Bachelor of Technology (Automation and Robotics/ Robotics and Automation)

KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Studies/Examination Semester III (w.e.f. session 2025-26)

S.N.	Course No./ Code	Subject	L:T:P	Hours /Week	Credits	Examination Schedule(Marks)				Duration of exam (Hours)
						End Semester Exam	Internal Assessment	Practical	Total	
1	B24-BSC-201	Higher Engineering Mathematics	3:1:0	4	4	70	30	0	100	3
2	B24-ARC-201	Digital Electronics	3:0:0	3	3	70	30	0	100	3
3	B24-ARC-203	Sensors and Instrumentation	3:0:0	3	3	70	30	0	100	3
4	B24-ARC-205	Mechanics of Solids	3:1:0	4	4	70	30	0	100	3
5	B24-ARC-207	Electronic Devices and Circuits	3:0:0	3	3	70	30	0	100	3
6	B24-ES-201	Engineering Mechanics	3:1:0	4	4	70	30	0	100	3
7	B24-ARC-209	Electronic Devices and Circuits Lab	0:0:2	2	1	-	40	60	100	3
8	B24-ARC-211	Digital Electronics Lab	0:0:2	2	1	-	40	60	100	3
9	B24-ARC-213	Mechanics of Solids Lab	0:0:2	2	1	-	40	60	100	3
10	B24-MAC-201	Environmental Studies	3:0:0	3	1	70	30	0	100	3
		Total	**21:3:6**	**30**	**25**	**490**	**330**	**180**	**1000**	

NCC/NSS/Sports/Yoga/Technical or cultural club/society activities may also be joined by students in second year and will be evaluated in 7th semester by the institute based upon continuous evaluation model as per guidelines

Bachelor of Technology (Automation and Robotics/ Robotics and Automation)

KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Studies/Examination Semester IV (w.e.f. session 2025-26)

S.N.	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-ESC-202	Materials Engineering	3:0:0	3	3	70	30	0	100	3
2	B24-ARC-202	Automatic Control Systems	3:0:0	3	3	70	30	0	100	3
3	B24-ARC-204	Computer aided design and Analysis	3:0:0	3	3	70	30	0	100	3
4	B24-ARC-206	Electrical Machines and Power Systems	3:0:0	3	3	70	30	0	100	3
5	B24-ARC-208	Kinematics and Dynamics of Machines	3:0:0	3	3	70	30	0	100	3
6	B24-HSM-202	Innovation, Start-up and Entrepreneurship	3:0:0	3	3	70	30	0	100	3
7	B24-ARC-210	Control Systems Lab	0:0:2	2	1	-	40	60	100	3
8	B24-ARC-212	Electrical Machines and Power Systems Lab	0:0:2	2	1	-	40	60	100	3
9	B24-ARC-214	Kinematics and Dynamics of Machines Lab	0:0:2	2	1	-	40	60	100	3
10	B24-MAC-202	Essence of Indian Traditional Knowledge	3:0:0	3	1	-	100	-	100	3
11	B24-ESC-216	Materials Engineering Lab	0:0:2	2	1	-	40	60	100	3
		Total	**21:0:8**	**29**	**23**	**420**	**440**	**240**	**1100**	

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

Semester-3

B24-BSC-201	HIGHER ENGINEERING MATHEMATICS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose	The objective of this course is to familiarize the prospective Engineers with Laplace Transform, partial differential equations which allow deterministic mathematical formulations of phenomena in engineering processes and to study numerical methods for the approximation of their solution.						
Course Outcomes: After studying the course, students will be able to:							
CO 1	Able to describe the concept of Laplace transform and how it is useful in solving the definite integrals and initial value problems.						
CO 2	Solve the Partial Differential Equations for multivariable differential equations originated from real world problems.						
CO 3	Solve the problems using numerical methods in a comprehensive manner						
CO 4	Able to describe the essential tool of Numerical differentiation and Integration needed in approximate solutions for the ordinary differential equations.						

UNIT-I

Laplace Transform

Laplace Transform, Laplace Transform of Elementary Functions, Basic properties of Laplace Transform, Laplace transform of periodic functions, finding inverse Laplace transform by different methods, Convolution theorem, solving ODEs by Laplace Transform method.

UNIT-II

Partial Differential Equations

Formation of Partial Differential Equations, Solutions of first order linear and non-linear PDEs, Charpit's method, Solution to homogenous linear partial differential equations (with constant coefficients) by complimentary function and particular integral method.

UNIT-III

Numerical Methods-1

Solution of polynomial and transcendental equations: Bisection method, Newton-Raphson method and Regula-Falsi method, Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae.

UNIT-IV

Numerical Methods-2

Numerical Differentiation using Newton's forward and backward difference formulae, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules, Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations.

Textbooks/References:

1. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993. AICTE Model Curriculum in Mathematics.
2. R. Haberman, Elementary Applied Partial Differential equations with Fourier Series and Boundary Value Problem, 4th Ed., Prentice Hall, 1998.
3. Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill, 1964.
4. Manish Goyal and N.P. Bali, Transforms and Partial Differential Equations, University Science Press, Second Edition, 2010.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008.
8. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company, 2nd Edition, Reprint 2012.
9. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.
10. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
11. Erwin Kreyszig and Sanjeev Ahuja, Applied Mathematics-II, Wiley India Publication, Reprint, 2015.

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-ARC-201	DIGITAL ELECTRONICS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	To make the students understand the concepts of digital electronics and its applications in different fields.						
Course Outcomes: After studying the course, students will be able to:							
CO1	Students will be able to understand the number systems and its arithmetic operations and Illustrate Use of Boolean algebra.						
CO2	Students will be able to formulate and apply Karnaugh Map to reduce Boolean expressions and logic circuits to their simplest POS and SOP forms						
CO3	Students will be able to design various combinational digital circuits using logic gates						
CO4	Students will be able to do the analysis and design procedures for synchronous and asynchronous sequential circuits						

UNIT-I

Binary Codes and Boolean Algebra

Signals: Analog and Digital, Binary Number System. Addition, Subtraction, Multiplication, Division of binary numbers, Subtraction using 2's complement method. Binary codes: weighted and non-weighted codes, self complementary.

Codes, BCD, Excesses-3, Gray codes, Alphanumeric codes, ASCII Codes.

Boolean algebra: Boolean Laws and Expression using Logic Gates, Realization of different gates using Universal gates, De- Morgan's Theorem, Duality Theorems.

UNIT-II

Boolean Function Minimization Techniques: Standard forms: SOP, POS, Simplification of Switching function & representation (Maxterm & Minterm), Boolean expression & representation using logic gates, Propagation delay in logic gate. Karnaugh map: K-map, mapping and minimization of SOP and POS expression, don't care condition, conversion from SOP to POS and POS to SOP form using K-map, Minimization of multiple output circuits,

UNIT–III

Combinational Circuits Design: Adder & Subtractor (Half and Full), Parallel Binary adder, BCD Adder, Binary multipliers, Code Converters, parity bit generator, Comparators, Decoder, BCD to 7-segment Decoder, Encoders, Priority Encoders, Multiplexers, De- Multiplexers.

Sequential Circuits Elements: Introduction to Sequential Circuit, Flip-flop and Latch: SR latch, JK flip-flop, Master Slave JK Flip-flop, T flip-flop, D flip-flop and latch, Master-slave RS flip-flop, Master-slave JK flip flop, asynchronous inputs.

UNIT–IV

Shift Registers and Counters: Shift registers: buffer register, controlled buffer register. Data transmission in shift resistor SISO, SIPO, PISO, PIPO, Bidirectional shift register, universal shift registers. Counter:

Classification, Ripple or asynchronous counter, Effect of propagation delay in ripple counters, up-down counter, Design of Mod-n counter, synchronous counter, Ring counter, Johnson counter.

Text books:

1. M. M. Mano, "Digital design", Pearson Education India, 2016.
2. Donald P. Leach and Albert Paul Malvino, Digital Principles and Applications, 8th Edition, TMH, 2003.
3. Taub Schilling, Digital Integrated Electronics, TMH

Reference Books:

1. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.
2. A.K. Maini, Digital Electronics, Wiley India
3. R P Jain, Modern digital electronics, TMH

Note: The paper setter will set the paper as per the question paper template provided.

B24-ARC-203	SENSORS AND INSTRUMENTATION						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	a) To understand the concepts of measurement technology. b) To learn the various sensors used to measure various physical parameters. c)To learn the fundamentals of signal conditioning, data acquisition and communication systems used in the development of mechatronics system.						
Course Outcomes: After studying the course, students will be able to:							
CO1	Familiarize with various basic principles, construction and operation of transducers.						
CO2	Understanding of temperature sensors, force sensors, and vibration sensors etc.						
CO3	Understand the basic principles of virtual instrumentation and smart sensors.						
CO4	Implement the Data Acquisition systems with different sensors for real time applications.						

UNIT-I

Introduction: Sensors : Definition, Classification & selection of sensors,
Transducers : Definition, Classification & selection of Transducers,
Potentiometer : Working Principle, types, advantages, disadvantages of potentiometer, Measurement of displacement using Potentiometer,
LVDT: Introduction,construction and working principle of LVDT**,**
Diaphragm: Working Principle, Types of Diaphragm, Measurement of pressure using LVDT based diaphragm.

UNIT-II

Measurement of Temperature: Thermistor: Construction, working principle, Resistance-Temperature Characteristics, Applications, **Thermocouple:**Construction, Working principle, advantages and disadvantages of thermocouple. **RTD (Resistance Thermometer):Co**nstruction,Working principle and analytical equations of resistance thermometer.
Strain guage: Introduction, Theory, Types of strain gauges, Measurement of force using strain guage.
Piezoelectric sensor: Construction, working principle, modes of operation, equivalent circuit of piezoelectric sensor, uses of piezoelectric sensor, **Proximity sensors:** Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, **Hall Effect Transducers:** Working principle and Applications of Hall effect transducers.

UNIT–III

Virtual Instrumentation: Introduction, Comparison with traditional techniques, Virtual Instrumentation Architecture, Distributed Virtual Instrumentation, Benefits of Virtual Instrumentation System.
Intelligent Sensors: Introduction, General Structure of smart sensors & its components, Characteristic of smart sensors, Application of smart sensors.

UNIT–IV

Data Acquisition Methods: Basic block diagram of data acquisition system, Analog Data Acquisition System, Digital Data Acquisition System,
Analog and digital system: Merits and Limitation of Digital Techniques, Types of ADC: Successive Approximation and sigma-delta, Types of DAC: Weighted Resistor and R-2R Ladder type.

TEXT BOOKS:

1. DVS Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013
2. D Patranabis, Sensors and Transducers, PHI 2nd Edition 2013.
3. S. Gupta, J.P. Gupta / PC interfacing for Data Acquisition & Process Control, 2nd ED / Instrument Society of America, 1994.
4. Gary Johnson / Lab VIEW Graphical Programing II Edition / McGraw Hill 1997.

REFERENCE BOOKS:

1. Arun K. Ghosh, Introduction to measurements and Instrumentation, PHI, 4th Edition 2012.
2. A.D. Helfrick and W.D. cooper,Modern Electronic Instrumentation & Measurement Techniques, PHI – 2001
3. Hermann K.P. Neubert, "Instrument Transducers" 2nd Edition 2012, Oxford University Press.
4. A.K Sawhney, "Electrical and Electronics Measurements and Instrumentation",Dhanpat Rai and Co.

Note: The paper setter will set the paper as per the question paper template provided.

B24-ARC-205	MECHANICS OF SOLIDS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose	a) To understand the concepts of stress, strain, principal stresses, and principal planes. b) To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses. c) To determine stresses and deformation in circular shafts and helical springs due to torsion. d) To compute slopes and deflections in indeterminate beams by various methods. e) To study the stresses and deformations induced in thin and thick shells.						
Course Outcomes: After studying the course, students will be able to:							
CO1	Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.						
CO2	To calculate the SF and BM in beams subjected to different loading conditions.						
CO3	To determine the torsion in the transmitting shafts subjected to different loading conditions and derive the derivations and solve the problems on slope and deflection						
CO4	To find strain energy in beams and shafts under different loading conditions and will be able to explain the energy methods and Castigliano's theorem.						

UNIT-I

Simple Stresses & Strains : Concept & types of Stresses and strains, Poisson's ratio, stresses and strain in simple and compound bars under axial loading, stress strain diagrams, Hook's law, elastic constants & their relationships, temperature stress & strain in simple & compound bars under axial loading, Numerical problems.

Principle Stresses: Two dimensional systems, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stresses, Numerical Problems.

UNIT-II

Shear Force & Bending Moments: Shear Force & Bending Moments: Definitions, SF & BM diagrams for cantilevers, simply supported beams with or without over-hang and calculation of maximum BM & SF and the point of contraflexture under (i) concentrated loads, (ii) uniformly distributed loads over whole span or a part of it, (iii)combination of concentrated loads and uniformly distributed loads, (iv) uniformly varying loads and (v) application of moments, relation between the rate of loading, the shear force and the bending moments, Numerical Problems.

Flexural and Shear Stresses – Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I,T, Angle, channel sections, composite beams, shear stresses in beams with derivation, shear stress distribution across various beam sections like rectangular, circular, triangular, I, T, angle sections, combined bending and torsion, equivalent torque,. Numerical problems.

UNIT–III

Torsion: Torsion formulation, stresses and deformation in circular and hollow shafts, stepped shafts, deflection in shafts fixed at both ends,Slope & Deflection: Relationship between bending moment, slope & deflection, moment area method, method of integration, Macaulay's method, calculations for slope and deflection of (i)

cantilevers and (ii) simply supported beams with or without overhang under concentrated load, Uniformly distributed loads or combination of concentrated and uniformly distributed loads, Numerical problem

UNIT–IV

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's theorem, Numerical.

Theories of Elastic Failures: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numerical problems

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

REFERENCES:

3. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
5. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
6. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010. edition, CRC Press, 2015

Note: The paper setter will set the paper as per the question paper template provided.

B24-ARC-207	ELECTRONIC DEVICES AND CIRCUITS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	a) To understand the structure of basic electronic devices. b) Be exposed to active and passive circuit elements. c) To familiarize the operation and applications of transistor like BJT and FET. d) Explore the characteristics of amplifier gain and frequency response. e) To learn the required functionality of positive and negative feedback systems.						
Course Outcomes: After studying the course, students will be able to:							
CO1	Explain the structure and working operation of basic electronic devices						
CO2	Analyze the characteristics of different electronic devices such as diodes and transistors						
CO3	Choose and adapt the required components to construct an amplifier circuit						
CO4	Employ the acquired knowledge in design and analysis of oscillators.						

UNIT-I

PN Junction Devices: PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance, Rectifiers – Half Wave and Full Wave Rectifier, clipping and clamping circuits. Display devices-LCD, LED, Seven Segment display, Laser diodes, Zener diode: characteristics and it's applications.

UNIT-II

Bipolar Junction Transistor - structure, operation, & characteristics, stability, stability factor, methods for Transistor Biasing. Amplifiers- BJT small signal model, Analysis of CE, CB, CC amplifier gain & frequency response.

UNIT–III

JFET- Structure, Operation & Characteristics, JFET small signal model, MOSFET structure, operation and characteristics, MOSFET Small signal model, Analysis of common source & source follower - gain & frequency response.

UNIT–IV

Feedback Amplifiers and Oscillators: Advantages of negative feedback, voltage series & current series feedback amplifier, Shunt feedback amplifier, positive feedback, Oscillators: Condition for oscillations, Types: phase shift, Wien Bridge, Hartley, Colpitts and Crystal oscillators.

OP-AMP: Introduction, Characteristics of Ideal Op-Amp, Open Loop and Closed Loop Configurations, Applications-Adder, subtractor, integrator, differentiator.

TEXT BOOKS:

1. David A. Bell ,"Electronic devices and circuits", Oxford University higher education, 5th edition 2008.
2. Sedra and smith, "Microelectronic circuits",7th Ed., Oxford University Press.

REFERENCES:

1. Balbir Kumar, Shail.B.Jain, “Electronic devices and circuits” PHI learning private limited, 2nd edition 2014.

2. Thomas L.Floyd, “Electronic devices” Conventional current version, Pearson prentice hall, 10th Edition, 2017.

3. Donald A Neamen, “Electronic Circuit Analysis and Design” Tata McGraw Hill, 3rd Edition, 2003.

4. Robert L.Boylestad, “Electronic devices and circuit theory”, 2002.

5. Robert B. Northrop, “Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation”, CRC Press, 2004

B24-ES-201	ENGINEERING MECHANICS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**1**	**0**	**4**	**70**	**30**	**100**	**3**
Purpose	a) To understand the vector and scalar representation of forces and moments, static equilibrium of particles and rigid bodies in two dimensions b) To comprehend the effect of friction on equilibrium and the laws of motion, the kinematics of motion and the interrelationship and to learn to write the dynamic equilibrium equation c) To emphasis the concepts through solved examples						
Course Outcomes: After studying the course, students will be able to:							
CO1	Apply knowledge of mathematics, science and engineering to analyze the vector and scalar representation of forces and moments, static equilibrium of particles and rigid bodies in two dimensions						
CO2	Design and conduct experiment, as well as to analyze the effect of friction on equilibrium and the laws of motion, the kinematics of motion and the interrelationship and analyze dynamic equilibrium equation						
CO3	Able to find moment of inertia of different sections.						
CO4	Design, construct and analyze Engineering Mechanics through solved examples						

UNIT-I

FUNDAMENTAL OF MECHANICS: Fundamental of Mechanics: Basic Concepts Force System and Equilibrium, Definition of Force, Moment and Couple, Principle of Transmissibility, Varignon_s theorem, Resultant of force system – Concurrent and non-concurrent coplanar forces, Condition of static equilibrium for coplanar force system, stability of equilibrium, applications in solving the problems on static equilibrium of bodies.

UNIT-II

PRACTICAL APPLICATION OF FORCE SYSTEM: Structural member: definition, Degree of freedom, concept of free body diagrams, types of supports and reactions, types of loads, Analysis of Trusses-method of joints, method of sections. Friction: Introduction, Static dry friction, simple contact friction problems, ladders, wedges.

UNIT–III

PROPERTIES OF SURFACES: Properties of sections – area, centroids of lines, areas and volumes, moment of inertia first moment of inertia, second moment of inertia and product moment of inertia, polar moment of inertia, radius of gyration..

UNIT–IV

KINEMATICS AND KINETICS OF PARTICLES: Equations of motion - Rectilinear motion, curvelinear motion, Relative motion, D_Alembert_s principle, work- Energy equation – Conservative forces and principle of conservation of energy.

KINEMATICS AND KINETICS OF RIGID BODIES: Plane motion, Absolute motion, Relative motion, translating axes and rotating axes, work and energy.

TEXT BOOKS:

1. Rajesekaran, S and Sankara Subramanian., G., Engineering Mechanics, Vikas Publishing House Private Ltd., 2012.

REFERENCES:

1. Palanichamy, M.S. Nagan, S., Engineering Mechanics – Statics & Dynamics, Tata McGraw-Hill,2001.

2. Beer, F.P and Johnson Jr. E.R, Vector Mechanics for Engineers, Vol. 1 Statics and Vol.2 Dynamics, McGraw – Hill International Edition, 1997

3. Bhavikatti,S.S and K.G.Rajashekarappa, Engineering Mechanics, New Age International (P) Ltd, New Delhi,2010.

B24-ARC-209	ELECTRONIC DEVICES AND CIRCUITS LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Practical**	**Total**	**Duration of exam (Hours)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	a) To introduce basic semiconductor devices, their characteristics and application b) To understand analysis and design of simple diode circuits c) To learn to analyze the PN junction behaviour at the circuit level and its role in the operation of diodes and active devices							
Course Outcomes: After studying the course, students will be able to:								
CO 1	Analyze PN junctions in semiconductor devices under various conditions.							
CO 2	Design and analyze simple rectifiers and voltage regulators using diodes.							
CO 3	Describe the behaviour of special purpose diodes.							
CO 4	Design and analyze simple BJT , FET circuits and oscillators.							

LIST OF EXPERIMENTS:

1. Design and assemble the circuit to draw the V-I characteristics of a P-N junction diode.
2. Design and assemble the circuit to draw the output of PN Junction diode based clipper circuit and clamper circuits.
3. Design and assemble the circuit to draw reverse breakdown characteristics of given Zener diode as a voltage regulator.
4. Design and assemble the circuit to study half wave rectifier , Full wave rectifier & bridge rectifier and effect of different filter circuits on ac ripple at different loads.
5. Design and assemble the circuit to draw and study the input and output characteristics of a given transistor in common emitter configuration
6. Design and assemble the circuit to draw and study characteristics of JFET & evaluate various parameters.
7. Design and assemble the circuit to get the output of Hartley Oscillator.
8. Design and assemble the circuit to generate the output of RC phase shift oscillator.
9. Design and assemble the circuit to generate the output of Wien bridge Oscillator.
10. Design and assemble the circuit study the different types of negative feedback in two stage amplifier and to observe its effects upon amplifier parameters.
11. Introduction to SMD components.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B24-ARC-211	DIGITAL ELECTRONICS LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Practical**	**Total**	**Duration of exam (Hours)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	a) To impart the basic practical aspects of Digital Electronics. b) To make a differentiation between the Analog Electronics and Digital electronics through practical modes. c) 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: After studying the course, students will be able to:								
CO1	Students will be able to know the fundamentals and the parameters of digital components related to their fabrication and internal circuitry							
CO 2	Students will be able to design various logic circuits.							
CO 3	Students will be able to design synchronous and asynchronous sequential circuits							
CO 4	Students will be able to verify the Truth Table							

LIST OF EXPERIMENTS:

1. Digital Signals Interface Compare analog and digital electronics systems (Tutorial)
2. Realization of basic and universal logic gates using ICS 7400, 7432, 7402, 7408, 7486, 7404.
3. Derived Basic gate using NAND and NOR Gate
4. Verification of Demorgan's theorem.
5. Develop Verification of Truth Table of 4:1 mux & 1:4 demux using IC's.
6. Verification of Truth Table of flip flops
7. Verification of Truth Table of shift registers (7495)
   a. SISO
   b. SIPO
   c. PISO
   d. PIPO
8. Verification of 4-bit Asynchronous mod-10 (decade) counter (IC 7490)
9. Verification of 4-bit synchronous up/down counter ((IC 74193)
10. Segment Display Decoder.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute

B24-ARC-213	MECHANICS OF SOLIDS LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Practical**	**Total**	**Duration of exam (Hours)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To make the students aware of different properties of material using different experiments.							
Course Outcomes: After studying the course, students will be able to:								
CO1	design and conduct experiments, acquire data, analyze and interpret data							
CO2	determine the behavior of ferrous metals subjected to normal and shear stresses by means of experiments.							
CO3	determine the behavior of structural elements, such as bars subjected to tension, compression, shear, bending, and torsion by means of experiments.							
CO4	physically insight into the behavior materials and structural elements, including distribution of stresses and strains, deformations and failure modes.							

List of Experiments:

1. To study the Brinell hardness testing machine & perform the Brinell hardness test.
2. To study the Rockwell hardness testing machine & perform the Rockwell hardness test.
3. To study the Vickers hardness testing machine & perform the Vickers hardness test.
4. To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test.
5. To study the Impact testing machine and perform the Impact tests (Izod&Charpy).
6. To study the Universal testing machine and perform the tensile, compression & bending tests.
7. To perform the shear test on UTM.
8. To study the torsion testing machine and perform the torsion test.
9. To draw shear Force, Bending Moment Diagrams for a simply Supported Beam under point and distributed Loads.
10. To prepare the composite specimen using hot compression molding machine and test for different mechanical properties.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B24-MAC-201	ENVIRONMENTAL STUDIES						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**1**	**70**	**30**	**100**	**3**
Purpose	To learn the multidisciplinary nature, scope and importance of Environmental sciences.						
Course Outcomes: After studying the course, students will be able to:							
CO1	learn the importance of natural resources.						
CO2	learn the theoretical and practical aspects of ecosystem.						
CO3	learn the basic concepts of conservation of biodiversity.						
CO4	understand the basic concept of sustainable development.						

UNIT 1

The multidisciplinary nature of environmental studies, Definition, Scope and Importance, Need for public awareness, Natural Resources: 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 forests and tribal people.
b) Water Resources: Use & over-utilization of surface & ground water, floods, drought, conflicts over water, dams-benefits and problems.
c) Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food Resources: World Food Problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy Resources: Growing energy needs, renewable & non-renewable energy sources, use of alternate energy sources. Case studies.
f) Land Resources: Land as a resource, land, degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyle.

UNIT II

Ecosystem-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: (a) Forest Ecosystem, (b) Grassland Ecosystem, (c) Desert Ecosystem and (d) Aquatic Ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Field Work: Visit to a local area to document Environment assets-river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban /Rural Industrial/Agricultural, Study of common plants, insects and birds, Study of simple ecosystems-pond, river, hill, slopes etc. (Field work equal to 5 lecture hours).

UNIT III

Biodiversity and its conservation: Introduction, Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity global, National and local levels. India as a mega-diversity nation Hot spots of Biodiversity, Threats to biodiversity: Habitat loss, poaching of wild life, man-wildlife conflicts, Endangered and endemic species of India, Conservation of Biodiversity- In situ and Ex-Situ conservation of biodiversity.

Environmental Pollution Definition: Cause, effects and control measures of (a) Air Pollution (b) Water Pollution (c) Soil Pollution (d) Marine Pollution (e) Noise Pollution (f) Thermal Pollution (g) Nuclear Hazards

Disaster management: floods, earthquake, cyclone and landslides

UNIT IV

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., 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, Public Awareness.

Suggested Books

1. Environmental Studies- Deswal and Deswal. Dhanpat Rai and Co.
2. Environmental Science and Engineering Anandan, P. and Kumaravelan, R. 2009. Scitech Publications (India) Pvt. Ltd., India.
3. Environmental Studies. Daniels Ranjit R. J. and Krishnaswamy. 2013. Wiley India.
4. Environmental Science- Botkin and Keller. 2012. Wiley , India

Note: The Examiner will be given the question paper template to set the question paper.

Semester-4

B24-ESC- 202	MATERIALS ENGINEERING						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose:	To develop capacity to identify crystal structure, designate various steels, create phase diagrams, analyse material failure mechanisms, perform heat treatment, study green energy materials and basic functioning of sophisticated material characterization techniques with overall objective of developing the understanding of micro structure-property relations.						
Course Outcomes							
CO1	Students will be able to identify and differentiate various types of the crystal structures and deformation mechanisms in various materials.						
CO2	Students will be able to designate various types of steels as per BIS and AISI-SAE standard specifications of steels						
CO3	Students will be able to draw various types of phase diagrams, Fe-C diagram and TTT curve.						
CO4	Students will be able to classify heat treatment processes and will be able to select suitable heat treatment process for any industrial application.						
CO5	Students will be able to explain various mechanisms of deformation and failure mechanisms like Creep and Fatigue.						
CO6	Students will be able to study various materials used for green energy production.						
CO7	Students will be able to explain the basic principles involved in the working of various types of material characterization techniques and will develop the capability to select a particular material characterization process for any given application.						

UNIT-I

Crystallography: Review of Crystal Structure, Space Lattice, Coordination Number, Number of Atoms per Unit Cell, Atomic Packing Factor; Numerical Problems Related to Crystallography.

Imperfection in Metal Crystals: Crystal Imperfections and their Classifications, Point Defects, Line Defects, Edge & Screw Dislocations, Surface Defects, Volume Defects.

Introduction to Engineering Materials and Standard Materials Designation: Introduction to Engineering Materials, Steel Terminology, Indian Standard Specifications for Steels as per BIS: Based on Ultimate Tensile Strength and Based on Composition, AISI-SAE Standard Designation for Steels and Aluminium Alloys.

UNIT-II

Phase Diagrams: Basic Concepts and Terms, Alloy Systems, Solid Solutions, Hume-Rothery's Rules, Phase Diagrams, Gibbs Phase Rule, Cooling Curves, Binary Phase Diagram, The Lever Rule, Applications of Phase Diagrams, Phase Transformation, Allotropic Forms of Iron, Micro-constituents of Fe-C System, Iron-Iron Carbide Phase Diagram, Modified Iron-Carbon Phase Diagrams, Isothermal Transformation, TTT Curve, CCT Curve.

Heat Treatment: Heat Treatment of Steels, Annealing, Normalizing, Hardening, Tempering, Ageing, Austempering and Martempering, Surface Hardening and Case Hardening Processes, Major Defects in Metals or Alloys due to Faulty Heat Treatment.

UNIT-III

Deformation of Metal: Elastic and Plastic Deformation, Mechanism of Plastic Deformation: Slip; Critical Resolved Shear Stress, Twinning, Conventional and True Stress-Strain Curves for Polycrystalline Materials, Yield Point Phenomenon, Bauschinger Effect, Work Hardening.

Fatigue Failure of Materials: Fatigue, Fatigue-Failure Models, Fatigue Loads, Mechanism of Fatigue Failure, Theories of Fatigue, Factors Affecting Fatigue, SN Diagram, Fatigue Life Calculations, Fatigue Tests.

Creep: Creep Curve, Types of Creep, Factors Affecting Creep, Mechanism of Creep, Creep Resistant Material, Creep Tests, Improving Creep Resistance.

UNIT-IV

Materials for Green Energy: Biodiesel, Bioethanol, Production Methods of Biofuels; Overview of Key Fuel Cell Technologies - Various Types of Fuel Cells, Materials for Electrodes, Electrolytes, and Other Components, Working Mechanisms, Hydrogen Generation and Storage, Limitations, Recent Progress in Fuel Cells.

Materials Characterization Techniques: Characterization Techniques such as X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Energy Dispersive X-Ray Spectroscopy (SEM-EDX), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM).

Textbooks:

1. Fundamentals of Material Science and Engineering by W.D. Callister, Wiley.
2. Material Science and Metallurgy by O.P. Khanna, Dhanpat Rai Publication.
3. Material Science by S.L. Kakani, New Age Publishers.
4. The Science and Engineering of Materials by Donald R. Askeland, Chapman & Hall.
5. Material Science by Narula, TMH.
6. Machine Design by Robert Norton, Pearson.
7. Phase Transformation in Metals and Alloys by D.A. Porter & K.E. Easterling.
8. Fuel Cell Systems Explained by Larminie and A. Dicks, 2nd Edition, Wiley.
9. Principles of Fuel Cells by Xianguo Li, Taylor and Francis.
10. Fuel Cells: From Fundamentals to Applications by S. Srinivasan, Springer.
11. Fundamental of Light Microscopy and Electronic Imaging by Douglas B. Murphy, Kindle Edition 2001.
12. Concise Encyclopedia of Materials Characterization by Robert Cahn, 2nd Edition (Advances in Materials Science and Engineering), Elsevier Publication 2005.

Note: The Examiner will be given the question paper template to set the question paper.

B24-ARC-202	AUTOMATIC CONTROL SYSTEMS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	To study the basics of control system and its response. Stability of mechanical and electrical systems. Use of MATLAB to design a stable control system. a) To introduce the elements of control system and their modelling using various Techniques. b) To introduce methods for analysing the time response. c) To impart knowledge about the frequency response and the stability of systems d) To introduce the state variable analysis method						
Course Outcomes: After studying the course, students will be able to:							
CO1	understand the basics of the control system						
CO2	study the concept of time response of control system						
CO3	study the concept of frequency response of control system & different types of stability criteria of the system.						
CO4	provide a complete idea about the behaviour of a system at any given time utilizing the history of system using state space analysis						

UNIT-I

Introduction: Basic elements of control systems- Open loop and closed loop systems-Differential equation representation of physical systems- Transfer function, Mathematical modelling of Electrical and Mechanical (translational and rotational) systems, Block diagram reduction techniques, Signal flow graph – Mason‟ gain formula.

UNIT-II

Time Domain Analysis: Time response analysis –Analysis of transient and steady state behaviour of control systems. Standard Test signals- Time response of first and second order system, Time domain specifications, Types of systems, Steady state error –generalized error coefficients – response with P, PD, PI and PID controllers.

UNIT–III

Frequency Domain Analysis and Stability: : Frequency domain specifications, Time and frequency response correlation , Characteristic equation , Routh Hurwitz criterion of stability , Nyquist stability , Nyquist stability criterion , Polar plot , Bode Plot, Root Locus.

UNIT–IV

STATE SPACE ANALYSIS: Limitations of conventional control theory, Concepts of state, state variables and state model , state model for linear time invariant systems , Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability., Introduction to state space representation using physical - Phase and canonical variables-diagonal canonical form-Jordan canonical form.

TEXT BOOKS:

1. Nagrath I J, and Gopal, M, 'Control Systems Engineering" Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007

REFERENCES:

3. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.
4. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
5. Norman C. Nise S, “Control system Engineering“, John Wiley & Sons, Singapore, 2004.

Note: The paper setter will set the paper as per the question paper templates provided.

B24-ARC-204	COMPUTER AIDED DESIGN AND ANALYSIS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	The subject empowers the students to know about the extreme function of computer in designing, manufacturing as well as in the business scenario						
Course Outcomes: After studying the course, students will be able to:							
CO1	describe the history and application CAD/CAM.						
CO2	aware about the Modeling of different types of curves, surface and solid. The modeling is used for further analysis.						
CO3	know about the transformation of points and lines in computer aided software.						
CO4	know the usages of the numerical control machines and its code and How computer is useful in making the process planning.						

UNIT-I

Introduction to CAD/CAM, Historical Development, Industrial look at CAD/CAM Application of CA/CAM, Display devices, Input/ Output Devices, CPU.
Introduction to CIM, Definition, Nature of Elements of CIM, CIM Wheel,
Introduction to computer aided quality control, Contact and Non Conduct Inspection Method.

UNIT-II

Wireframe modeling, Representation of curves, Parametric and non-parametric curves, straight lines, Hermite cubic splines, B splines curves.
Plane surface, ruled surface, surface of revolution, bi-cubic surface, Bezier surface, B spline surface, Solid modeling, boundary representation, sweeping, parametric solid modeling.
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UNIT-III

Introduction, Transformation of points & line, 2-D translation, rotation, Reflection, Scaling, shearing and combined transformation, Homogeneous coordinates, Orthographic and perspective Projections.
Group technology, Part families, Part classification and coding, Optiz method, product flow analysis, Machine cell Design, Advantages of GT

UNIT-IV

Numerical control, Types of NC systems, MCU & other components, Co-ordinate system, NC manual part programming, G & M codes, part program for simple parts, Computer assisted part programming.
Introduction, FMS component, Types of FMS, FMS layout, planning for FMS, advantage and applications
Introduction, conventional process planning, Steps in variant process planning, types of
CAPP, planning for CAPP

Text books:

1. **Chris McMahon and Jimmie Browne**, CAD/CAM – Principle Practice and Manufacturing Management, Addison Wesley England, Second Edition, 2000.
2. **Rogers, D.F. and Adams, A**., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989
3. **Ibrahim Zeid**, CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.
4. **M.P. Groover**, Automation, Productions systems and Computer-Integrated Manufacturing by Prentice – Hall

Reference Books:

1. **Ibrahim Zeid**, Mastering CAD/CAM, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. **P. Radhakrishnan, S. Subramanayan and V.Raju**, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.
3. **Groover M.P. and Zimmers E. W.**, CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.
4. **Dr. Sadhu Singh**, Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.
5. **Chang, Wang &Wysk** Computer Aided Manufacturing. Prentice Hall
6. **Kundra** &**Rao**, Numerical Control and Computer Aided Manufacturing by, Rao and Tiwari, Tata Mc-Graw Hill.
7. **Mattson**, CNC programming Principles and applications, Cengage Learning India Pvt. Ltd. Delhi

NOTE: The paper setter will set the paper as per the question paper templates provided.

B24-ARC-206	ELECTRICAL MACHINES AND POWER SYSTEMS						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	a) To study about basic electrical prime movers, electrical transmission and distribution systems. b) To study about the transformers c) To study about the different types of induction motors d) To study about the special machines e) To study about the power system						
Course Outcomes: After studying the course, students will be able to:							
CO1	Understand the principles of operations and characteristics of DC machines						
CO2	Describe the electrical transformers and induction motors						
CO3	visualize the operation of synchronous motors, stepper and servo motors						
CO4	understand about the basic structure of power system.						

UNIT–I

D.C. Machines: Constructional details , EMF equation , methods of excitation – self and separately excited generators , characteristics of series and shunt generators , principle of operation of D.C. Motor , function of commutator in DC motors, back emf and torque equation , characteristics of series, shunt and compound motors , starting of D.C. Motors , types of starters , speed control and braking of DC. Motors. Introduction to BLDC motors and its types.

UNIT–II

Transformer: Constructional detail , Working Principle , EMF Equation ,Transformation Ratio , Transformer on No Load , Transformer on Load , Equivalent Circuit, Parameters referred to HV/LV Windings , Phasor diagram at ideal, no load and on load conditions, Losses, Voltage regulation and efficiency, OC & SC test, Load Test , concept of auto transformer

UNIT–III

Induction Motors: Construction , types , principle of operation of three-phase induction motors ,equivalent circuit , Torque equation, Torque-slip characteristics, starting and speed control of three phase induction motor, single-phase induction motors (only qualitative analysis).

Synchronous and Special Machines: Construction of Synchronous machine, types, emf equation, Brushless alternators, Reluctance motor, Stepper motor, Servo motor.

UNIT–IV

Introduction to Power System: Structure of electric power systems: generation, transmission, and distribution systems, EHVAC and EHVDC transmission system , Underground and overhead system, Modern trends in power system transmission, Effects of increase in Voltage on transmission line efficiency, Radial and ring main system. Relative copper consumption in various systems. Conductor size and Kelvin's Law, substation layout. (Concepts only).

TEXT BOOKS:

1. Murugesh Kumar K. , “Electric Machines Vo I”, Vikas Publishing House Pvt Ltd, 2010.

2. Murugesh Kumar K. , “Electric Machines Vol II”, Vikas Publishing House Pvt Ltd, 2010

3. Mehta V.K. and Rohit Mehta, “Principles of Power System”, S.Chand and Company Ltd, 2003.

REFERENCE BOOKS:

1. Fitzgerald A.E., Charles Kingsley, Stephen.D.Umans, “Electric Machinery”, Tata McGraw Hill publishing Company Ltd, 2003.

2. Gupta J.B., “Theory and Performance of Electrical Machines”, S.K.Kataria and Sons, 2002

3. Kothari D.P. and Nagrath I.J., “Electric Machines”, Tata McGraw Hill Publishing Company Ltd, 2002.

4. Bhimbhra P.S. “Electrical Machinery”, Khanna Publishers, 2003.

Note: The paper setter will set the paper as per the question paper templates provided.

B24-ARC-208	KINEMATICS AND DYNAMICS OF MACHINES						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	a) To understand the basic knowledge about kinematics of machines. b) To understand the basic components and layout of linkages in the assembly of a system/ machine. c) To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism. d) To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions. e) To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components						
Course Outcomes: After studying the course, students will be able to:							
CO1	Understand the basic knowledge of kinematics of machines						
CO2	apply fundamentals of mechanism for the design of new mechanisms						
CO3	know about the linkages, design few linkage mechanisms and cam mechanisms for specified output motions						
CO4	Impart knowledge about the gears and gear trains						

UNIT-I

Kinematic of Machines: Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT-II

Robot Kinematics and Dynamics: Direct kinematics of a manipulator, workspace, Inverse kinematics, Algebraic approaches to inverse kinematics, Lagrange – Euler formulation of dynamic equations of a manipulator, Geometric approaches for inverse kinematics

Gears and Gear Trains: Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains

UNIT–III

Force Analysis: Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D‟Alembert‟s principle – superposition principle – dynamic Force Analysis in simple machine members

UNIT–IV

Balancing and Vibration: Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft

TEXT BOOKS:

1. Ambekar A.G., “Mechanism and Machine Theory” Prentice Hall of India, New Delhi, 2007

2. Shigley J.E., Pennock G.R and Uicker J.J., “Theory of Machines and Mechanisms”, Oxford University Press, 2003

REFERENCES:

1) Thomas Bevan, “Theory of Machines”, CBS Publishers and Distributors, 1984.

2) Ghosh. A, and A.K. Mallick, “Theory and Machine”, Affiliated East-West Pvt. Ltd., New Delhi, 1988.

3) Rao.J.S. and Dukkipatti R.V. “Mechanisms and Machines”, Wiley-Eastern Ltd., New Delhi, 1992.

4) John Hannah and Stephens R.C., “Mechanics of Machines”, Viva Low Prices Student Edition, 1999.

5) V.Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.

6) Robert L.Norton, Design of Machinery, McGraw-Hill, 2004.

Note: The paper setter will set the paper as per the question paper templates provided.

B24-HSM-202		INNOVATION, START-UP AND ENTREPRENEURSHIP					
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**3**	**70**	**30**	**100**	**3**
Purpose	The objective of this course is to inspire students and help them imbibe an entrepreneurial mindset.						
CO1	Understanding 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.						
CO2	Understanding, the dynamic role of entrepreneurship and small businesses, types of business structure, organizing and managing a Small Business.						
CO3	Understanding the concept of start-ups, control strategic marketing planning, concept of incubation and prototype, new product development, and business plan creation.						
CO4	Understanding the concept of start-ups, strategic marketing planning and control, the concept of incubation and prototyping, new product development, and business plan creation.						

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, entrepreneurship, entrepreneurial motivation, functions of an 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 start-ups, role of entrepreneurs in economic development, future of entrepreneurs, and the 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, and 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, 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, including funding and mentorship. IPR - legal protection of a person's or organization's rights to their invention, brand, or creative work.

Suggested Readings:

1. Shrutin N Shetty,(2018),Design the Future:Simplifying Design Thinking to Help You, Notion Press
2. Entrepreneurshipdevelopment small business enterprises",Pearson, Poornima M Charantimath,2013.
3. Roy Raj,"Entrepreneurship",Oxford University Press,2011.
4. Innovation and Entrepreneurship",Harper business-Drucker.F,Peter,2006.
5. 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
6. The Three-BoxSolution :AS trategy for Leading Innovation By Vijay Govindarajan
7. Boutellier,Roman; Gassmann,Olivervon Zedtwitz, Maximilian(2000).Managing Global Innovation. Berlin: Springer.. ISBN 3-540-66832-2.
8. Brown K.and Stephen P.Osborne (2005)Managing change and innovation in public service organization. New York: Routledge
9. CappellinR.andWinkR.(2009)International Knowledge and Innovation Networks Knowledge Creation and Innovation in Medium-technology Clusters. UK: Edward Elgar Publishing Limited.
10. Eveleens, C. (2010). Innovation management; a literature review of innovation process model sand their implications.Working Paper HAN University of Applied Sciences.
11. Entrepreneurship Development-S.Chand &Co.,Delhi-S.S.Khanka1999
12. Small-Scale Industries and Entrepreneurship. HimalayaPublishing House, Delhi– Vasant Desai 2003.
13. Entrepreneurship Management-Cynthia,Kaulgud,Aruna,VikasPublishingHouse, Delhi, 2003.
14. Entrepreneurship Ideas in Action-L.Greene,Thomson AsiaPvt.Ltd.,Singapore,2007

Note: The paper setter will set the paper as per the question paper templates provided.

B24-ARC-210	CONTROL SYSTEMS LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Practical**	**Total**	**Duration of exam (Hours)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To make students capable to design solutions for Control System engineering problems and design system components or processes that meet the specified needs of modern automated engineering industries.							
Course Outcomes: After studying the course, students will be able to:								
CO 1	students will be able to execute time response analysis of a second order control system using MATLAB							
CO 2	Students will be able to design Lag, Lead, Lead-Lag compensators and verify experimental results using MATLAB.							
CO 3	Analyze toque- speed characteristics of DC and AC servomotors.							
CO 4	Analyze and interpret stability of the system through Bode plot and Nyquist plot.							

List of Experiments:

1. Using MATLAB obtain time response of a second order system in case of under-damped, over damped and critically damped systems.
2. To design a passive RC lead compensating network for the given specifications and to obtain its frequency response.
3. To design a passive RC lag compensating network for the given specifications and to obtain its frequency response.
4. To obtain torque speed characteristics of AC servo motor.
5. To obtain torque speed characteristics of DC servo motor.
6. To determine frequency response of a second order system and evaluation of Frequency domain specifications.
7. To simulate a DC position control system and hence to find the step response using MATLAB.
8. Obtain the phase margin and gain margin for a given transfer function by drawing bode plots and verify the same using MATLAB.
9. To digitally simulate the time response characteristics of Linear SISO systems using state variable formulation.
10. Experiment to draw the frequency response of a given lead-lag compensating-network.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the lab.

B24-ARC-212	ELECTRICAL MACHINES AND POWER SYSTEMS LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Practical**	**Total**	**Duration of exam (Hours)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	a) To impart Knowledge about the basic operations of DC machines and help them to develop experimental skills. b) To measure equivalent circuit parameters of single phase transformers. c) To expose the students to the basic operations of AC machines and help them to develop experimental skills.							
Course Outcomes: After studying the course, students will be able to:								
CO 1	describe basic operation of DC machines and help them to develop experimental skills.							
CO 2	describe various characteristics of DC generators and determine the efficiency of DC Machines.							
CO 3	determine the equivalent circuit parameters of single phase transformers.							
CO 4	operate AC electrical machines and determine the equivalent circuit parameters of single phase & 3-phase Induction motor.							

LIST OF EXPERIMENTS:

1. Draw characteristics of series, shunt and compound generators.
2. To perform load test on DC shunt generator & find efficiency & observe speed at different load.
3. To perform Hopkinson's test of DC shunts M/Cs.
4. To perform Swinburne's test of DC shunts motor and find efficiency.
5. Speed control of DC shunt motor by armature & field control method, draw graph between speed & field current.
6. Parallel operation of two 1-phase transformers and observe load sharing.
7. To perform open & short circuit tests on a 1-phase transformer & find parameters.
8. To perform light running and block rotor test on 1-phase induction motor and to determine the parameters of the equivalent circuit.
9. To perform no load test and block rotor test on 3-phase induction motor and draw the circle diagram.
10. To perform load test on a 3-phase induction motor & DC generator set and to determine the efficiency of induction motor.
11. Determine mechanical losses by light running of a 3-phase induction motor.
12. To calculate regulation by synchronous impedance method:-
    a) Conduct open and short circuit test on a three phase alternator.
    b) Determine and plot variation of synchronous impedance with If
    c) Determine SCR
    d) Determine regulations for 0.8 lagging power factor, 0.8 leading power factor and unity PF.
13. To plot V curves of a synchronous machine.
    a) Determination of Xo of a synchronous machine.
    b) Measurement Xd & Xq (Direct axis and Quardrature axis reactance) by slip test
14. To perform and study parallel operation of synchronous generators.

Note**:** At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.

B24-ARC-214	KINEMATICS AND DYNAMICS OF MACHINES LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Practical**	**Total**	**Duration of exam (Hours)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To supplement the principles learnt in kinematics and Dynamics of Machinery. To understand how certain measuring devices are used for dynamic testing.							
Course Outcomes: After studying the course, students will be able to:								
CO 1	demonstrate the principles of kinematics and dynamics of machinery							
CO 2	use the measuring devices for dynamic testing.							
CO 3	learn the various mechanism have used in Machines and Robots							
CO 4	understand the concepts and working of Flywheel, Governor and Cams							

LIST OF EXPERIMENTS:

1. a) Study of gear parameters.
   b) Experimental study of velocity ratios of simple, compound, epicyclic, and differential gear trains.
2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double Crank, Double Rocker, and Oscillating Cylinder Mechanisms.
   b) Kinematics of single and double universal joints.
3. a) Determination of mass moment of inertia of flywheel and axle system.
   b) Determination of mass moment of inertia of axisymmetric bodies using turntable apparatus.
   c) Determination of mass moment of inertia using bifilar suspension and compound pendulum.
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor – Determination of range, sensitivity, effort, etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, motion curves, and study of jump phenomenon.
7. a) Single degree of freedom spring mass system – Determination of natural frequency and verification of laws of springs – Damping coefficient determination.
   b) Multi-degree freedom suspension system – Determination of influence coefficient.
8. a) Determination of torsional natural frequency of single and double rotor systems – Undamped and damped natural frequencies.
   b) Vibration absorber – Tuned vibration absorber.
9. Vibration of equivalent spring mass system – Undamped and damped vibration.
10. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
11. a) Balancing of rotating masses.
    b) Balancing of reciprocating masses.
12. a) Transverse vibration of free-free beam – With and without concentrated masses.
    b) Forced vibration of cantilever beam – Mode shapes and natural frequencies.
    c) Determination of transmissibility ratio using vibrating table.

Note: At least eight experiments are required to be performed by students from the above list, and two may be performed from the experiments developed by the institute.

B24- MAC-202	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE						
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of exam (Hours)**
3	**0**	**0**	**1**	**-**	**100**	**100**	**3**
Purpose	To facilitate the students with the concepts of Indian traditional knowledge and to help them understand the importance of the roots of the knowledge system, analyze, and apply it to their day-to-day life.						
	CourseOutcomes						
CO1	The students will be able to understand, connect, and explain the basics of Indian traditional knowledge in a modern scientific perspective.						
CO2	The students will be able to understand holistic health using the Indian knowledge system.						
CO3	The students will be able to manage thoughts and emotions, and will learn positivity, self-regulation, and control.						
CO4	The students will be able to achieve consciousness through the Indian knowledge system.						

UNIT-I

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-II

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

UNIT-III

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-IV

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:

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

B24-ESC-216	MATERIALS ENGINEERING LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**End Semester Exam**	**Internal Assessment**	**Practical**	**Total**	**Duration of exam (Hours)**
0	**0**	**2**	**1**	**0**	**40**	**60**	**100**	**3**
Purpose	To make the students prudent in metallographical sample preparation, microstructure analysis, basic heat treatment operations and production of Biofuels.							
Course Outcomes: After studying the course, students will be able to:								
CO 1	Students will have the ability to design and conduct experiments, acquire data, analyze and interpret data							
CO 2	Students will have the ability to determine the grain size and microstructure in different Ferrous alloys by means of experiments							
CO 3	Students will have the ability to identify and differentiate microstructures of different Non-Ferrous alloys.							
CO 4	Students will be able to perform various heat treatment processes using muffle furnace in the lab.							
CO5	Students will have the ability to analyse microstructure of Heat-treated specimens and perform Fatigue and creep test on different materials.							
CO6	Students will be able to perform lab scale production of Biofuel.							

1. To Study various Crystal Structures through Ball Models.
2. To study the components and functions of Metallurgical Microscope.
3. To learn about the process of Specimen Preparation for metallographic examination.
4. To perform Standard test Methods for Estimation of Grain Size.
5. To perform Microstructural Analysis of Carbon Steels and low alloy steels.
6. To perform Microstructural Analysis of Cast Iron.
7. To perform Microstructural Analysis of Non-Ferrous Alloys: Brass & Bronze.
8. To perform Microstructural Analysis of Non-Ferrous Alloys: Aluminium Alloys
9. To Perform annealing of a steel specimen and to analyze its microstructure.
10. To Perform Hardening of a steel specimen and to analyze its microstructure.
11. To perform Jominy End-Quench Hardenability Test.
12. To perform Fatigue test on fatigue testing machine.
13. To perform Creep test on creep testing machine.
14. To produce a sample of Biodiesel.
15. To study the functioning of fuel cells.

Note: At least eight experiments are required to be performed by students from the above list and two may be performed from the experiments developed by the institute.