4th Semester Mechanical Engineering

Course No.	*Course Name*	*Credits*	*L*	*T*	*P*
MEC 401	Materials Science	3	2	1	0
MEC 402	Mechanics of Materials- II	4	3	1	0
MEC 403	Theory of Machines -I	4	3	1	0
MEC 404	Applied Thermodynamics-I	3	2	1	0
MEC 405	CAM & Industrial Automation	4	3	1	0
ELE 406	Electrical Engineering Technology	3	2	1	0
MEC 403P	Theory of Machines-I Lab.	1	0	0	2
MEC 404P	Applied Thermodynamics-I Lab.	1	0	0	2
MEC 405P	CAM & Industrial Automation Lab.	1	0	0	2
ELE 407P	Electrical Engineering Technology Lab.	1	0	0	2
	Total of Credits & LTP	**25**	**15**	**6**	**8**

Course No.: MEC 401 **MATERIALS SCIENCE** **C L T (3 2 1)**

COURSE OUTCOMES:

1. **Understand the crystal structure and classification of materials.**
2. **Understand methods of determining mechanical properties and their suitability for applications.**
3. **Classify cast irons and study their applications.**
4. **Interpret the phase diagrams of materials.**
5. **Select suitable heat treatment process to achieve desired properties of metals and alloys.**

UNIT I

Introduction to material science and engineering, why study material science and engineering, classification of materials, modern and advanced materials, human needs and materials selection, and design considerations. Atomic structure and bonding, fundamentals of electron arrangements and modern periodic table, primary bonds and secondary bonds, energy related concepts. Structure of metals and ceramics, concept of unit cells and lattice arrangements.

UNIT II

Density computations for metals, ceramic crystal structure and density computations. Polymorphism and Allotropy, crystal systems, crystallographic directions and planes, Atomic densities (linear and planar), single crystals, polycrystalline materials anisotropy, x-ray diffraction and determination of crystal structures, Polymer structure, hydrocarbon molecules, polymer molecules and their chemistry, molecular weight and shape and structure, thermoplastic and thermosetting polymers, Imperfections in solids, point defects, line defects and volume defects

UNIT III

Impurities and their role in materials, grain size determination, Diffusion mechanism, steady state diffusion, nonsteady state diffusion, factors that influence diffusion, diffusion in ionic and polymeric materials. Deformation and strengthening mechanisms, plastic deformation of polycrystalline metals, Deformation by twining, strengthening by grain size reduction, Phase diagrams, solubility limit, phases, micro-structure and phase equilibria.

Text Book:

Callister,W.D, "Fundamentals of Materials Science and Engineering", *John Wiley & Sons, Inc. 2001*

Reference Books:

1. Cahn, R.W., Haasen P., " Physical Metallurgy", Vo I, II, III, *North-Holland, 1996.*
2. Ashby,M., Johonson,K., "Materials and Design" *Butterworth-Heinemann, 2002.*

Course No: MEC 402 **MECHANICS OF MATERIALS- II** **C L T (4 3 1)**

COURSE OUTCOMES:

1. **Describe various energy theorems & compute deflection of beams/trusses using energy principles.**
2. **Evaluate the rotational stresses.**
3. **Recall the stresses in unsymmetrical bending/curved beams.**
4. **Analyse the effect of forces on springs.**

UNIT I

Strain energy due to normal and shear stresses, The total elastic strain of dilation and distortion, The energy elastic theorems, Theorems on virtual work, Castigliano's theorem, Complementary energy theorems, Strain energy due to axial bending and Torsional loads, Stresses due to suddenly applied loads, Use of energy theorems to determine deflection of beams and twists of shafts, Maxwell's theorem of reciprocal deflections and its corollaries, Unit couple and unit load methods of determining slopes, deflections.

Stresses in rotating disc of constant thickness, Stresses in hollow & solid discs, stresses in rotating solid and hollow cylinders, stresses in spooked rim.

UNIT II

Overview of Ixx, Iyy, & Ixy. Stresses due to unsymmetrical bending, combined bending & axial loads, Shear centre for symmetrical and unsymmetrical sections. Alternative procedures for calculation of stresses. Deflection of straight beams subjected to unsymmetrical bending,

Bending of beams with large initial curvature. Circumferential stresses, location of the neutral axis, Application to beams with rectangular, circular and trapezoidal cross sections. Stresses in crane hook, Stresses in a ring, stresses in a chain link. Deflection of curved bars, Deflection of curved bars by Castigliano's theorem.

UNIT III

Close coiled helical spring, axial load, axial torque, strain energy in the spring, spring under impact load, springs in series and parallel, concentric springs, open coiled helical spring, axial load, axial torque, stresses in spring wire, combined action of axial load and moment, flat spiral springs, leaf springs, semi-elliptical spring, quarter elliptical leaf spring, graduated & full length leaves, equalized stress in spring leaves, conical springs.

Text Books:

1. Popov, E.P., Balan,T.A, "Mechanics of Solids", *Prentice Hall of India,New Delhi, 2007.*
2. Shames, I.H., Pitaresi, J.M., "Introduction to Solid Mechanics" *Prentice Hall of India, EEE, New Delhi, 2006.*

Reference Books:

1. Fung, Y.C., “Foundations of Solid Mechanics”, *Prentice Hall of India, New Delhi,1968.*

Course No.: MEC 403 **THEORY OF MACHINES-II** **C L T (4 3 1)**

COURSE OUTCOMES:

1. **Evaluate the velocity & acceleration of links in a mechanism or machine.**
2. **Explain the working principle of different machines.**
3. **Design linkages & gear mechanisms for a given motion or a given input/output motion relationship.**
4. **Apply the laws of friction in applications of mechanisms and machines.**

UNIT I

Introduction, Kinematics and dynamics, Lower pairs & higher pairs, Degree of freedom (DOF), Gruebler's eqn. and Kutzbach's criterion, Mechanisms and DOF, Inversions, Grashof's law and Quick return mechanism, Coupler curves, Velocity and acceleration analysis, Mechanical advantage, Transmission and deviation angle, Instantaneous centre.

Friction: Types, Laws, Friction of nut and screw, Screw jack, Torque required to lift and lower loads, efficiency, Pivot and collars & journal bearings, Friction clutches, Single and multi-disc plate clutch, Brakes, classification, Braking of vehicle.

Governors: Difference between flywheel and governor, Watt governor, Porter governor, analysis, effect of friction, Proell governor, Hartnell governor. Controlling force, sensitivity, stability, hunting, Isochronism, effort and power of a governor.

UNIT II

Gears: Rolling contact and positive drive, classification of gears, Nomenclature, Law of gearing, Conjugate teeth, involute and cycloidal profile system of gear teeth, Length of path of contact, arc of contact, contact ratio, Interference and undercutting, interchangeable gears, Helical and spiral gears. Gear trains: Classification, Types, simple gear train, speed ratios, Compound, reverted, Epicyclic gear train, tabulation and algebraic method, Compound epicyclic train.

UNIT III

Cams: Comparison with lower paired mechanisms, Classification of cams and followers, Terminology for cams, types of follower motions, pressure angle, considerations influencing choice of cam, construction of cam profiles, layout, Offset followers. Precessional motion and angular acceleration, Gyroscopic couple, reaction couple. Effects on an aeroplane, naval ship, gyroscopic ship stabilization, Stability analysis of a two-wheel vehicle, Stability of a four-wheel drive on a curved path. Acceleration in Cartesian and Spherical co-ordinates, Inertia forces and D'Alembert's principle.

Text Book:

1. Shigley J.E, "Theory of Machines and Mechanisms", *Mc Graw Hill, New York,1995*.

Reference Book:

1. Mabie H.H., Reinholtz C.F, "Mechanism and Dynamics of Machinery" Fourth edition, *John*

Wiley & Sons, 1987.

2. Ambekar A., "Mechanisms and Machine Theory", *Prentice Hall, New Delhi, 2007.*

Course No.: MEC 404 **APPLIED THERMODYNAMICS-I** **C L T(3 2 1)**

COURSE OUTCOMES:

1. **Able to analyze the thermal systems,based on ideal and actual working conditions.**
2. **Able to identify various components of steam power cycles,compressors and boilers.Understand the working of boilers ,boiler mountings and accessories.**
3. **Able to compute the efficiency and other system parameters of steam power cycles,steam turbines,air standard cycles,compressors and nozzles.**
4. **Able to understand the working of actual IC engines and compressors based on actual cycle.**

UNIT I

Carnot cycle for steam, Rankine and modified Rankine cycle, deviation of actual cycles from ideal cycles, cycle efficiency, second law analysis of vapour power cycle, binary vapor power cycles, Types of nozzles, isentropic flow through nozzles, effect of friction, nozzle efficiency, critical pressure ratio for maximum discharge, throat and exit areas, supersaturated flow.

UNIT II

Classification of boilers (Water tube, Fire tube), boiler mountings and accessories, boiler draught, boiler rating, boiler performance, heat balance, Steam Turbines, Position of steam turbine in power industry, types and applications, impulse turbines, pressure and velocity compounding, velocity diagram, work output, blade, stage, internal and overall efficiency, reaction turbines, velocity diagram, degree of reaction, work out put, losses and efficiency, Reheat cycle, regenerative feed heating, Direct and indirect feed heating, efficiency and work out put calculations, governing of steam turbines

UNIT III

Single stage compressor, induction diagram and power requirement, effect of clearance volumetric efficiency, Multistage compressors, indicators diagram with and without clearance, effect of intercooling, power requirement, Air standard Cycles, Carnot, Otto, diesel and dual cycles, work output and efficiency, mean effective pressure, deviation of actual cycles from ideal cycles.

Text Books:

1. Eastop, T.D., "Applied Thermodynamics for Engineering Technologist", *Pearson education, 1990.*

1. Rogers G.F.C., Mayhews, "Engineering Thermodynamics", *Pearson Education, 1990.*

Reference Book:

1. Kearton, W.J., “Steam Turbines”, *CBS Publishers, New Delhi, 1960*.

Course No.: MEC405 **CAM & INDUSTRIAL AUTOMATION** **C L T (4 3 1)**

COURSE OUTCOMES:

1. **Able and identify the functioning of CNC machines,manufacturing systems and support systems in industries.**
2. **Explain the process of non-conventional machining along with their advantages and applications.**
3. **Recognize the need of limits ,fits and tolerancesin manfacturing and apply knowledge to design gauges for various industrial applications.**
4. **Analyze and access the importance of industrial automated systems and identify the use of design systems in manufacturing industries.**

UNIT 1

Brief history of NC and CNC machines, Open loop & closed loop CNC machines, classification of CNC machines, Advantages of CNC machines, setup time reduction, Introduction to CNC programming, Adaptive control, machining parameters selection, Introduction to robotics and Automated Guided vehicles(AGV's), Introduction to Flexible manufacturing systems (FMS), Elements of FMS and its advantages, Cellular manufacturing, Expert systems in manufacturing & simulation, maintenance automation.

UNIT II

Introduction to unconventional machining processes, Abrasive Jet Machining (AJM), Abrasive water jet machining (AWJM), advantages and applications, Ultra Sound machining(USM), process variables and advantages, Electro Discharge Machining (EDM), process variables. Metrology: Limits, fits and tolerances: hole basis and shaft basis system, unilateral and bilateral system, Taylor's principles of gauge design, Sine bars and gauge blocks manufacturing method and their applications, use of Dial indicators, Comparators and Coordinate measuring machine (CMM).

UNIT III

Introduction to industrial automation, and justification, pneumatics and electro-pneumatics, different valves, design of different pneumatic circuits for various industrial automation related applications, fluid logic control systems, Automated inspection, Introduction to PLC's (??) and its applications.

Text Books

1. Degarmo, E.P., Black, J.T. and Kohser, R.A, " Materials and Processes in Manufacturing",

*Prentice Hall of India***,** New Delhi, 2006.

2. Anthony, E., “Fluid Power with applications”, *Prentice Hall of India ,New Delhi, 2007.*

3. Zeid, I., “CAD/CAM Theory & Practice”, *Tata Mc-Graw Hill, New Delhi, 2008*

Reference Book:

1. Serop K. Steven, “Manufacturing Processes for Engineering Materials”, *Prentice Hall of India, New Delhi, 2004.*

Course No.: ELE406 ELECTRICAL ENGINEERING TECHNOLOGY C L T (3 2 1)

COURSE OUTCOMES:

1. **To analyze and evaluate the electrical circuits ,apply basic laws in circuit theory and to determine electric circuit parameters.**
2. **To identify and analyze various energy sources and their transformations.**
3. **Power and energy relations ,analysis of series-parallel D.C. circuits and network theorem along with applications.**
4. **To study the transducers used for mechanical circuits,transformers open circuit and short circuit tests,D.C. machines.**
5. **To study the analogue and digital energy meters, Measurement of R, L and C, Extension of voltmeters and ammeters.**

UNIT I

Network Analysis and theorems, Basic Circuit Theory (D.C and A.C), Resistance, Inductance and Capacitance, Ohm's law, KCL (??) ,KVL (??) , Power and energy relations, superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power transfer theorem, Sinusoidally – excited circuits; Basic definitions of A.C. circuits, phasor algebra and complex number representations, solutions of sinusoidally excited R. L.C circuits, Introduction to 3 – phase circuits.

UNIT II

Transformers; Construction, Principle of operation, e.m.f. equation, Phasor diagrams, No Load and on load, Equivalent circuit model, Voltage regulation and test, Introduction to 3-phase transformers, Applications.

D.C. Generators and motors; Basic construction, Principles of operation, Types of D.C. generators and motors, Applications.

UNIT III

Transducers; Definitions, Types of transducers and their applications for mechanical measurements, Ammeters and voltmeters: Meter range extension and their connections in their circuits, Bridge methods to measure; Resistance, inductance and capacitance; various types of bridges and their applications for measuring, R, L and C., Measurement of power and energy; watt meters, measurement of power using Watt meters, energy meters and measurement of electrical using energy meters, Digital Instruments; Introduction to digital meters for the measurement of various electrical quantities.

Text Book:

1. Nagrath, I.J., Kothari, D. P., "Electrical Machines," *Tatal Mc Graw Hill, New Delhi, 1985.*

Reference Books:

1. Del Toro, V., "Principles of Electrical Engineering," *Prentice Hall International, 1985.*

MEC 403P THEORY OF MACHINES-I LAB. C P(1 2)

COURSE OUTCOMES:

1. **Explain the working principle of machine & machine components.**
2. **Evaluate the design & working of the gears & cam followers.**
3. **Evaluate the characteristics of governor.**

1. Study of kinematic pairs & working of stroboscope.
2. Slider crank motion, reciprocating engine mechanism, Inversion of four bar chain, Oscillating cylinder mechanism and Whitworth quick return mechanism.
3. Various models of brakes, and Working of a clutch using clutch model.
4. Study the characteristics of a Watt Governor.
5. Study the characteristics of a Proell Governor
6. Study the characteristics of a Porter Governor
7. Study the characteristics of a Hartnell Governor
8. Generation of involute gear tooth profile.
9. Involute teeth in contact & interference and under cutting of gear and its significance.
10. Study of pairs of cams and follower
11. Determine the velocity of precession of a given motorized gyroscope.

MEC 404 P APPLIED THERMODYNAMICS-I LAB. C P (1 2).

COURSE OUTCOMES:

1. **Able to identify various parts of a boiler.**
2. **Able to calculate the dryness fraction of steam using calorimeter.**
3. **Able to prepare heat balance sheet.**
4. **Able to determine COP of refrigerator.**
5. **Able to identify various parts of cooling tower.**

1. Study of Nestler Boiler.
2. Calculation of dryness fraction of steam.
3. Calculation of heat balance sheet of a boiler
4. Determination of COP of a refrigeration system.
5. Study of cooling tower.

Add three more experiments or include number of classes for each experiment

MEC 405P CAM & INDUSTRIAL AUTOMATION LAB. C P (1 2)

COURSE OUTCOMES:

1. **Explain the working and use of various components of CNC machines.**
2. **Identify the sequence of codes to process a job.**
3. **Create CNC program for turning and milling operations.**
4. **Produce different profiles on the surface of a given material**

A) Jobs on CNC lathe machine.

1. Safety precautions and Study of CNC lathe machine.
2. Performing step turning.
3. Performing taper turning.
4. Performing radius turning.
5. Performing multiple turning cycle.
6. Performing pattern repetition cycle operation.

B) Jobs on CNC Milling machine.

1. Study of CNC Milling machine.
2. Performing linear cuts and circular cuts
3. Performing linear and circular cuts using subroutines
4. Performing pocket milling

C) Metrology

1. Use of sine bars and slips gauges for angle measurement.
2. Use of bevel protector and dial gauges

ELE-407 P ELECTRICAL ENGG. TECH. LAB. C P (1 2)

COURSE OUTCOMES:

1. **To study the basic equipments e.g. Ammeter, voltmeter, Multimeter, etc.**
2. **To apply basic electrical theorems for the circuit analysis e.g. KVL,KCL.**
3. **To apply circuit theorems e.g. Superposition theorem, Thevenin`s theorem, norton theorem, maximum power theorem. To analyze the circuit**
4. **To solve the complex circuits using series parallel or star delta transformation.**

1. To study the overall safety procedures to be employed, while working with electric circuits.
2. To study the series and parallel operations of resistors, inductors and capacitors.
3. To verify
    - KVL and KCL in DC circuits.
    - Superposition theorem.
    - Thevenin's Theorem
4. To measure electric power in a single phase AC circuit with resistive load, R – L and RLC load.
5. To study the overall construction of electric machines.
6. Measurement of Electric Energy by
    - KWH Meter
    - Watt meter
7. Measurement of Power factory by
    - Power Factor Meter
    - Voltmeter, ammeter and watt meter method