and properties of purine and pyrimidine bases. A brief introduction of ATP, GTP, CTP and UTP.
6. **Enzymes:** Classification of Enzymes according to enzyme commission report. Activation energy and rate of reaction. Rate constant, reaction order. A brief introduction of mechanism of enzyme catalysis. Enzyme inhibition and concept of allostery. Michaelis- Menten equation.

UNIT-III

7. **Carbohydrate Metabolism:** Glycolysis and TCA cycle. Pentose phosphate pathway and its significance. Gluconeogenesis pathway. Glycogenolysis, glycogenesis and control of glycogen metabolism.
8. **Lipid Metabolism:** Beta -oxidation of saturated fatty acids, Degradation of triacylglycerols by lipases. Biosynthesis of saturated fatty acids. Biosynthesis of triacylglycerols, phospholipids.

UNIT -IV

9 Amino Acid Metabolism: General reactions of amino acids metabolism- transamination, oxidative and non-oxidative deamination and decarboxylation. Urea cycle and its regulations.

10. Nucleic Acid Metabolism: Catabolism, *de novo*-biosynthesis .

11. Mitochondrial oxidative phosphorylation: Mitochondrial electron transport chain. Hypotheses of mitochondrial oxidative phosphorylation.

Text

1. Biochemistry, concepts and connections, 1st edition, by Dean R. Appling, Spencer J. Anthony-Cahill and Christopher K. Matthews (2015). Pearson Education, Inc.

2. Biochemistry, 4th edition, by L. Stryer (1995). W.H. Freeman & Co. NY

3. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers

References Books:

1. Biochemistry, 4th edition, by G. Zubay (1998). Wm.C. Brown Publishers.

2. 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.

3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999) . Saunders college Publishing, NY. Sons, NY.

4. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999) , John Wiley & Sons, NY

5. Harper's Biochemistry, 25th edition, by R.K. Murray, P.A. Hayes, D.K. Granner, P.A. Mayes and V.W. Rodwell (2000). Prentice Hall International.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

B24- BTT -203	MICROBIOLOGY (B.Tech. Biotechnology Semester III)						
Lecture	**Tutorial**	**Practical**	**Credit**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time**
3	**-**	**-**	**3**	**70**	**30**	**100**	**3 Hrs.**
Purpose	**The course provides the students both conceptual and experimental background in the broad discipline of microbiology**						

Course outcome	
CO1	**Student to learn the history and classification of microbiology**
CO2	**The students will be introduced to microbial diversity and various microbiological techniques**
CO3	**Emphasis has been laid on bacterial growth, nutrition, control, metabolism and Genetics.**
CO4	**Course also introduces the students to the Microbial ecology and relevance of microbes in the field of medicine, agriculture and industry.**

UNIT – I

Introduction to Microbiology: History and Various branches of microbiology, Organization of Prokaryotic and Eukaryotic Cell Structure and Function, Viruses.

Classification of Microorganisms: Microbial Taxonomy- Criteria used including molecular approaches. Current classification of bacteria.

UNIT – II

Diversity of Microbial World: Microbial Evolution, Microbial Diversity.

Control of Microbial Growth: Effect of heat, sterilization, disinfectants, therapeutic agents, antimicrobial resistance, purification and preservation of microbes.

Microbial Nutrition and Growth: Types of growth media, growth phases, culture methods,

UNIT – III

Microbial Metabolism: Aerobic & anaerobic respiration, fermentation, Entner Duodruffs pathway, photosynthesis, nitrogen fixation

Microbial Molecular Biology and Genetics: Genome and gene structure, Replication, Expression, Regulation of gene expression (operon system), transformation conjugation and transduction

UNIT - IV

Microbial Ecology: Microbes from marine, freshwater and terrestrial environments, Microbial Interactions (Symbiotic, non-symbiotic), Pathogenic microbes

Application of Microbiology: Role of Microbes in agriculture, public health, medicine and industry

Text Books/References:

1. Prescott's Microbiology by Willey, Sherwood and Woolverton.
2. Brock Biology of Microorganisms by Madigan, Martinko, Stahl and Clark.
3. General Microbiology by Stanier, Ingraham, Wheelis and Painter.
4. Microbiology, M. Pelczar, E. Chan, N. Kreig, 5th ed, MGH.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

B24-BTT-205	Molecular Biology (B. Tech. Biotechnology Semester III)						
Lecture	**Tutorial**	**Practical**	**Credit**	**End semester Exam**	**Internal Assessment**	**Total**	**Time**
3	0	**0**	**3**	**70**	**30**	**100**	**3 Hrs**
Purpose	**To understand the basics of molecular biology**						
Course Outcomes							
CO 1	**To learn about genetic material and replication process.**						
CO 2	**To learn about the process of transcription and gene expression.**						
CO 3	**To learn about process of splicing.**						
CO 4	**To know about the next step of transfer of genetic information by translation process**						

UNIT- I

1. **Genes :** DNA/RNA as the genetic material. Double helical structure of DNA.Types of DNA.Super coiling and periodicity of DNA.Linking number of DNA. Euchromatin and heterochromatin.
2. **From Genes to Genomes :** Exons and introns, repetitive and non –repetitive DNA, C-value paradox.
3. **DNA Replication :**Origin of DNA replication. Bacterial and eukaryotic replicons. DNA polymerases. Mechanism and regulation of DNA replication in prokaryotes and eukaryotes.

UNIT - II

4. **Transcription:** Various RNA species and their properties- tRNA as an adapter and turnover of mRNA.
5. **Transcription in Prokaryotes:** RNA polymerases. Mechanism of transcription- initiation, elongation and termination.Role of sigma factor in transcription.
6. **Transcription in Eukaryotes:** RNA Polymerases. Downstream and upstream promoters.. Mechanism of transcription. Interaction of upstream factors with basal apparatus. Post-transcriptional modifications of various RNA species (mRNA, rRNA, tRNA).

UNIT III

7. **Nuclear Splicing :**Lariat formation Sn RNAs group I & II introns cis-splicing and trans-splicing reactions. Catalytic RNA- Ribozymes- Ribonuclease .
8. **Control of transcription**: Operon concept Positive and negative control lac trp operon repressor-inducer complex, catabolite repression and attenuation.

UNIT - IV

9. **Genetic Code:** Evidence for triplet code. Properties of genetic code, Wobble hypothesis.
10. **Protein Synthesis :** Structure of prokaryotic and eukaryotic ribosomes and their role in protein synthesis. Mechanism of initiation, elongation and termination of protein synthesis. Regulation of translation in prokaryotes and eukaryotes. Post translational modifications of proteins.
11. **Protein folding:** Role of molecular chaperones.

Text/Reference Books :

1. Genes XI Lewin, Benjamin(2013)OUP, Oxford.
2. Genomes,2nded, Brown, T. A.(2002) John Wiley and sons ,Oxford
3. Molecular biology of cell 4thed Alberts, Bruce; Watson,J D(2002) Garland Science Publishing, New York.
4. Molecular cell biology 4th edLodish, Harvey and. Baltimore,D(2000) W.H. Freeman and Co., New York
5. Cell and Molecular Biology 8th ed, Robertis, EDP De &Robertis, EMF De(2002) lippincott Williams & Wilkins international student edition, Philadelphia.
6. Essentials of Molecular Biology 4th ed, Malacinski, G. M. (2003) Jones &Bartlet Publishers, Boston
7. Cell and Molecular Biology: concepts and experiments 3rd ed Karp, Gerald(2002) John Wiley and sons, New York.
8. The Cell-a molecular approach, 3rd ed Cooper, G M&Hausman, R E(2004) ASM Press, Washington D C

B24- BTT -207	Green Biotechnology and Pollution Abatement (B. Tech. Biotechnology Semester III)						
Lecture	Tutorial	Practical	Credits	End Sem. Exam	Internal assessment	Total	Time
3	-	-	3	70	30	100	3 Hrs
Purpose	To familiarize the students with fundamentals of Green Biotechnology and Pollution Abatement.						
Course Outcomes							
CO 1	Students will learn principles and different methods for waste water treatment and solid waste management						
CO 2	Students will understand novel biotechnological methods for degradation of xenobiotics and recalcitrant compounds						
CO 3	Students will know how biotechnology can help in removal of the pollutants from soil and waste water using bioremediation and phytoremediation.						
CO 4	Developing an understanding of new trends of developing ecofriendly biproducts such as biopesticides, biofuels, renewable energy sources.						

Unit I

Classification and Characterization of waste: Physicochemical Characteristics of waste. Waste material suitable for biological treatment : Biological Waste Treatment : Solid waste management: landfills, recycling and processing .

Unit II

Biodegradation of Hydrocarbons, Xenobiotic and Recalcitrant Compounds: Xenobiotic compounds–Definition and examples. Recalcitrant Compounds- Definition and examples. Biodegradation- Introduction, effect of chemical structure on biodegradation, co metabolism . Factors affecting biodegradation, microbial degradation of hydrocarbons.

Unit III

Bioremediation and Introduction and types of bioremediation, In situ and Ex-situ technologies, Bioaugmentation, Biostimulation; Phytoremediation- Introduction and Types of phytoremediation; Advantages and limitations of bioremediation; Biorestoration: reforestation through micropropagation.

Unit IV

Eco-Friendly Bioproducts and Processes: Basic concepts and prospects of biofuel production: bioethanol, biohydrogen and biodiesel; Biogas , biofertilizers and biopesticides. Fundamentals of composting and vermicomposting process. Use of mycorrhizae and microbes for improving soil fertility. Organic Farming. Biotechnology in Environment Protection: Current status of biotechnology in environment protection and its future.

Text Books/Reference Books:

1. **Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications**
2. **Introduction to Wastewater Treatment- R. S. Ramalho, Academic Press.**
3. **Elements of Water Pollution Control Engineering – O.P. Gupta, Khannabooks.**
4. **Energy Technology- O.P. Gupta, Khannabooks, 2018**
5. **Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.**
6. **Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.**
7. **Environmental Biotech- Pradipta Krimar, I.K. International Pvt. Ltd., 2006.**
8. **Environmental Microbiology & Biotechnology- D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.**
9. **Biodegradation and Bioremediation 1999 (2nd edition). Martin Alexander, Elsevier Science & Technology.**
10. **Environmental Biotechnology by Bruce Rittmann and Perry McCarty.**

B24-BTT-209	Genetics and Cell Biology (B. Tech. Biotechnology Semester III)						
Lecture	**Tutorial**	**Practical**	**Credit**	**End semester Exam**	**Internal Assessment**	**Total**	**Time**
3	**-**	**-**	**3**	**70**	**30**	**100**	**3 Hrs**
Purpose	**To familiarize the students with fundamentals of genetics and cell biology.**						
Course Outcomes							
CO 1	**To understand the basis of Mendelian inheritance along-with exceptions to this pattern of inheritance.**						
CO 2	**To learn structural and molecular mechanism of gene aberrations and gene mapping using variable methods.**						
CO 3	**Students will acquire knowledge of organizational and functional aspects of cell.**						
CO 4	**Able to learn interaction of cells with outside environment through exchange of information and transport of molecules.**						

UNIT I

1. **Mendelian inheritance and its exceptions**; History of genetics, Reproduction as basis of heredity, Mendelian principal of genetics, Co-dominance (Blood group system), incomplete and complete dominance. Multiple alleles (skin color in Rabbits).Linkage phenomenon, types and detection.

2. **Polygenic Inheritance:** Nelsson- Ehle experiment, Yule experiment, Skin color in human beings, Numerical problems on Mendelian and polygenic inheritance.

UNIT II

3. **Basic inheritance linked to sex chromosomes:** Sex limited, Sex Influenced and Sex Linked inheritance patterns, Sex Determination, Chromosomal Theory of inheritance, Pedigree analysis, Lethality Concept.

4. **Genome Mapping**: Physical mapping, Genetic mapping, Chromosomal mapping, Two point cross (*Neurospora crassa*) to map genes, Three point test cross mapping, Somatic cell hybrid for mapping, Human Genome project. Mapping in Prokaryotes and Eukaryotes.

UNIT-III

5. **Cell Division**: Mitosis, Meiosis, Phases of cell division. Cell cycle regulation along with checkpoints, Intracellular trafficking and cell death via apoptosis.

6. **Cell Signaling:** -Cell-cell interactions, Cell Receptors, Ligands and Trans-membrane signaling, Signal Transduction Pathways.

UNIT IV

7. **Mutations:** Introduction, types of mutation, application of mutations, Different modes of introducing mutations via mutagens, DNA Repair Mechanism (Photoreactivation, Mismatch repair).

8. Problem Solving: Numericals on Mendelian inheritance, Co dominance, Linkage, Pedigree analysis, Gene mapping via two point and three point test cross, Polygenic inheritance and gene and genotype frequency calculations.

Text Books:

1. Concepts of Genetics: Klug, W.S. and Cumming, M.R., Pearson Education, Inc.
2. Principles of Genetics by Snustad, S. John Willey& sons Inc Hoboken,2003.
3. Molecular Biology of the cell: Bruce A., Alexander J., Julian L., Martin R., Keith R., Peter W.; 6th edition, New York: Garland Science, 2008.
4. Cell and Molecular Biology-Concepts and Experiments, Gerald Karp et al., John Wiley, 8th Edition,2015.

Reference Books:

1. Fundamental of Genetics, Singh, B. D., Kalyani Publishers, New Delhi.
2. Basic Genetics.(2004),Miglani,G.S.,Narosa Publishing House, New Delhi.
3. Cell Biology:Organelle structure and Functions, Sadava, D.E., (2004), Panima Publications, New Delhi.

B24- BTT -211	Green Biotechnology and Pollution Abatement LAB (B.Tech. Biotechnology Semester III)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**Practical Exam**	**Total**	**Time**
-	**-**	**3**	**1.5**	**40**	**60**	**100**	**3 Hrs**
Purpose	**To learn the practical aspects of Green biotechnology and Pollution Abatement**						
Course Outcomes							
CO1	**Students will learn to test water samples**						
CO2	**Students will learn to test polluted soil samples**						
CO3	**Students will learn the technique of isolation of bacteria from contaminated soil**						
CO4	**Students will explore the vermicomposting , biogas and organic farming plant**						

Laboratory Experiments:

1. Qualitative analysis of water/waste water/soil:
2. Bacterial analysis of water samples.
3. Determination of hardness, alkalinity, Electrical conductivity.
4. Determination of soluble phosphates. chlorides and pH In water samples.
5. Determination of BOD and DO contents.
6. Decolourization of industrially important dyes from waste water with help of resistant microbes.
7. Isolation of resistant microbes from contaminated soil.
8. Effect of temperature and pH on activity of microbes used for bioremediation.
9. Visit to Vermicomposting and Biogas Plant .

Text Books:

1. Microbiology- A laboratory manual. 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.

2. Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W.(1995) Academic Press, New York.

Reference Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. Aneja, K.R. (2003) Age International Publishers, New Delhi**.**

2. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

B24-BTT-213	MOLECULAR BIOLOGY LAB (B.Tech Biotechnology Semester III)						
Lecture	Tutorial	Practical	Credit	Internal Assessment	Practical Exam	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the practical aspects of Molecular Biology						
Course Outcomes							
CO1	Students will be able to learn Isolation of DNA from Prokaryotic and Eukaryotic Cells						
CO2	Learning of Gel Electrophoresis for separation of DNA, RNA and Proteins						
CO3	Students will learn the technique of PCR Amplification of Nucleic Acids						
CO4	Students will learn Restriction Mapping of Plasmid DNA						

LABORATORY EXPERIMENTS

1. Isolation of genomic DNA from eukaryotic cells.

2. Isolation of RNA from eukaryotic cells.

3. Isolation of proteins from eukaryotic cells.

4. Isolation of genomic DNA from prokaryotic cells.

5. Gel electrophoretic separation of DNA and molecular wt. determination.

6. Gel electrophoretic separation of RNA.

7. Gel electrophoretic separation of proteins.

8. PCR amplification of DNA: Visualization by gel electrophoresis.

Reference Book:

1. **Molecular Cloning – A laboratory manual: 3rd Edition Vol. 1-3. Sambrook J and Russell D.W. (2001). Cold Spring Harbor laboratory Press, New York.**

B24- BTT -215	MICROBIOLOGY LAB (B.Tech. Biotechnology Semester III)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**Practical Exam**	**Total**	**Time**
0	**0**	**3**	**1.5**	**40**	**60**	**100**	**3 Hrs**
Purpose	**At the end of the course students will be aware about the conspicuous presence of microbes in the environment and their influence in our daily lives as part of food, soil, air environment and disease development.**						
Course Outcomes							
CO1	**Students will be able to operate microscopes and staining methods**						
CO2	**Learning of Culture Media Preparation for Microbial Growth**						
CO3	**Students will learn Pure Culture Techniques for maintenance and preservation of microbes.**						
CO4	**Students will learn various aspects of Biochemical Tests used in Microbial Taxonomy**						

LABORATORY EXPERIMENTS

1. Microbial Good Lab Practices and Biosafety
2. Media preparation and sterilization
3. Microscopic examination of different groups of microorganisms
4. Total count and viable count determination
5. Microbial simple and differential staining methods
6. Isolation of pure culture and its preservation
7. Microbial Growth curve determination
8. Effect of physical and chemical environment on growth
9. Biochemical tests for Microbial identification
10. Antibiotic Sensitivity of Microorganisms

Text Book/ References Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition.Aneja, K.R. (2003), New Age International Publishers, New Delhi**.**

2. Microbiology- a laboratory manual. 4th edition.Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.

3. Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W. (1995) Academic Press, New York.\

B24-BTT-217	BIOCHEMISTRY LAB (B.Tech. Biotechnology) Semester-III						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**Practical Exam**	**Total**	**Time**
-	**-**	**3**	**1.5**	**40**	**60**	**100**	**3 Hrs**
Purpose	**To learn the practical aspects of Biochemistry**						
Course Outcomes							
CO1	**Students will be able to learn qualitative and quantitative estimation of biomolecules.**						
CO2	**Students will be able to learn procedure to perform enzyme assay**						
CO3	**Students will learn technique of paper and thin layer chromatography.**						
CO4	**Students will be able to determined molar extinction coefficient of NADH/NAD**						

LABORATORY EXPERIMENTS

1. Qualitative tests for amino acids, proteins, Lipids and carbohydrates.
2. Quantitative estimation of proteins by Lowry method.
3. Determination of reducing sugar by Nelson-Somogyi's method
4. EnzymeAssay of protease/amylase/peroxidase/catalase.
5. Identification of amino acid by paper chromatography.
6. Determination of Km and Vmax of any commonly occurring enzyme.
7. Identification of sugars by thin layer chromatography.
8. To verify the validity of Beer,s law and determined the molar extinction coefficient of NADH.

Text/ Reference Books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.

2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.

3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill, Book company, UK.

B24-MAC -201	Environmental Studies (B.Tech. Biotechnology Semester III)						
Lecture	**Tutorial**	**Practical**	**Credit**	**End semester Exam**	**Internal Assessment**	**Total**	**Time**
3	**-**	**-**	**1**	**70**	**30**	**100**	**3 Hrs**
Purpose	**To learn the multidisciplinary nature, scope, and importance of Environmental studies.**						
Course Outcomes (CO)							
CO1	**Students will be able to learn the importance of the environment and natural resources.**						
CO2	**To learn the structure and functions of different types of ecosystems and understand the different conservation methods of biodiversity.**						
CO3	**Will be able to understand the types of pollution, the various social issues, and their impacts on the environment.**						
CO4	**The students will be able to understand the relationship between the human population and the environment.**						

UNIT- I

The Multidisciplinary nature of environmental studies: Definition; Scope and importance, Need for public awareness.

Natural resources and associated problems. Forest resources: Use and Over-exploitation, deforestation. Timber extraction, mining, dams, and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Energy resources: Growing energy needs, renewable and non-renewable energy sources, and use of alternate energy sources. Land resources: Land as a resource, land degradation, soil erosion, and desertification. Role of an individual in the conservation of natural resources.

UNIT II

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. Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem**,** Desert ecosystem**,** Aquatic ecosystems.

Biodiversity and its Conservation: Introduction-Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation. 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.

UNIT-III

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. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

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.

Environment Protection Act. 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.

UNIT-IV

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. Role of information Technology in Environment and human health. 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.

Field Work (Practical). 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..

Suggested Books:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.

2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad -380013, India, Email: mapin@icenet. net (R).

3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.

4. Clerk B.S., Marine Pollution, Clanderson Pross Oxford (TB).

5. Cunningham, W.P.Cooper, T.H. Gorhani, E & Hepworth, M.T.2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p.

6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.

7. Down to Earth, Centre for Science and Environment (R).

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

B24-BTT - 219	Presentation Skills (3rd sem.)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal assessment**	**End Sem Exam**	**Total**	**Time**
-	**-**	**1**	**0.5**	**100**	**-**	**100**	**1 Hr.**
Purpose	To learn different aspects of Presentation Skills						
Course Outcomes							
CO1	Students will be able to demonstrate a sound technical knowledge of their selected presentation topic.						
CO2	Students will undertake problem identification, formation and solution.						
CO3	Students will communicate with engineers and the community at large.						
CO4	Students will learn about attributes of a professional engineer.						

- In presentation Skills, a student is expected to do an in depth study in a specialized area by doing literature survey, understanding different aspects of the problem and arriving at a status report in that area. The student is expected to learn investigation methodologies, study relevant research papers, correlate work of various authors/researchers critically, study concepts, techniques, prevailing results etc., analyze it and present a report.
- The grading is done on the basis of the depth of the work done, understanding of the problem, report and presentation by the student concerned.
- **Merits of evaluation**:

1.) Quality of work: Based on: Depth of work done and understanding of the problem. Whether the student has learnt investigation methodologies described above.

2) Quality of presentation: Based on: Whether the student has been able to express his/her understanding of the topic. Whether the student has been able to satisfactorily answer questions of the panel members.

B24-BTT-202	BIOPROCESS ENGINEERING (B.Tech. Biotechnology) Semester -IV						
Lecture	**Tutorial**	**Practical**	**Credit**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time**
3	**-**	**-**	**3**	**70**	**30**	**100**	**3 Hrs.**
Purpose	**To introduce the basics of Bioprocess Engineering to the students for applications in Biotechnology**						
Course Outcomes							
CO1	**Introduce the fundamentals of Bioprocess Engineering**						
CO2	**To make the students aware of the importance of rate kinetics, formulation of culture media and sterilization of process fluid**						
CO3	**To introduce the concept of configuration and different types of bioreactors**						
CO4	**o make aware of the applications of Bioprocess Engineering to non- conventional Biological Systems**						

UNIT-I

1. **Introduction.** History and scope of Bioprocess Engineering. Basic concepts and approaches used in Bioprocess Engineering. Upstream and downstream processing. Bioprocesses and regulatory constraints. Major products of bioprocess engineering.
2. **Basics of Bioprocess Engineering**. Introduction to the fundamentals of heat transfer, mass transfer and diffusion with reference to Bioprocess Engineering. Principles of material and energy balances in a macroscopic view. Concepts of variables, dimensions and units, standard conditions and ideal gases. Concept of unit operations and unit processes.

UNIT-II

3. **Bioreaction Engineering.** Concepts of Rate Law, Zero and first order kinetics. Kinetics of cell growth. Enzyme Kinetics. Substrate utilization and product formation, Structured and unstructured models. Batch, fed- batch and continuous processes. Introduction to various kinds of bioreactors. Basic knowledge of bioreactor instrumentation and process control. Optimization and scale up.

UNIT-III

4. **Media formulation and optimization**. Sterilization of air and media; Methods of purification of fermented products. Basic concepts of filtration, centrifugation and principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC; Extraction, adsorption and drying.

UNIT-IV

5. **Advances in Bioprocess Engineering**. Immobilized cell systems. Solid State Fermentation and its applications. Scale-up and scale down concepts. Fermentation economics. Bioprocess considerations in using plant and animal cell cultures. Use of genetically engineered microorganisms in bioprocess development.

Text Books

1. Shuler. M. L. and Kargi, F. 2017. Bioprocess Engineering-Basic Concepts. 3/e. Prentice Hall India, New Delhi.
2. Doran, P.M. 2013. Bioprocess Engineering Principles. Elsevier.
3. Mukhopadhyay, S. N. 2012. Process Biotechnology- Theory and Practice. The Energy and Research Institute, New Delhi.

B24-BTT-204	Structural Biology (B.Tech Biotechnology Semester IV)						
Lecture	**Tutorial**	**Practical**	**Credit**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time**
3		**-**	**3**	**70**	**30**	**100**	**3**
Purpose	To provide a solid foundation of understanding structural biology						
Course Outcomes	**After completion of course students will be able**						
CO 1	To explain the concepts of protein stucture and sequence alignment						
CO 2	To articulate the concepts of protein crystallization .and associated techniques.						
CO 3	To explain the technique of Cryo Electron Microscopy and X- ray crystallography.						
CO 4	To write the basic concepts of nucleic acid structure and M.D. simulation.						

Unit-I

Protein structural biology: Protein sequences, sequence alignment, hierarchy in protein folds: secondary structure, tertiary structure, quaternary structure. Chaperones assisted protein production, Protein structure and analysis.

Unit-II

Phase diagram and separation, crystallization, Use of robotics in crystallization, symmetry, structure determination; NMR sample preparation, Sample preparation for Cryo EM, Structure validation

Unit-III

Protein fold-function relationships, Protein Data Bank (PDB) and EM Data Bank, Methods for atomic-resolution structure determination: X-ray crystallography, solution- and solid-state NMR spectroscopy, Single particle Cryo Electron Microscopy.

Unit-IV

DNA and RNA structures: DNA and RNA secondary structures (duplex, triplex, quadruplexes and aptamers), RNA secondary structure prediction. Structure of Sugars and lipids Structural dynamics: Dynamics of Protein-RNA complexes; Simulations: Protein functional dynamics, Protein dynamics studies by MD simulations.

Text Books/References:

1. Structure and Mechanism in Protein Science by Alan Feverish.
2. Proteins: Structures and Molecular Properties, by Thomas E. Creighton.
3. RNA Sequence, Structure, and Function: Computational and Bioinformatic Methods by Walter L. Ruzzo, Jan Gorodkin, Springer 2014.
4. Crystallography made crystal clear by Gale Rhodes.
5. NMR of Proteins and Nucleic Acids by Kurt Wüthrich.
6. The Art of Molecular Dynamics Simulation by D. C. Rapaport Cambridge University Press; 2nd edition 2004.

B24-BTT-206	Immunology and Diagnostic Techniques (B.Tech. Biotechnology Semester IV)						
Lecture	**Tutorial**	**Practical**	**Credit**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time**
3	**-**	**-**	**3**	**70**	**30**	**100**	**3 Hrs**
Purpose	**To learn the role of various components of immune system and their response against various diseases**						
Course Outcomes							
CO 1	**The students will be able to learn the basic concepts of cells and organs related to immune system.**						
CO 2	**Able to learn and understand various effector responses of body against an infection**.						
CO 3	**To learn the concepts of various Immunological techniques**						
CO 4	**To learn the immunological reasons behind various diseases with advanced molecular diagnostics**.						

UNIT I

1. **Introduction to Immune System:** Innate and acquired immunity, cells and organs of immune System- B-Lymphocytes and T-Lymphocytes, primary and secondary lymphoid organs, humoral and cell mediated immune response. Antigens. Immunoglobulins-structure and function

UNIT II

2. **Generation of B and T Cell Responses:** Major histocompatibility complex. Antigen Processing and presentation.
3. **Immune Effector Responses:** Cytokines. Complement system

UNIT III

4. **Immunological Techniques:** Immuno-precipitin reactions, agglutination reactions, ELISA, RIA, Immuno-fluorescence, FACS
5. **DNA Dignostics:** Radioactive and non radioactive nucleic acid hybridisation.

UNIT IV

6. **Immune System in Health and Disease:** Hypersensitive reactions. Auto immunity and immune response to infectious diseases. Immune response to transplants. Vaccines
7. **Molecular Diagnosis for Genetic Disorder:** PCR/OLA Procedures for diagnosis heredity disease caused by mutation without affecting restrictions sites. Genotyping with FISH and related techniques. Detection of Mutation.

Text Books:

1. Moloecular Biotechnology: Principles and Applications of Recombinant DNA. 3rd Edition. Glick Bernard R.and Pasternak Jack J. (1998), ASM Press washington DC.
2. Kuby's immunology, 5th Edition. Goldsby, R A., Kindt, T.Jand Osborne B.A.(2003). W. H. Freeman and company, New york..

Reference Books:

1 Essential Immunology, 10th ed Roitt, Ivon; Delves, Peter (2001) Blackwell Scientific Publications Oxford.
2 Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York.
3. Immunology by Presscot.

B24-BTT-208	Recombinant DNA Technology (B.Tech Biotechnology IV Semester)						
Lecture	Tutorial	Practical	Credit	d Semester Exam	Internal Assessment	Total	Time
3	0	-	3	70	30	100	3 Hrs
Purpose	is intended to impart basic undergraduate-level knowledge in the area of recombinant DNA technology						
Course Outcomes							
CO1	The students will learn about different enzymes and vectors						
CO2	The students will learn how to clone a gene and its selection						
CO3	Students will learn about sequencing techniques						
CO4	Student will understand application of all RDNA tools and techniques in biotechnology						

UNIT I

1. **Tools of Recombinant DNA:** DNA modifying enzymes: Methylase, Alkaline phosphatase, Terminal deoxy nucleitidyl transferase, T4 polynucleotide kinase, Restriction endonucleases. Linkers adapters, Blunt end ligation, DNA labelling and detection
2. **Vectors:** Plasmid Bacteriophage Phagemid Cosmid cloning vectors. Vectors for cloning large pieces of DNA. Creating and screening a gene library cDNA library.

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UNIT II

3. **Identification and Isolation of cloned genes:** Selection and screening of cloned genes. Probes to locate clones and related genes Identification and isolation of tissue specific cDNA. Procedures to analyze proteins encoded by cDNA clones.
4. **DNA markers**: RFLP RAPD and DNA fingerprinting.

UNIT III

5. **Chemical synthesis, sequencing and amplification of DNA:** Chemical synthesis of DNA. DNA sequencing techniques. PCR. Analysis of eukaryotic DNA by chromosomal walking. Southern and Northern Blotting. Western Blotting. *In situ* hybridization.

UNIT IV

6. **Application of recombinant DNA in biotechnology:** In medicine and Industry: Production of small biomolecules: vitamin-C, amino acids and indigo. Production of insulin, Human growth hormone, Hepatitis-B virus vaccine. Tailoring antibodies for specific applications. Biopolymers production. Marshalling recombinant DNA to fight AIDS.

Text Books:

1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
2. Molecular Biotechnology: Principles Application of Recombinant *DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.
3. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
4. An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.
5. Genetic Engineering: *An introduction to Gene analysis and exploitation in eukaryotes*. Kingsman and Kingsman (1998) Blackwell Scientific Publication, Oxford.
6. DNA cloning: *A Practical Approach.* Glover and Hames (2001) Oxford University Press.

B24-BTT-212	BIOPROCESS ENGINEERING LAB (B.Tech. Biotechnology) Semester -IV						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**Practical Exam**	**Total**	**Time**
-	**-**	**3**	**1.5**	**40**	**60**	**100**	**3 Hrs.**
Purpose	**To learn the Practical Aspects of Bioprocess Engineering**						
Course Outcomes							
CO1	**Learning of Fermentor and sterilization techniques used in Bioprocessing Lab**						
CO2	**Learning of Isolation, Identification and Preservation of industrially important microorganisms**						
CO3	**Students will learn methods of screening of microbes for various industrially important metabolites**						
CO4	**Students will learn various optimization processes and statistical tools used in fermentation tecbnology**						

LABORATORY EXPERIMENTS

1. Sterilization Techniques (Media, air and water)
2. Study of various fermentors (bioreactors)
3. Isolation, Identification, Preservation and Screening of industrially important microorganisms for primary and secondary metabolite production.
4. Formulation of fermentation media for production of industrially important metabolites by microorganisms.
5. Effect of pH on fermentation processes using microorganisms.
6. Effect of temperature on fermentation processes using microorganisms.
7. Effect of Carbon and nitrogen sources on fermentation processes using microorganisms.
8. Study of statistical tools used in Bioprocess Engineering.

Reference Books:

1. Fermentations & Biochemical Hand Book: Principles, Process Design and Equipment. Vogel, H.C. and Todaro, C. L. Noyes Publication (1996).
2. Microbiology- A Laboratory Manual. Cappuccino and Welsh (2017), 11/e, Pearson.
3. Manual of Industrial Microbiology and Biotechnology. 2/e. Eds. Arnold L. Demain and Julian E. Davies (1999) ASM Press, Washington D.C.

B24-BTT-214	Immunology and Diagnostic Techniques Lab (B.Tech. Biotechnology) Semester -IV						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**Practical Exam**	**Total**	**Time**
-	**-**	**3**	**1.5**	**40**	**60**	**100**	**3 Hrs**
Purpose	**To learn the practical aspects of Immunology**						
Course Outcomes							
CO1	**Students will be able to learn basic techniques in handling laboratory animals.**						
CO2	**Learning of techniques for purification and detection of immunoglobulins.**						
CO3	**tudents will learn the technique of Immunoprecipitation and Agglutination.**						
CO4	**Students will learn the principles of ELISA.**						

LABORATORY EXPERIMENTS

1. Routine techniques in handling laboratory animals: feeding, cleaning and bleeding procedure for mice and rabbit.
2. ABO blood group typing
3. Estimation of heamoglobin in blood sample
4. Detection of antigen/antibody from test sample
5. Purification of immunoglobulins.
6. Immunoprecipitation techniques
7. Agglutination techniques
8. ELISA

Reference Books:

1. Using Antibodies: A Laboratory Manual. Harlow &Lane (1998) Cold Spring Harbor Lab Press.
2. Immunological Techniques Made Easy. Cochet, et al.(1998)Wiley Publishers,Canada.

B24-BTT -216	Recombinant DNA Technology Lab(B. Tech. Biotechnology Semester IV Sem)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**Practical Exam**	**Total**	**Time**
-	**-**	**3**	**1.5**	**40**	**60**	**100**	**3 Hrs**
Purpose	**To learn the experiments of Genetic engineering**						
Course Outcomes							
CO1	**The students will be able to digest, ligate and amplify the DNA**						
CO2	**To learn how to design primers**						
CO3	**The students will be able to digest, ligate and amplify the DNA**						
CO4	**Students will learn Techniques of DNA extraction and its analysis**						

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LIST OF EXPERIMENTS

1. Restriction Digestion of DNA
2. Ligation of desired fragments
3. Restriction mapping
4 .Target selection
5. Primer design
6. Isolation of genomic DNA
7. Gene amplification by PCR
8. Elution of DNA from gel
9. DNA fingerprinting by using molecular marker
10. Extraction of DNA from gel

References Book:

1. Molecular Cloning – A laboratory manual 3rd Edition Vol. 1-3. Sambrook J. and Russell D.W. (2001) Cold Spring Harbor laboratory Press, New York
2. Molecular Biology-Principles and Practices. Singh, N. and Siwach, P. Luxmi Publications, Delhi

B24-MAC-202	Essence of Indian Traditional Knowledge (B.Tech. Biotech. Engineering , Semester IV)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Internal Assessment**	**End Sem, Exam**	**Total**	**Time**
2	**-**	**-**	**1**	**100**	**-**	**100**	**3 Hrs**
Purpose	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system , analyse and apply to their day to day life.						
	Course Outcomes						
CO 1	The students will be able to understand , connect up and explain basics of Indian traditional knowledge in modern scientific perspective						
CO2	The students will be able to understand Holistic Health using Indian Knowledge System						
CO3	The students will be able to Manage thoughts and Emotions , will learn positivity, self regulation and control						
CO4	The students will be able to Achieve Consciousness through Indian Knowledge System						

Unit 1

Introduction to Indian Traditional knowledge: Define traditional knowledge, importance, kinds of traditional knowledge. Philosophical systems, Basics of Rajyoga and Karamyoga,
Benefits of Rajyoga and Karamyoga.

Unit 2

Holistic Health using Indian Knowledge System:
Basic principles of natural life style, Benefits through five elements. Healing through food, Chakras and Mudras.
Physical, Mental, Emotional and Spiritual health using traditional knowledge .

Unit 3

Positivity: Traditional approaches. Happiness: objective and subjective measures of wellbeing, life satisfaction. Resilience,
Self-regulation and self-control, optimism, self-esteem. Managing thoughts and Emotions with the help of Rajyoga.
Achieving Powers for Self Mastery.

Unit 4

Achieving Consciousness through Indian Knowledge System: Emotional intelligence, Indian approach to Psychology.
Consciousness; levels, body-mind relationship, self motivation, Self and Identity in modern Psychology and Indian thought.,
Spirituality and well being.

Reference and Text Books:

- Mahadevan, M., Bhat, V.R. & Pavana N. (2022). Introduction to Indian Knowledge System: Concepts and Applications. PHI Learning.
- Baumgardner, SR & Crothers, MK (2009). Positive Psychology. Prentice Hall/Pearson Education.
- Cornelissen, R.M., Misra G. & Varma S. (2014). Foundations & Applications of Indian Psychology. Pearson Education.
- Rajyoga Education and Consciousness Improvement Programme for Educators, Rajyoga Education and Research Foundation.
- Rajyoga Meditation Course, Thoughkart, Jaipur(Rajasthan), India.
  Prakartik Swasthya Shastra, Publisher Natural Lifestyle.

B24-HSM-202		Innovation, Start ups and Entrepreneurship (Sem.-IV)						
Lecture	**Tutorial**	**Practical**	**Credit**	**End Semester Exam**	**Internal Assessment**	**Total**	**Time**	
3	**-**	**-**	**3**	**70**	**30**	**100**	**3** Hours	
Purpose	**The objective of this Course is to inspire students and help them imbibe entrepreneurial mindset.**							
	Course Outcomes							
CO 1	**nderstanding the essence of innovation and features of innovative processes; models and methods of innovative entrepreneurship, the role of innovation as a major factor in creating the value of companies**							
CO 2	**Understanding, the dynamic role of entrepreneurship and small businesses, , types of business structure, organizing and managing a Small Business**							
CO 3	**Understanding concept of start ups, Control Strategic Marketing Planning , concept of incubation and proto type, new Product Development, Business Plan Creation.**							
CO 4	**Understanding risk analysis in business, financing methods, role of government in supporting entrepreneurship**							

Unit -I

Introduction to Innovation and Entrepreneurial Idea Generation and Identifying Business Opportunities, Management Skills for Entrepreneurs, Innovations and their forms, Innovation - features and characteristics, Factors initiating innovations, Innovation process and its stages, Statistical measurement of innovation, Model of innovation, Source of innovation, Technological transfer, Information technology to support innovation, difference between technological and non-technological innovation

Unit-II

Introduction to Entrepreneurship and Start – Ups - Definitions, Traits of an entrepreneur, Intrapreneurship, Entrepreneurial Motivation ,Functions of Entrepreneur, Concept, Growth of Entrepreneurship in India, Types of Business Structures, Similarities /differences between entrepreneurs and managers, Business Ideas and their implementation, Discovering ideas and visualizing the business, Activity map, Types of startups, role of entrepreneurs in economic development, future of entrepreneurs, entrepreneurial process

Unit -III

Start ups - Initial idea generation and planning stages, and incubation referring to the development process of identifying and developing new ideas for products, services, or processes, and creating a working model or prototype to test the feasibility of the concept.

Market Analysis – Identifying the target market, Competition evaluation and Strategy Development, Five Cs of Opportunity Identification, Market Opportunity Identification in emerging technology companies, Process of creating and growing a new business venture, Business plan of the innovation project.

Unit -IV

Risk Analysis: Risk management in venture projects, Financing and Protection of Ideas- Financing methods available for start-ups in India, Communication of Ideas to potential investors – Investor Pitch, Patenting and Licenses, Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy, venture capital, angel investment, and crowdfunding.

Government support- programs and initiatives aimed at supporting the development of new ideas, innovations, and startups, funding and mentorship, IPR - legal protection of a person's or organization's rights to their invention, brand, or creative work

Suggested Readings:

- Shrutin N Shetty, (2018), Design the Future: Simplifying Design Thinking to Help You, Notion Press
- "Entrepreneurship development small business enterprises", Pearson, Poornima M Charantimath,2013.

Roy Rajiv, "Entrepreneurship", Oxford University Press, 2011.

- "Innovation and Entrepreneurship",Harper business- Drucker.F, Peter, 2006.
- "Entrepreneurship", Tata Mc-graw Hill Publishing Co.ltd new Delhi- Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 8th Edition, 2012
- The Three-Box Solution: A Strategy for Leading Innovation By Vijay Govindarajan
- Boutellier, Roman; Gassmann, Oliver; von Zedtwitz, Maximilian (2000). Managing Global Innovation. Berlin: Springer.. ISBN 3-540-66832-2.
- Brown K. and Stephen P. Osborne (2005) Managing change and innovation in public service organisation. New York: Routledge
- Cappellin R. and Wink R. (2009) International Knowledge and Innovation Networks Knowledge Creation and Innovation in Medium-technology Clusters. UK: Edward Elgar Publishing Limited.
- Eveleens, C. (2010). Innovation management; a literature review of innovation process models and their implications. Working Paper HAN University of Applied Sciences.
- Enterpreneurship Development- S.Chand & Co.,Delhi- S.S.Khanka 1999

- Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi –Vasant Desai 2003.

- Entrepreneurship Management -Cynthia, Kaulgud, Aruna, Vikas Publishing House, Delhi, 2003.

    - Entrepreneurship Ideas in Action- L. Greene, Thomson Asia Pvt. Ltd., Singapore, 2007