COURSES OF STUDY FOR
B. TECH.
MECHANICAL ENGINEERING
AT

N.I.T. SRINAGAR Hazratbal, Srinagar
J&K 190006

CONTENTS

Course wise Credit Scheme

3rd Semester Mechanical Engineering					
Course No.	Course Name	Credits	L	T	P
MEC 301	Fundamental Dynamics	3	2	1	0
MEC 302	Mechanics of Materials-I	4	3	1	0
MEC 303	Fluid Mechanics	3	2	1	0
MEC 304	Engineering Thermodynamics	3	2	1	0
MEC 305	Manufacturing Technology	3	2	1	0
MEC 306	Engineering Graphics & Computer Modelling	3	0	0	6
MTH 304	Mathematics	3	2	1	0
MEC 302P	Mechanics of Materials –I Lab.	1	0	0	2
MEC 303P	Fluid Mechanics Lab.	1	0	0	2
MEC 305P	Manufacturing Technology-I Lab.	1	0	0	2
	Total of Credits & LTP	25	13	6	12

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

5th Semester Mechanical Engineering					
Course No.	Course Name	**Credits**	**L**	**T**	**P**
MEC 501	Theory of Machines-II	4	3	1	0
MEC 502	Machine Design-I	4	3	1	0
MEC 503	Hydraulic Machinery	3	2	1	0
MEC 504	Heat Transfer	3	2	1	0
MEC 505	Industrial Engineering-I	4	3	1	0
ECE 508 /507	Industrial Electronics	3	2	1	0
MEC 501P	Theory of Machines-II Lab.	1	0	0	2
MEC 504P	Heat Transfer Lab.	1	0	0	2
MEC 505P	Industrial Engineering-I Lab.	1	0	0	2
ECE 508P	Industrial Electronics Lab.	1	0	0	2
	Total of Credits & LTP	25	15	6	10

6th Semester Mechanical Engineering					
Course No.	Course Name	**Credits**	**L**	**T**	**P**
MEC 601	Automatic Control	4	3	1	0
MEC 602	Machine Design-II	4	3	1	0
MEC 603	Fundamentals of Tribology	4	3	1	0
MEC 604	Linear Optimization in Engineering	4	3	1	0
MEC 605	Introduction to Mechatronics	4	3	1	0
MEC 606	SEMINAR	3	0	0	6
MEC 603P	Fundamentals of Tribology Lab.	1	0	0	2
MEC 605P	Mechatronics-Lab.	1	0	0	2
	Total of Credits & LTP	25	15	05	10

7th Semester Mechanical Engineering					
Course No.	Course Name	**Credits**	**L**	**T**	**P**
MEC 701	Basic Fracture Mechanics	3	2	1	0
MEC 702	Measurement and Instrumentation	4	3	1	0
MEC 703	Industrial Engineering-II	4	3	1	0
MEC 704	Applied Thermodynamics-II	4	3	1	0
MEC 705	Computer Applications in Mech. Engg.(CAME)	3	2	1	0
MEC 703P	Industrial Engineering-II Lab.	1	0	0	2
MEC 705P	CAME Lab.	1	0	0	2
MEC 706	Final Year Project	3	0	0	6
MEC 707	Practical Training & Professional Viva	2	0	0	0
	Total of Credits & LTP	25	13	05	10

8th Semester Mechanical Engineering					
Course No.	Course Name	**Credits**	**L**	**T**	**P**
MEC 801	Production & Operations Management	4	3	1	0
MEC 802	Internal Combustion Engines	4	3	1	0
MEC 803	Departmental Elective-I	3	2	1	0
MEC 804	Departmental Elective -II	3	2	1	0
MEC 805	Final Year Project	10	0	0	20
MEC 802P	I.C. Engine Lab.	1	0	0	2
	Total of Credits & LTP	25	10	04	22

ELECTIVE-I	
Course No.	Course Name
MEC 80*	Value Engineering
MEC 80*	Theory of Elasticity(TOE)
MEC 80*	Introduction to Acoustics
ELECTIVE-II	
MEC 80#	Power Plant Engineering(PPE)
MEC 80#	CAD of Thermal systems
MEC 80#	Introduction to MEMS

ME 3rd Semester

Course No.: MEC 301 FUNDAMENTAL DYNAMICS C L T (3 2 1)

Course outcomes (COs)

CO1: Introduce students to the concepts of dynamics. The students are expected to develop working skills in the dynamic analysis of both particles and rigid bodies, determine the dynamic response of the system to applied loadings, using Newton's Laws, and apply the Principle of Work and Energy and the Principle of Impulse and Momentum to mechanical systems
CO2: Master the basics of dynamics, including free body diagrams and kinematics, and broadens those basics through the extensive use of vector math to 3-D problems, solve plane motion rigid body dynamics problems using full vector notation approaches.
CO3: Choose carefully among different fundamental equations of dynamics to solve problems such as conservation of energy, conservation of momentum, or Newton's 2nd law, Write linear and angular impulse moment for 3D problems.
CO4: Learn the mathematical formulations of dynamics problems, solve selected 3D rigid body problems using dynamics and kinematics equations presented.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	1							2		3	2	2	1
CO 2	3	3	2							3		3	2	3	1
CO 3	2	3	3							3		3	2	3	1
CO 4	3	1	1							1		1	2	1	1

UNIT I

Kinematics of Particles: Introduction, Rectilinear Motion, Plane Curvilinear Motion , Rectangular coordinates (x-y), Normal and Tangential coordinates (n-t), Polar coordinates (r-θ), Space curvilinear Motion, Relative Motion, Constrained particle Motion. (Vectorial approach to bead opted)

UNITII

Kinetics of Particles: Review of Force, Mass, Acceleration, Impulse, Momentum, Work and Energy, Linear impulse and linear momentum, Angular impulse and angular momentum, Impact, Central-Force and motion, and relative motion.
Kinetics of Systems of Particles: Introduction, Generalized Newton's second law, Work-Energy, Impulse-Momentum, Conservation of Energy and Momentum, Steady Mass Flow, Variable mass.

UNIT III

Plane Kinematics of Rigid Bodies: Introduction, Rotation, Absolute Motion, Relative velocity, Instantaneous center of zero velocity, Relative acceleration, Motion relative to rotating axes.
Plane Kinetics of Rigid bodies: Introduction, General equation of Motion, Translation, Fixed axis rotation, General plane motion, Work energy relations, acceleration from work-energy; virtual work, Impulse-Momentum equation.

Text Book:

1. Meriam, J.L., Kraige, L.G., "Engineering Mechanics: Vol.2, Dynamics". S.I., Version, JohnWiley&SonsInc.,1996.

Reference Book:

1. Hibbeler, R.C.,"Dynamics",PrenticeHall,N.Jersy,USA,2000.

Course No.:MEC302 MECHANICS OFMATERIALS-I C L T (4 3 1)

Course outcomes (COs)

CO1: Explain stress-strain, relate & evaluate them for different planes in a structural member.
CO2: Compute deformation in pressure vessels.
CO3: Compare different theories of failure & propose the appropriate one for particular material/situation.
CO4: Estimate bending stresses & deflection of beams/columns under various conditions.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	2			1						1	1	2	
CO 2	3	2	2			1						1	2	2	
CO 3	2	3	3			2						2	3	1	
CO 4	3	3	2			1						2	3	2	

UNIT I

General concepts: Free body diagram, section forces in beams, general concepts of stress and strain, stresses on inclined plane in an axial member, strain displacement equation, compatibility conditions, statically indeterminate structures, thermal effects.
Analysis of stress and strain: Three dimensional states of stress, Mohr's circle, Cauchy's formula, principal stresses and principal planes, three dimensional state of strain, principal strains and principal axes, Generalized Hook's law, elastic constants and their relationships, measurement of strain, strain energy.
Pressure Vessels: Stresses and strains in thin cylindrical and spherical shells, thick cylinders, Lame's theory, radial deflection, compound cylinder, effective proportions, laminated cylinders.

UNITII

Introduction to mechanical properties of solids: Stress – strain diagrams, resilience, hardness, impact strength. Symmetric beam bending: The elastic flexural formula and applications, built-up and composite beams. Integration method of solution, Macaulay's method of solution, Area moment method, statically indeterminate beams, Conditions for indeterminacy, Energy methods for beams, strain energy and complementary strain energy.

UNITIII

Theories of Elastic Failures: Various theories of elastic failure, significance of the theories of failure, comparison and graphical representation.
Columns: Concept of elastic stability, Euler's theory of buckling of columns, eccentric loading, short columns.

Torsion: Torsion of circular shafts, comparison between hollow & solid shafts, tapered circular shafts, torsion of thin circular tubes, statically indeterminate shafts.

Text Books:

Popov, E. P., Balan, T.A, "Mechanics of Solids", Prentice Hall of India, N. Delhi, 2007.
Shames, I.H., Pitaresi, J.M., "Introduction to Solid Mechanics" Prentice Hall of India. EEE, 2006.
Kazmi, S. M. A, "Solid Mechanics", Tata Mc-GrawHill, 1998.

Reference Books:

Fung, Y. C., "Foundations of Solid Mechanics", Prentice Hall of India, 1968.
Hearn, E. J., "Mechanics of Materials", Vol. I, Pergamon press, 1989.

Course No.:MEC303 FLUID MECHANICS C L T (3 2 1)

Course Outcomes

CO1: Apply conservation laws to fluid flow problems in engineering applications.
CO2: Design experimental procedure for physical model studies.
CO3: Compute drag and lift coefficients using the theory of boundary layer flows
CO4: Analyze and design free surface and pipe flows.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	2	2								2	2	1	
CO 2	3	3	3	3								2	2	1	
CO 3	2	1	3	1	1							1	2	1	
CO 4	2	1	3	2				1				1	2	1	

UNIT I

Introductory definitions, fluids, types of fluids, Continuum approach to stress, Fluid properties, Fluid at rest, Pascal's law, Barometers, Manometers, Hydrostatic pressure thrusts, Buoyancy, Flotation, Stability, Scalar and velocity fields, Flow field and description of fluid motion.

UNIT II

Continuity equation, Momentum equation, Energy equation, Euler's equation, Bernoulli equation, Ideal fluids, Naiver-stokes equations, exact solutions, Laminar boundary layer, boundary layer equations, Blausius flow, momentum-integral equation of boundary layer.

UNIT III

Turbulent flow, Laminar-Turbulent Transition, Fluctuations, Turbulent boundary layer equations, Shear stress models, Universal velocity distribution law, pipe flow, friction factor, fully developed pipe flow, pipe bends, pipe losses, Dimensional homogeneity, Raleigh methods, Buckingham's theorem, typical non-dimensional parameters, Geometric, kinematics and dynamics similarity, model testing.

Text Book:

White , F.M., "FluidMechanics",Mc-GrawHill,2001.

Munson,B.R., "Fundamental of FluidMechanics",JohnWiley,2002.
CengalY.,"FluidMechanics",McGrawHill,2001.

Course No.: MEC 304 ENGINEERING THERMODYNAMICS C L T (3 2 1)

Course Outcomes (COs)

CO1: Develop the concept of basic laws of thermodynamics and thermodynamics systems.
CO2: Apply and analyze First & Second Law of Thermodynamics.
CO3: Apply the concept of Carnot cycle on heat engine & heat pumps.
CO4: Develop the basic knowledge of thermodynamics relation.

CO PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	1							2		3	2	2	1
CO 2	3	3	2							3		3	2	3	1
CO 3	2	3	3							3		3	2	3	1
CO 4	3	1	1							1		1	2	1	1

UNIT I

Introduction and historical development, Microscopic and macroscopic views of matter, Thermodynamic systems, properties, processes, cycles, thermal equilibrium, Zeroth law of thermodynamics, temperature, thermodynamic equilibrium, Energy and the first law, Mechanical concept of energy, internal energy, conservation of energy, energy transfer as work, various modes, energy transfer as heat, First law for closed system, The state postulate, pure substance, simple compressible substances, specific heat, isothermal, isobaric, isentropic compressibility.

UNIT II

First law for open systems, enthalpy, first law for cyclic processes, applications, Second law of Thermodynamics, Entropy and second law, Thermodynamic reservoirs, various statements and their equivalence, reversible cycle, Carnot cycle, efficiencies of reversible cycle, Carnot's theorem, Thermodynamic temperature scale, Clasius's theorem, entropy concept, inequality of Clasius's principles of increase of entropy and its applications, Second law for closed system, Second law for open system.

UNIT III

Energy, Gibb's function, Helmholtz function, Relationship between specific heats, Clapeyron equations, thermodynamic relations for ideal gases (computation of entropy and internal energy from measurable quantities, Process with ideal gases and vapors, Calculations involving heat transfer, work transfer and change in thermodynamic properties with various processes, Ideal gas mixture, various definitions, Dalton's law, Gibb's – Dalton's law, Amagat -Leduc law, internal energy, enthalpy, specific heat and entropy of an ideal gas mixture, air water vapor mixture, Complete and incomplete combustion analysis, heating value of fuels, analysis of products of

combustion, Orsat apparatus.

Text Books:
Moran, M.J., Shapiro, "Fundamentals of Engineering Thermodynamics", John Wiley, 2005.
Wark, K., "Thermodynamics",Mc-GrawHill,2001.

Reference Books:
Cengal, Y.,Boles,"Thermodynamics",Mc-GrawHill,2001.
Van-Wylen, G.J., "Fundamentals of Classical Thermodynamics", John Wiley,2001.

Course No.:MEC305 MANUFACTURING TECHNOLOGY C L T(3 2 1)

Course Outcomes (COs)

CO1: Analyze the application of various casting processes in manufacturing domain.
CO2: Understand the basics and mechanics of metal cutting with reference to different types of machine tools.
CO3: Explain and be able to analyze the conventional and advanced metal forming processes.
CO4: Analyze the welding process behavior for fusion and solid state welding techniques.

CO PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3				2	3	2	2				3	2	2	2
CO 2	3	2	2		2	3	2	2	2	2	2	3	2	1	
CO 3	3				2		2	2				3	1	2	
CO 4	3	2	3	2	2		3	2	2	2		3	2	2	2

UNIT I

Introduction to basic manufacturing processes and engineering materials, Casting terminologies, solidification, expendable mould casting processes, patterns and risers, investment casting and plaster mould castings, die casting , centrifugal casting. Introduction to metal cutting, machining processes and machine tools. Orthogonal machining, Cutting forces, shear plane angle, Ernst Merchant theory, mechanics of metal cutting. Tool life equation. Lathe parts and turning operations, Cutting tool nomenclature, tool materials, tool wear. Various machine tools and operations.

UNIT II

Metal Forming: fundamentals of metal forming, independent and dependent variables, hot working and cold working, warm forming, rolling. Forging and various types of forging, extrusion and various types of extrusion. Introduction to various press work operations, press working dies, shearing load and press selection, spinning, High energy rate forming, explosive forming, Electromagnetic forming and its applications, Fabrication of composites.

UNIT III

Welding: Introduction to welding, types of welding. Welding machines, Shielded Metal Arc Welding (SMAW) process, Gas Metal Arc Welding(GMAW) process, Gas Tungsten Arc Welding(GTAW) process, Shielded Arc welding (SAW) process, Resistance welding, Seam, Spot and Flash butt welding, Ultrasonic welding, Laser beam welding, Automation in welding and various defects.

Text Book:

Degarmo, E.P., Black,J.T.andKohser,R.A.,"MaterialsandProcessesinManufacturing", PrenticeHallofIndia,2005.

Reference Books:

Serop, K., Steven, R.S., "Manufacturing Processes for Engineering Materials", Prentice Hall ofIndia,1998.

Course No.:MEC306 ENGINEERING GRAPHICS&COMPUTER MODELLING C L P(3 06)

Course Outcomes (COs)

CO1: Classify the various principles of engineering drawing and examine CAD for 2D and 3D modelling.
CO2: Design and analyze the assembly modelling and surface modelling of machine components.
CO3: Ability to modify the developed assembly model for machine components.
CO4: Evaluation of designed components and thereby procuring the knowledge of new product development.

CO PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	3	1	3	2		1		1	1	3	3	3	2
CO 2	3	3	3	2	3	1	2	2	2	1		3	3	2	3
CO 3	2	3	2	3	2	3	3	3	2	3	3	2	2	3	2
CO 4	3	3	2	3	3	3	3	3	1	2	3	2	3	2	3

UNIT I

Introduction to CAD, Theory of general engineering design, conceptual design, embodiment design involving layout and form designing to standard, geometrical modelling: basic sketching, lines and arcs, extrude and revolve features.

UNIT II
Extrude cut and fillets, solid modelling of Oldham's coupling components, surface modelling, merging of surfaces, assembly modelling, assembly modelling of Oldham's coupling, machine elements.

UNIT III

Tail stock components and assembly of tail stock components, components of globe valve, and assembly of globe valve components of butterfly valve, assembly of butterfly valve, Introduction to animation, Mini Project.

Text Books:

Bhat, N.D., "Machine Drawing", Charotar Publishing House Pvt. Ltd., 2008.
Gill, P.S., "Machine Drawing", Kataria and Sons, New Delhi, 2008.

Reference Book:

ZeidI.,"CAD/CAMTheory&Practice",TataMc-GrawHill,NewDelhi,2008.

Course No.: MTH 304 MATHEMATICS C L T (3 2 1)

Course Outcomes (COs)

CO1: Demonstrate the properties of Laplace transforms and be able to solve differential equations by applying Laplace transforms.
CO2: Able to study harmonic functions with their applications.
CO3: Calculate poles and residues of real and complex functions and hence evaluate contour integrals.
CO4: Able to apply Fourier transforms for solving boundary value problems.

CO PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3		1						3			2	3	1
CO 2	3	3	1	1						2			2	3	1
CO 3	3	3	2	1						2			1	2	1
CO 4	3	3	3	3						3			2	3	2

UNIT 1

Laplace transform, shifting theorem, Laplace transforms of derivatives and integrals, Heaviside's unit function. Dirac Delta function and its Laplace transforms. Laplace transforms of periodic functions, Heaviside's expansion theorem, Inverse Laplace transforms, initial and final value theorems.

UNIT II

Convolution theorem and its applications, use of Laplace transforms in the solution of linear differential equations.
Complex variables, analytic functions, Cauchy Riemann equations, Complex integration, Cauchy's fundamental theorem, Cauchy's integral formula, Cauchy's inequality and Liouville's theorem on integral function.

UNIT III

Taylor's & Laurent's expansions, Zeros & poles of analytic functions, Residues. Fourier series, Harmonic analysis, Definition of Fourier transform. Fourier sine and cosine transform. Fourier integral formula and its applications to solution of boundary value problems.

Text Books:

Churchill, R.V., "Complex Variables and Applications", McGraw Hill.

Titchmarsh, E.C., "Theory of functions", Academic University Press.

Reference Books:

Spiegel,"Laplacetransform",Schaumseries,Snedden,I.N.,"TheuseofIntegralTransform",Tata McGrawHill, New Delhi, Year.
Loknath, Debnath, "Integral Transforms" CRC Press, New York, USA.

MEC302P MECHANICS OFMATERIALS–ILAB. C P (12)

Course Outcomes (COs)

CO1: Predict the behavior by conducting tests and evaluate the modulus of elasticity, yield strength, UTS and shear strength of different engineering materials

CO2: Compute modulus of rupture of beams and critical load of columns by performing experiments

CO3: Determine the notch toughness and hardness of engineering materials

CO4: Find out the compressive strength, angle of twist and shear modulus of test specimen. Determine the notch toughness and hardness of engineering materials.

CO PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1	1	1						1				2	2	
CO 2	2	1	1						1				2	2	
CO 3	2	1	1						1				3	2	
CO 4	2	1	1						1				2	1	

1. Tensile test of mild steel and aluminium bars.
2. Shear test on specimen of two different metals.
3. Bending tests on a steel bar/wood.
4. Impact tests on metals: a) Izod Test; b) Charpy Test
5. Torsion test on specimen of different metals for determining the angle of twist for a given torque.
6. Hardness tests on metal to determine Brinell and Rockwell hardness.
7. Buckling load for a column.
8. Compressive test of a specimen.

Course No: MEC303P **FLUID MECHANICS LAB** **C P (1 2)**

Course Outcomes

CO1: Develop procedure for standardization of experiments
CO2: Calibrate flow discharge measuring device used in pipes channels and tanks
CO3: Determine fluid and flow properties.
CO4: Characterize laminar and turbulent flows.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2		3					1			1	2	1	
CO 2	2	2	2	3					1			1	2	1	
CO 3			1	3									2	1	
CO 4	2	2	2	3	1				1			1	2	1	

1. To determine the Viscosity of a fluid by falling sphere (ball) viscometer.
2. Critical Reynolds number in pipe flow.
3. Verification of the Bernoulli's theorem.
4. To find coefficient of discharge for Venturimeter.
5. Calibration of a Rotameter.
6. Measurement of velocity in the wind tunnel with pitot static tube.
7. Measurement of pressure with pressure sensors.
8. Flow visualisations past bluff and streamline bodies in as moke tunnel.
9. Calculation of flow rate using an orificemeter.

MEC305P MANUFACTURINGTECHNOLOGY-ILAB. C P (1 2)

Course Outcomes (COs)

CO1: Describe the geometry of single point cutting tool.
CO2: Apply knowledge of metal cutting to perform various machining operations.
CO3: Explain the working and use of various components of conventional machine tools.
CO4: Identify the sequence of operation to process a job.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3				2			2	2	2		2	1		
CO 2	3	2	2	2	3	3	2	2	3	2	2	3	3	2	
CO 3	3		2		2		2	2		2		3	2	2	1
CO 4	3	2					3	2	2			3	3		2

1. Testing moldings and for permeability, shear strength and compression strength.
2. Percentage of cross-sectional area reduction by rolling and wire drawing.
3. SMAW, welding parameters selection for MS strips.
4. Study of lathe machine.
5. Performing step turning and taper turning on lathe machine.
6. Performing drilling and boring operations on lathe machine.
7. Performing external thread cutting on lathe machine.
8. Study of bench type drilling machine.
9. Performing various operations like drilling, reaming, counter boring and counter sinking on drilling machine.
10. Study of a surface grinding machine. Performing surface grinding on washers.
11. Study of dividing head and performing gear milling.

ME 4TH SEMESTER

Course No.: MEC401 MATERIALS SCIENCE C L T (3 2 1)

Course outcomes (COs)

CO1: Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc.

CO2: Understand concept of mechanical behavior of materials and calculations of same using appropriate equations and can explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions.

CO3: Understand and suggest the heat treatment process & types. Significance of properties Vs microstructure. Surface hardening & its types. Introduce the concept of hardenability & demonstrate the test used to find hardenability of steels.

CO4: Explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials etc.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	1							2		3	2	2	1
CO 2	3	3	2							3		3	2	3	1
CO 3	2	3	3							3		3	2	3	1
CO 4	3	1	1							1		1	2	1	1

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.

UNITII

Densitycomputationsformetals,ceramiccrystalstructureanddensitycomputations.Polymorphism and Allotropy, crystal systems, crystallographic directions and planes, Atomic densities (linear and planar), single crystals, polycrystalline materials anisotropy, x-ray diffractionanddeterminationofcrystalstructures,Polymerstructure,hydrocarbonmolecules,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.

UNITIII

Impurities and their role in materials, grain size determination, Diffusion mechanism, steady state diffusion, non-steady state diffusion, factors that influence diffusion, diffusion in ionic andpolymericmaterials.Deformationandstrengtheningmechanisms,plasticdeformationofpolycrystalline metals, Deformation by twining, strengthening by grain size reduction, Phasediagrams,solubilitylimit,phases,micro-structureandphaseequilibria.

Text Book:

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

Reference Books:

Cahn, R.W., Haasen P., "Physical Metallurgy",Vo I,II, III, North-Holland,1996.
Ashby,M.,Johonson,K.,"MaterialsandDesign"Butterworth-Heinemann,2002.

Course No: MEC402 MECHANICSOFMATERIALS-II C L T (4 3 1)

Course Outcomes (COs)

CO1: Describe various energy theorems & compute deflection of beams/trusses using energy principles.
CO2: Illustrate and evaluate the rotational stresses.
CO3: Identify & calculate the stresses in unsymmetrical bending / curved beams
CO4: Analyze the effect of forces on springs.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	3			1						1	1	2	
CO 2	2	2	3			1						1	2	2	
CO 3	3	3	3			1						1	3	2	
CO 4	3	2	2									1	1	2	

UNIT I

Strain energy due to normal and shear stresses, The total elastic strain of dilation anddistortion,Theenergyelastictheorems,Theoremsonvirtualwork,Castigliano'stheorem,Complem entary energy theorems, Strain energy due to axial bending and Torsional loads, Stressesduetosuddenlyappliedloads,Useofenergytheoremstodeterminedeflectionofbeamsandtwists 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 spooke drim.

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:

Popov, E.P., Balan,T.A,"Mechanics of Solids",PrenticeHallofIndia,NewDelhi,2007.
Shames, I.H., Pitaresi, J.M., "Introduction to Solid Mechanics" Prentice Hall of India,EEE,NewDelhi,2006.

Reference Books:

1. Fung, Y.C.," Foundations of Solid Mechanics",PrenticeHallofIndia,NewDelhi,1968.

Course No.: MEC403 THEORY OF MACHINES-II C L T(4 3 1)

Course outcomes (COs)

CO1: Evaluate the velocity and acceleration of links in a mechanism or machine.
CO2: Explain the working principle of different machines.
CO3: Design linkages and gear mechanisms for a given motion or a given input/output motion or force relationship.
CO4: Apply the laws of friction in applications of mechanisms and machines.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	3	1	1								1		
CO 2	2	2	3	1	1								1		
CO 3	2	2	3	1	1								1		
CO 4	2	2	3	1	1								1		

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'slawandQuickreturnmechanism,Couplercurves,Velocityandaccelerationanalysis,Mechanicaladvantage,Transmissionanddeviationangle,Instantaneouscentre.
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, and 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 airplane, 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", McGraw Hill,NewYork,1995.

Reference Book:

Mabie H.H.,Reinholtz C.F, "Mechanism and Dynamics of Machinery" Fourth edition, John Wiley & Sons, 1987.
Ambekar A., "Mechanisms and Machine Theory", Prentice Hall, New Delhi, 2007.

Course No.:MEC404 APPLIED THERMODYNAMICS-I C L T(3 2 1)

Course Outcomes (COs)

CO1: Able to analyze the thermal systems, based on ideal and actual working conditions.
CO2: Able to identify various components of steam power cycles, compressors and boilers.
CO3: Understand the working of boilers, boiler mountings and accessories.
CO4: Able to compute the efficiency and other system parameters of steam power cycles, steam turbines, air standard cycles, compressors and nozzles.
CO5: Able to understand the working of actual IC engine and compressor based on actual cycle.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	2	3	3	1	1						2	2	1
CO 2	3	3	2	3	1	2	2			2			2	2	1
CO 3	3	3	2	2	1							2		2	1
CO 4	3	3	2	2	1							2	1	2	

UNIT I

Carnot cycle for steam, Rankine and modified Rankine cycle, deviation of actual cycles from ideal cycles, cycle efficiency, second law analysis of vapor 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 output, losses and efficiency, Reheat cycle, regenerative feed heating, Direct and indirect feed heating, efficiency and work output 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:

Eastop, T.D., "Applied Thermodynamics for Engineering Technologist", Pearson education, 1990.
RogersG.F.C., Mayhews,"EngineeringThermodynamics",PearsonEducation,1990.

Reference Book:

1. Kearton,W.J.,"SteamTurbines",CBSPublishers,NewDelhi,1960.

Course No.: MEC405 CAM&INDUSTRIAL AUTOMATION C L T (4 31)

Course Outcomes (COs)

CO1: Identify and Analyze functions and functioning of CNC machines, manufacturing systems and support systems in industries.
CO2: Illustrate underlying mechanisms in non-conventional machining processes along with their advantages and applications.
CO3: Recognize the need of limits, fits and tolerances in manufacturing and apply knowledge to design gauges for various industrial applications.
CO4: Analyze and access the importance of industrial automated systems and identify the use of design systems in manufacturing industries.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	2		2	2		2	2	2		3	3	2	
CO 2	3	2	2	1	3	2			2			3	2		
CO 3	3	2	3	1	3			2	2	2		3	3	2	2
CO 4	3	3	3	2	2	3	3		2	2	2	3	3	2	1

UNIT1

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.

UNITII

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).

UNITIII

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.

TextBooks

Degarmo, E.P., Black, J.T. and Kohser, R.A, "Materials and Processes in Manufacturing", Prentice Hall of India,NewDelhi,2006.
Anthony,E.,"FluidPowerwithapplications",PrenticeHallofIndia,NewDelhi,2007.
Zeid,I., "CAD/CAMTheory&Practice",TataMc-GrawHill,NewDelhi,2008

Reference Book:

1.Serop K.Steven, "Manufacturing Processes for Engineering Materials", Prentice Hall ofIndia,NewDelhi,2004.

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

Course Outcomes (COs)

CO1: To analyze and evaluate the electrical circuits, apply basic laws in circuit theory and to determine electric circuit parameters.
CO2: To identify and analyze various energy sources and their transformation.
CO3: Power and energy relations, analysis of series-parallel D.C. Circuits and network theorem along with applications.
CO4: To study the transducers used for mechanical circuits, transformer open circuit and short circuit tests, D. C. Machines.
CO5: To study the analogue and digital energy meters, Measurement of R, L and C, Extension of voltmeters and ammeters.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3		1									3		
CO 2	3	3		3									3		
CO 3	3	3	2	2									3	2	1
CO 4	3	2	2	2									3	3	1
CO 5	3	3	2	2									3	3	1

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.

UNITII

Transformers; Construction, Principle of operation, e.m.f. equation, Phasor diagrams, No Load and on load, Equivalent circuit model, Voltage regulation and test, Introduction to3-phasetransformers, Applications.
D.C. Generators and motors; Basic construction, Principles of operation, Types of D.C. generators and motors, Applications.

UNITIII

Transducers;Definitions,Typesoftransducersandtheirapplicationsformechanicalmeasurements,

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.,"ElectricalMachines,"TatalMcGrawHill,NewDelhi,1985.

Reference Books:

1. DelToro,V.,"PrinciplesofElectricalEngineering,"PrenticeHallInternational,1985.

MEC403P THEORYOFMACHINES-ILAB. C P (12)

Course Outcomes (COs)

CO1: Explain the concepts of kinematic chains, mechanisms.
CO2: Explain the working principle of machine and machine components.
CO3: Evaluate the characteristics of governor.
CO4: Analyze the design and working of the gears and cam-followers.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	1		1								1		
CO 2	2	2	1		1								1		
CO 3	2	2	1		1								1		
CO 4	2	2	1		1								1		

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 undercutting of gear and its significance.
10. Study of pairs of cams and follower
11. Determine the velocity of precession of a given motorized gyroscope.

Course No.: MEC404 P APPLIED THERMODYNAMICS-I LAB C P(1 2)

Course Outcomes:

CO1: Able to identify various parts of boiler.
CO2: Able to calculate the dryness fraction of steam using calorimeter
CO3: Able to prepare heat balance sheet.
CO4: Able to identify various parts of cooling tower
CO5: Able to determine cop of refrigerator

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1	2		1		2	1		3			3	3	1	2
CO 2	3	3		1		2	2		3			3	3	1	3
CO 3	3	3		3		2	3		3			3	3	1	2
CO 4	3	3		3		2	3		3			3	3	1	2
CO 5	3													1	2

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

MEC405P CAM&INDUSTRIAL AUTOMATIONLAB. C P (1 2)

Course Outcomes (COs)

CO1: Explain the working and use of various components of CNC machines
CO2: Identify the sequence of codes to process a job.
CO3: Create CNC program for turning and milling operations
CO4: Produce different profiles on the surface of a given material

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3				2	2	2	2				3	3	1	
CO 2	3	2			3	2		2	2	2		3	3	2	
CO 3	3	1	3	2	2			2	3	2		3	3	2	2
CO 4	3	1	3	2	3		2	2	2			3	3		2

Jobs on CNC lathe machine.
Safety precautions and Study of CNC lathe machine.

Performing step turning.

Performing taper turning.

Performing radius turning.

Performing multiple turning cycle.

Performing pattern repetition cycle operation.

Jobs on CNC Milling machine.
Study of CNC Milling machine.

Performing linear cuts and circular cuts

Performing linear and circular cuts using subroutines

Performing pocket milling

Metrology
Use of sine bars and slips gauges for angle measurement.

Use of bevel protector and dial gauges

ELE-406P ELECTRICAL ENGG.TECH.LAB. C P (1 2)

Course Outcomes (COs)

CO1: Connection of Ammeters, Voltmeters, Wattmeter's and multi-meters in DC and AC circuits and selection of their ranges, overall safety procedures to be employed while working with electric circuits, series and parallel operation of resistors, inductors and capacitors
CO2: To verify the KVL, KCL, star/delta transformation, superposition and maximum power transfer theorem on DC circuits
CO3: To measure electric power in single-phase AC circuits with resistive load, RL load and RLC load.
CO4: To study the overall construction of electric machines, measure the Energy, power and power factor in three phase AC circuits

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2		1		3	1				2		2	2	1
CO 2	3	2		3		3	3				2		2	3	1
CO 3	3	2		3		3	3				2		2	3	1
CO 4	3	2		1		3	3				2		2	3	1

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

Course No.: MEC501 THEORYOFMACHINES-II C LT (4 3 1)

Course Outcomes (COs)

CO1: Develop the mathematical models of vibrating systems, determine their DOF, and determine the free and forced vibration response of such systems

CO2: Determine the response of linear time-invariant systems to arbitrary forcing conditions using the convolution integral and the Laplace Transform method

CO3: Formulate the equations of motion of multiple degree of freedom systems, express it as an eigenvalue problem and determine the free and force vibration response

CO4: Derive the equations of motion of a continuous system, determine its natural frequencies and mode shapes, and obtain the free vibration response to given initial conditions

CO5: Appreciate the need of static and dynamic balancing of rotating machinery, determine the unbalance and provide the corrections necessary to eliminate the unbalance.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	1	2	1	1	1				1	2	1	1	2
CO 2	2	3	3	2	1		1		1		1	2	3	2	2
CO 3	2	3	2	2	1	1					1	1	2	3	2
CO 4	2	2	2	1	1		1				1	1	1	1	2

UNIT I

Harmonic motion, periodic motion, vibration terminology, complex method of representing harmonic vibration, Fourier series and harmonic analysis, Mathematical modelling for vibrations springs in series and parallel, differential equation of motion, solution of differential equation, torsional vibrations.

Various types of damping: dry friction and coulomb damping, structural damping. Free vibration with and without viscous damping. Logarithmic decrement. Energy methods

UNITII

Forced harmonic vibration, rotating unbalance, support motion, vibration isolation, energy dissipated by damping, equivalent viscous damping, structural damping, vibration measuring instruments, impulse excitation, arbitrary excitation, Laplace transform formulation, pulse excitation and rise time, shock response spectrum, shock isolation.

UNITIII

Normal mode analysis, initial conditions, coordinate coupling, forced harmonic vibration, vibration absorbers and vibration dampers, Generalized coordinates, natural frequencies and mode shapes (Eigen values and Eigen vectors), Modal analysis, continuous systems.

Critical speed of a light shaft without damping, and with damping, critical speed of shaft having multiple discs, secondary critical speed, critical speed of a light cantilever shaft, Balancing of engines.

TextBook:

1. Grover, G. K. “Mechanical Vibrations, 7th edition, Nem Chand and Bros, New Delhi, India1996.

ReferenceBooks:

Meirovitch, “Elements ofvibrationanalysis,”2ndedition,McGrawHill,1998.
Thomson, W. T., “Theory of Vibrations with applications” 5th edition, Pearson Education,2004.

Course No.: MEC502 MACHINE DESIGN-I CLT (4 31)

Course Outcomes (COs)

CO1: Demonstrate knowledge on basic machine elements used in machine design.
CO2: Understand the stress and strain on machine components and identify and quantify failure modes for machine parts.
CO3: Design machine elements to withstand the loads and deformations for a given application.
CO4: Approach a design problem successfully, taking decisions when there is not a unique answer.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	3	2	1							1	3	1	1
CO 2	3	3	3	2	1							1	3	1	1
CO 3	3	3	3	3	1							1	3	1	1
CO 4	2	3	3	3	1							2	3	2	1

UNIT I
Introduction to design, design and designer, objective of design, design definitions, design process, System design verses component design, Introduction to behavior of mechanical systems, transformation of customer requirements into design artefacts, functional and structural hierarchies, functional and structural hierarchies of Gear, Engine, etc.

UNITII
Various types of loading in mechanical systems, stress concentration, endurance limit, S N and SNP diagrams, stress concentration and its mitigation, manufacturing consideration in design, standardization, tolerances and fits, BIS code –IS-919, manufacturing processes , Introduction to single and multi-variable optimization.

UNITIII
Materials, material selection at design stage, design for permanent fastening joints , Riveted joints, nomenclature of riveted joints , efficiency of joints, Lap joint analysis, Butt joint analysis, Boiler joint, Welded joints, design for fastener, joints, and fasteners, nut and bolt assembly, screwjack, efficiency of screwjack.

Text Books:

1. Ullman D.G., "TheMechanicalDesignprocess",3rd edition, McGraw Hill,2009.
2. Mott, R.L, "Machine Elements in Mechanical Design", 4th edition, Prentice Hall, Singapore, 2005.
3. Shigley, J.E.,Mischke, C.BrownT.,"Standard Handbook of Machine Design" McGrawHill.
4. Shigley, J.E.,"HandBookofMachineDesign",McGrawHill,2004.

Course No.: MEC503 HYDRAULIC MACHINERY C L T(32 1)

Course Outcomes (COs)

CO1: Evaluate the forces exerted by a jet of fluid on vanes of different shapes under static and dynamic condition
CO2: Discuss the construction features and working of different hydraulic turbines and pumps
CO3: Evaluate the performance characteristics of hydraulic turbines and pumps
CO4: Analyze the working principles of various hydraulic systems

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	2	3	1					1		1	2	2	
CO 2	3	3	3	2	2				1			1	2	3	
CO 3	3	3	2	2	1	2	1		2			1	2	2	
CO 4	3	2	2	2	1				1			1	2	3	

UNIT I
Force due to a jet on a curved plate, Velocity diagram for axial and radial flow turbine blades, Work output and efficiency, Pelton turbine, main components nozzle and jet diameters, mean diameter of Pelton runner, jet ratio, minimum number of buckets, work done, power developed and turbine efficiencies, Governing of impulse turbines.

UNITII
Reaction turbine, Francis turbine, main components, design of spiral casing guide vanes, runner and number of runner blades, types of Francis runners, Kaplan turbine, velocity diagram power and efficiency calculations, draft tube, cavitation factor, Governing of reaction turbines. Principles of similarity: unit and specific quantities, performance characteristics, selection, of water turbines, hydro-electric power plants.

UNITIII
Roto-dynamic pumps, classification, centrifugal pumps, specific speed, velocity diagrams,heads,powerandefficiency,specialfeaturesofpropellerandmixedflowpumps,Positivedisplacement pumps, reciprocating pump, Indicator diagram, effect of friction and acceleration, Theory of air vessel, Hydraulic systems and power transmission, pumps and other devices used in hydraulic systems, Gear pump, vane pump, screw pump, pressure intensifier, Hydraulic coupling,torqueconverteranddynamometer.Hydraulicpowertransmission

Text Book:

Massey, B.S.,"MechanicsofFluid",6thEdition,VanNostrandReinholdco.,1968.
Jagdish, L., "Hydraulic Machines including Fluidics", Mertopolitan Books co. Pvt. Ltd.,1997

Reference Books:

Guthrie, Brown, "Hydroelectric Engineering Practice,CBS Publishers,NewDelhi,1993.
Douglas, Gasiorek, Swaffield,"FluidMechanics",PearsonEducation,,2007.
Kumar, D.S.,"FluidMechanics&FluidPowerEngineering",S.K.Kataria&Sons.,NewDelhi,2008.

Course No.:MEC 504 HEATTRANSFER C LT (3 21)

Course Outcomes (COs)

CO1: Identify, formulate and solve steady, transient and multidimensional heat conduction problems
CO2: Understand the phenomenon of convection and be able to evaluate heat transfer coefficients for natural and forced convection.
CO3: Calculate radiation heat exchange between black as well as non-black surfaces.
CO4: Be able to solve a wide range of real world problems involving conduction, convection and radiation

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	3	2	2	1	2	2				2	3	2	3
CO 2	3	3	3	2	2	1	2	2				2	3	2	3
CO 3	3	3	3	2	2	1	2	2				2	3	2	3
CO 4	3	3	3	3	2	2	2	2				2	3	2	3

UNIT I
Introduction, Fourier's law of heat conduction, Thermal conductivity of solids, liquids andgases,combinedheattransferproblems,Onedimensionalsteadyheatconduction,Thermalresistance,General threedimensionalheatconductionequationinCartesian,cylindricalandspherical coordinates, heat conduction with heat generation, Fins, Two dimensional steady stateheatconductionthroughplanewall,Unsteadyheatconductionwithnegligibleinternaltemperature gradients, spheres, cylinders and cubes heat conduction when internal temperature gradients are not negligible, sphere, long cylinder and large slab, heat flow in semi-infinite solids, with periodic change in surface temperature.
UNITII
Free and forced convection, hydrodynamic and thermal boundary layer, Empirical relations for convection heat transfer, Heat transfer with change of phase, film and drop wise condensation,empiricalequations,fundamentalofboilingheattransfer,poolboiling.
UNITIII
Thermal radiation, black and gray surfaces, Radiation laws, Heat transfer by radiation between black and gray surface shape factors, Heat transfer by radiation between two surfaces, heat transfer in presence of reradiating surfaces, radiation shields, Heat exchangers, Fouling factor, overall heat transfer coefficient, logarithmic mean temperature difference, effectiveness, NTU methods, engineering applications of heat transfer

Text Book:

Holman, J.P., "Heat Transfer", 10th Edition, McGraw Hill India, 2011
In cropera, F.P., "Fundamentals of Heat and Mass Transfer", John Wiley, 2005.

Reference Book:

Bejan, A., "Heat Transfer", John Wiley, 1998.
Kreith F., Bohn, "Principles of Heat Transfer", Cengage publishers, 2006.

Course No.: MEC505 INDUSTRIAL ENGINEERING -I CLT (4 31)

Course Outcomes (COs)

CO1: Understanding the concept and applications of Industrial Engineering with a focus on Productivity, Work Design and Work Study.
CO2: Analyzing and applying the method study techniques in relation to a particular job environment.
CO3: Analyzing and evaluating various engineering work measurement techniques designed to establish the time for a qualified worker to carry out a specific job at a defined level of performance.
CO4: Attain a grasp of the fundamental principles of experimental design, collection of data related to work study, and their analysis and interpretation.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	2	2	2	3	3	2	2	1	2	2	3	3	2
CO 2	3	3	3	3	2	2	3	2	3	2	2	2	3	3	3
CO 3	3	3	3	2	2	2	2	2	2	1	2	2	2	3	2
CO 4	3	3	3	2	2	3	3	2	3	2	2	2	3	3	2

UNIT I
Concept of industrial productivity: Introduction and significance of Industrial engineering withbriefexplanationofitstechniques,FunctionsofIndustrialEngineering,Definitionsandexplanation of Productivity with significance in Industries, Productivity measurements, Factors affecting productivity, Basic work content and excess work content, Industrial applications to calculate total and partial productivities, Introduction to Work study and its basic procedures, definitions and concept of work study with examples, Human factor in the application of work study, Factors for selecting the work study, Ergonomics: scope and objectives of ergonomics, application of human factors in engineering work place design, etc.
UNITII
Introduction to Method study and the selection of jobs, Record, Examine and Develop, Objectives and basic procedure of Method study, Recording techniques (Process Charts (PC),and Diagrams), Outline PC, Flow process charts, Two hand process charts, MAC (??), Simo chart, Flow diagram, String diagram, Cycle graph, Chronocycle graph, Travel chart, Define, Install and Maintain, the principles of motion economy,
UNITIII
Work measurement and its applications, Time study, Work Sampling, Rating and their methods, Breaking the jobs into Elements, types of Elements, Allowances and their calculations, Calculation of Standard time, Examples of Time study, PMT(??) systems, synthetic data, Various applications and examples.

Text Book:
1.Barnes,R.L.,"MotionandTimeStudy,Design&MeasurementofWork"7thedition,JohnWiley&Sons,NewYork, 1980.
Reference Books:
International Labor Office, Geneva,"IntroductiontoWorkStudy"4thEdition,Geneva,

1985.
CurrieR.M,"Workstudy",ELBS&Pitman,London,1977.
Mundel, M.E., "Motion and Time Study", 5th Edition, Prentice Hall, Englewood Cliff,NewYork,1978.

Course No.: ECE507/8 INDUSTRIAL ELECTRONICS C L T (32 1)

Course Outcomes (COs)

CO1: Utilize the knowledge of diodes, transistors and their characteristics in design of mechatronic systems.
CO2: Discuss the basic principles of operational amplifiers and their applications
CO3: Explain the fundamentals of oscillators, modulation and power supplies
CO4: Discuss the basic principles of power electronic devices such as SCR.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	3	2	2	3	3		1			3	2	3	3
CO 2	2	1	3	1	1	3	2		2			3	2	2	3
CO 3	3	2	2	1	2	1	1					3	3	2	1
CO 4	2	2	1	2	0	1	2					3	2	2	1

UNIT I

Introduction to Semiconductors; Intrinsic & extrinsic semiconductors, transport mechanism of charge carriers, electrical properties, P – N Junction Diode: Characteristic of Diode capacitances, application of Diode. Diode as a Switch. Different types of Diode and their applications.
UNITII
BJT's: Types, Operations and characteristics, CE, CB, CC configurations, Transistor circuits, transistor as an amplifier, transistor as a switch, Operational amplifier basis, OPampa suneverting and nonuneverting amplifier and its applications.
UNITIII
Oscillators: Barkhausan's C and different types of oscillators, Modulation: Amplitude Modulation, frequency Modulation. Types of Modulators, Power Electronics circuits: SCR, Drac, Twac. Regulated Power Supplies, Electronic Welding.

Text Book:
1.Millman,J.,Halkias,Ch.C.,"BasicElectronics",TataMcGrawHill,NewDelhi,1998.

MEC501P THEORYOFMACHINES–II LAB. CP(1 2)

Course Outcomes (COs)

CO1: The student should be able to prepare technical reports and documents detailing the experimental methodology.
CO2: Determine the time period of a simple and compound pendulum and visualize the basic characteristics of a simple harmonic motion.
CO3: Determine the mass moment of inertia (ROG) of irregularly shaped objects using bifilar and trifilar suspensions
CO4: Analyze the free and forced vibration characteristics of an equivalent spring mass system and determine its frequency response function

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1	1	1	2					3	3	2		1	2	
CO 2	3	2						2	3	2	2	2		2	
CO 3	3	3				1			3	2	2	2		2	
CO 4	3	2						2	3	2	2	2		2	

Determine the time period of a simple pendulum. Verify that the time period is independent of the mass of the bob.
Determine the radius of gyration compound pendulum.

DeterminetheradiusofgyrationofagivenbarbyusingaBifilarsuspension.

Study the undamped free vibration of an equivalent spring mass system.

Study the forced vibration of an equivalent spring mass system.

Study the torsional vibration of a single rotor shaft system.

Determine the frequency response function of an equivalent spring-mass-dashpot system.

Pressure profile measurement on Journal bearing

MEC504P HEAT TRANSFERLAB. CP (12)

Course Outcomes (COs)

CO1: Acquire a thorough outlook regarding the steps to design and conduct experiments for measuring specific physical variables
CO2: To apply the concepts learnt in Heat Transfer theory subject to do hands on experiments
CO3: To calculate thermal conductivity, heat transfer coefficient, and other parameters relevant in heat transfer.
CO4: Communicate effectively in completing written reports of laboratory work.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	3	2	2	1	2	2	2	2	2	2	3	2	3
CO 2	3	3	3	2	2	1	2	2	2	2	2	2	3	2	3
CO 3	3	3	3	2	2	1	2	2	2	2	2	2	3	2	3
CO 4	3	3	3	3	2	2	2	2	2	2	2	2	3	2	3

1. To determine the thermal conductivity of a metal bar.
2. To determine the thermal conductivity of a liquid
3. To study the heat transfer through the insulating medium
4. To study heat conduction in a composite wall
5. To study heat transfer from a pin fin
6. To study heat transfer in natural convection
7. To study heat transfer in forced convection
8. To study the heat transfer phenomena in parallel / counter flow arrangements
9. To determine Stefan Boltzmann constant

MEC505 INDUSTRIALENGINEERING-ILAB. CP(12)

Course Outcomes (COs)

CO1: Demonstrate human factors/ergonomic principles (HF/E) that influence the design, performance and safety of work systems.
CO2: Apply HF/E guidelines and use standard HF/E in the design of work systems.
CO3: Model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activity charts, block diagrams, and process maps, for purposes of work system documentation, analysis, and design.
CO4: Determine the time required to do a job using standard data, occurrence sampling, time study, and predetermined time systems.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	2	2	2	3	3	2	2	1	2	2	3	3	2
CO 2	3	3	3	3	2	2	3	2	3	2	2	2	3	3	3
CO 3	3	3	3	2	2	2	2	2	2	1	2	2	2	3	2
CO 4	3	3	3	2	2	3	3	2	3	2	2	2	3	3	2

Ergonomic design study (Present/proposed/new) of a product, equipment or work environment (human-machine interface) – (This involves about four to five laboratory classes/ sessions)
To assembly a product (electrical holder, etc.), record the cycle time and draw learning curve of the operator performing the assembly.
Draw Out line process chart and two hand flow process charts for the assembly performedinexperimentno.2, and analyse the present method and also suggest improved method/s.
Study and draw of flow process charts (some suitable assembly operation)

Study and draw multiactivity chart of a suitable method and propose better method/s. (Man and machine)
Study suitable movements/travel of man, material or equipment, and draw string diagram, travel chart and flow diagrams.
To calculate the standard time of a suitable job, using predetermined time standard techniques.

ECE 508P INDUSTRIAL ELECTRONICSLAB. CP (12)

Course Outcomes (COs)

CO1: Analysis of waveforms using CRO and study of diode characteristics
CO2: Observe the working of diode as a rectifier, clipper, clamper and also analyse Zener diode characteristics
CO3: Analysis of input and output characteristics of a BJT.
CO4: Study the working of op-amp as an integrator, differentiator, etc & also the performance of IC chip.

CO-PO Mapping

Course Outcome	Program Outcome												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	1	3	3	2	1	3	3	3	2	3	3	3	3
CO 2	3	2	3	3	2	2	3	3	3	2	2	3	3	3	3
CO 3	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3
CO 4	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3

Study of CRO Measurement of Voltage, frequency and Phase of a given wave form.

To obtain diode characteristics.

a) To assemble a half wave and a full wave rectifier and to study their performance.
b) To suppress the ripple using RC filter.

To obtain Zener diode characteristics and to use Zener diode as a voltage regulator.

Toassembleandobservetheperformanceofclippingandclampingcircuits.

To obtain transistor characteristics in the following configurations:

i) Common base. ii.)Common emitter

To assemble a CE amplifier and observe the performance.

To assemble a differential amplifier and obtain in CMRR circuits (??).

To study different application of OPAMPS.

OP–AMP as an inverting amplifier.

OP–AMP as a Non inverting amplifier.

OP–AMP as an integrator

OPAMP as a differentiator.
To study the performance of a voltage regulator IC Chip.

Course No.: MEC 601 AUTOMATIC CONTROL C L T(4 3 1)

COURSE OUTCOMES

1. Develop the mathematical models of LTI dynamic systems, determine their transfer functions, describe quantitatively the transient response of LTI systems, interpret and apply block diagram representations of control systems and understand the consequences of feedback.
2. Use poles and zeroes of the transfer functions to determine the time response and performance characteristics and design PID controllers using empirical tuning rules.
3. Determine the stability of linear control systems using the Routh-Hurwitz criterion and classify systems as asymptotically and BIBO stable or unstable.
4. Determine the effect of loop gain variations on the location of closed-loop scales, sketch the root locus and use it to evaluate parameter values to meet the transient response specification od closed loop systems.
5. Define the frequency response and plot asymptotic approximations to the frequency response function of a system. Sketch a Nyquist diagram and use the Nyquist criterion to determine the stability of a system

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2									2	3	1
CO2	3	3	3	2									3	3	2
CO3	3	2	2	2									2	3	2
CO4	3	3	3	2									1	3	2
CO5	3	3	2	2									3	3	1

UNIT I

Introduction: Concept of automatic control, open loop and closed loop systems, servo mechanism, block diagram, transfer function. Representation of control components and systems: Translation and rotational mechanical components, electrical components -series and parallel combinations, comparators for rotational and linear motions, integrating devices, hydraulic servomotor temperature control systems ,speed control systems.

UNIT II

System response: First and second order systems, response to step, pulse, ramp and sinusoidal inputs, systems with distance velocity lag. Modes of controls: Proportional control, Proportional pulse reset control, proportional pulse rate control, proportional reset rate control, two position control. Controller Mechanism: Pneumatic, hydraulic and electric controllers, general principles and circuits for generating various control actions.

UNIT III

Control system analysis: Transient response of simple control systems, stability of control systems, Mouths criterion. Frequency response analysis, polar rectangular and logarithmic plots, experimental determination of frequency response, Bode and Inquest stability criteria, gain and phase margins. Root locus plots of simple transfer function, transient response from root locus. Electronic Analogue computers: Elements of analogue computers, solution of simple differential equations.

Text Book:

1. Ogata,K., " Modern Control engineering", Prentice Hall of India, 3rd edition, New Delhi, 1997.

Reference Book:

1. Raven, F., "Automatic Control" McGraw Hill Int., 1999.

Course No.: MEC 602 MACHINE DESIGN- II C L T(4 3 1)
Course Outcomes (COs)

CO1: Analyse the stress and strain of mechanical components
CO2: Demonstrate knowledge of basic machine elements used in machine design
CO3: Design machine elements to perform functions in order to obtain desired objectives under various operating conditions.
CO4: Conduct a failure analysis for the design of mechanical components to select the suitable materials and manufacturing considerations

CO PO Mapping

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	-	1	-	1	1	2	3	2	3
CO2	3	3	3	3	1	1	3	2	1	2	1	-	3	2	3
CO3	3	3	3	3	2	-	3	1	1	2	-	3	3	3	2
CO4	3	3	3	3	-	2	3	-	2	-	2	3	3	2	3

UNIT I

Design of friction elements, various types of brakes, design equations for various types of brakes, design analysis of all types of brakes, e.g., band brake, long shoe brake, etc. design analysis of all types of clutches, design of couplings and keys for shafts, etc, design and analysis of flat and V-belt, equations for power, slip, etc, design of chain drive.

UNIT II

Introduction to gear design, design of spur gear, equation for σ band σc for spur gear, design analysis for bending, force analysis for Helical gear, design analysis for helical gear, design of bevel gear, determination of bearing forces, horizontal and vertical shafts, design analysis for bevel gear, design analysis for worm gear.

UNIT III

Introduction to Plain bearings, Bearing surface at Micro level, Derivation of Energy equation and PV factor , PV graph, Values of PV , Derivation of Wear coefficient equation, Step-by-step procedure for Plain bearing design, Self lubricating bearings and use of clearance for life ofbearing,DesignofHydrodynamicbearings,DerivationofReynoldsequationforthreedimensional case, Journal bearing geometry, Variation of viscosity with pressure and temperature, Viscosity index, Sommerfeld number, Analysis of ho, hmin, Qin, Q loss, Tin , Tout, Introduction to Rolling element bearings, Design of AFB (??) , Equations for L10 life, Static loading and dynamic loading ,Use of AFB catalogue, Determination of Load based on radial and thrust load for ball bearings, Derivation of Load equation for Tapered AF (??) bearings, Design analysis on the basis of loads and selection of AFB from a catalogue.

Text Books:

Mot, R.L., "Machine Elements in Mechanical Design", Maxwell Mac Millan Intl. editionN.York,USA,1992.
Shigley,J.E.,"MachineEngineeringDesign",McGrawHill,highereducation,2004.

Reference Books:

Shigley,J.E.,Mischke,C.BrownT.,"StandardHandbookofMachineDesign"McGrawHill.

CourseNo.:MEC603 FUNDAMENTALS OF TRIBOLOGY CL T (4 3 1)

COURSE OUTCOMES (CO)

CO1: To introduce students the field of tribology and its historical development and understand the surface phenomena related to relative motion and the nature of friction.

CO2: Students will demonstrate the role of tribology in industry and also reveal the basic understanding of friction.

CO3: Understand the concept of friction, wear, analysis of friction & wear, techniques to control the wear and measurement technique to analyze friction and wear.

CO4: Familiar the students with the concept of lubricants, types of lubricants, compare boundary lubrication, mixed lubrication and hydrodynamic lubrication and materials for tribological applications.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1	-	3	-	-	-	-	-	3	3	3	2
2	3	3	3	1	-	3	-	-	-	-	-	2	3	3	2
3	3	3	3	2	1	3	-	-	-	-	-	3	3	3	2
4	3	2	3	2	1	3	1	-	-	-	-	2	3	3	2

UNIT - I

Introduction to tribology, tribology in Industry, energy saving through tribology engineering, Surfaces and interaction between surface, production of engineering surface, surface roughness, RMS value, average value and ten point average of surface roughness. Development of engineering surface and measurement of surface roughness, Tribology in Industry, Losses of due to friction and wear in industry, Tribo-elements and a systems concept in tribology, Introduction to friction static and dynamic friction analysis, Da Vinci concept of friction, Amonton's laws of friction, Coulomb's laws of friction, Bowden and Tabor concept of friction.

UNIT II

Wear and Types of wear, adhesive wear and its mathematical model, Two body abrasive wear, Three body abrasive wear, abrasive wear and its mathematical model, corrosive wear model, erosive wear model, cavitation wear, scuffing wear, delimination wear, pitting wear, wear coefficient and wear measurement, wear measurement through Pin- on-Disc machine, Pinon-ring, Profilometer, wear coefficient of various materials.

UNIT III

Lubricants, types of lubricants, physical adsorption, Chemisorption, Self lubrication properties of materials, Solid lubrication, Lubrication in space, Food industry, etc, High temperature lubrication, Hydrodynamic lubrication, Various components of Reynolds equation, Sommerfeld number and its use in hydrodynamic lubrication, Materials for tribological applications.

Text Books

[1] Czichos, H., "A system approach to science and Technology of Friction, Lubrication and Wear" Volume I, Tribology series, Elsevier Publications, 1978.

[2] Glaeser, J " Marerials for Tribology",Tribology series Vol. 20, Elsevier Publications, , 1992.

Reference Books

[1] Peterson M.B.,Winner W.O, "Wear control Handbook" sponsored by The Research Committee on Lubrication, Publsher, , 1980.

[2] Cameron A., "The principles of Lubrication", Longman, London, 2000.

CourseNo.: MEC604 LINEAR OPTIMIZATION IN ENGINEERING CL T (4 31)

Course Outcomes (COs)

CO1: Develop critical thinking and objective analysis of real-life decision problems which could be analysed under the ambit of Operations Research.

CO2: Formulate and solve linear programming problems using appropriate techniques and models, interpret the results obtained and translate solutions into directives for action.

CO3: Realise the project life cycle and perform project planning activities that accurately forecast project costs, timelines, and quality in order to implement processes for successful resource, time, communication, risk and change management.

CO4: Analyse and solve real life industrial engineering problems, using mathematical tools, arising from a wide range of applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS1	PS2	PS3
C01	3	3	3	3	2	2	2	1	2	2	3	2	2	3	2
C02	3	3	3	3	2	-	2	-	2	2	3	2	2	2	2
C03	3	3	3	3	3	2	2	1	2	2	3	2	3	2	2
C04	3	3	3	3	3	2	2	1	2	2	3	2	3	2	2

UNIT I

Overview of Operations Research (OR), OR Methodology and techniques, Introduction to Linear Programming (LP), Application of LP techniques in Production management, graphical solutions, the simplex method, Duality and Sensitivity analysis, transportation model problems and their variants, assignment model problems.

UNIT II

Project planning and scheduling, CPM & PERT, Project crashing and recourse allocation problems, decision theory, steps in decision making, decision making under uncertainty and under risk, marginal analysis, decision trees.

UNIT III

Flow shop scheduling, Job shop scheduling, Queuing theory and their applications, Waiting line models and their applications, introduction and basic concepts of Simulation.

Text Books:

1. Taha, H.A., "Operation Research- an Introduction", 6th edition, Prentice Hall of India, New Delhi, 2000.

Reference Books:

1. Joseph Ecker, Michael K, "Introduction to Operations Research" John Wiley & Son, , 1998.
2. Hillier &Lieberman, "Introduction to Operations Research", McGrawHill, Singapore, 2001.
3. Gupta M.P, Khanna R.B., "Quantitative Techniques for Decision Making", Prentice Hall of India, New Delhi, 2008.

Course No.:MEC605 INTRODUCTION TO MECHATRONICS C L T (4 3 1)

Course Outcome

CO-1 Explain the architecture of various mechatronic systems.
CO-2 Identify and analyze the modern electrical and electronic components used in mechatronic systems.
CO-3 Select and integrate various sensors and actuators to meet a mechatronic product requirement.
CO-4 Determine and analyze the dynamic response of the zero, first and second order mechatronic systems.
CO-5 Program and analyze new mechatronic products using embedded systems.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	3	2									3	1	3
CO2	3	3	2	2									3	2	2
CO3	1	1	2	2									2	2	2
CO4	3	3	1	1									1	3	1

UNIT I

Introduction to mechatronics, mechatronic design approach, system interfacing, instrumentation and control systems microprocessor-based controllers and microelectronics, mechatronics; a new directions in nano-, micro-, and mini-scale, electromechanical systems design, physical system modelling, electromechanical systems structures and materials, modelling of mechanical systems for mechatronics applications,

UNIT II

Sensors and actuators, fundamentals of time and frequency, sensor and actuator characteristics, linear and rotational sensors, acceleration sensors, force measurement, torque and power measurement, flow measurement, temperature measurements, distance measuring and proximity sensors, light detection; image, and vision systems, integrated micro-sensors, actuators; electro-mechanical actuators, electrical machines, piezo electric actuators; hydraulic and pneumatic actuation systems.

UNITIII

Micro transducers analysis, design and fabrication, role of controls in mechatronics, role of modeling in mechatronics design, response of dynamic systems, introduction to computer and logic systems, logic concepts and design system interfaces, communication and computer networks, fault analysis in mechatronic systems, logic system design, programmable logic controllers, software and data acquisition.

Text Book:
1.ShettyD.,Richard A.K., "Mechatronics system design", Cengage learning, ,2011.

Reference Books:
DanS.N.,"Mechatronics"PrenticeHall,,2002.
"Micro mechatronics - Modeling, Analysis, and Design with Matlab", CRC Press,London,2004.

MEC603 P FUNDAMENTALS OF TRIBOLOGY LAB CP(1 2)

CO1: Students able will be able to understand the preparation of samples for friction and wear tests.

CO2: Students able will be able to conduct the experimentation to measure the friction and wear analysis of various engineering materials.

CO3: Students able will be able to analyze wear and extreme pressure tests for particle count and wear shape classification of different types of lubricants.

CO4: Students will be able to work in a team, communicate effectively and would develop ethical responsibility in design of engineering components with effective Tribological analysis.

CO v/s PO/PSO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	-	3	1	-	2	2	1	-	2	3	3	1
CO2	2	1	1	-	3	-	1	3	2	1	1	2	3	3	2
CO3	1	-	-	3	3	1	1	3	1	2	-	-	2	-	-
CO4	-	-	-	1	1	2	1	3	1	2	2	3	1	3	3

List of Experiments:

1. Preparation of samples for friction and wear tests
   - Polishing
   - Cleaning.
2. Microhardness Measurement; Knoop and Vicker for metals, polymers and ceramics
   - HV V/s Load plots
   - HK V/s Load Plots
   - Influence of indentation time
   - HV V/s Indentation time
   - HK V/s Indentation time
3. Measurement of Friction
4. Measurement of Wear through weight loss, etc.
5. Plot of friction coefficient V/s Load, and Plot of wear volume V/s Load
6. Calculation of wear coefficient for a metallic material
7. Calculation of Wear coefficient for ceramics
8. Measurement of friction in presence of lubricant at room temperature
9. Measurement of wear under lubricated conditions for metallic materials
10. Influence of additives on friction and wear of metals.

Text Books

[1] Czichos, H., "A system approach to science and Technology of Friction, Lubrication and Wear" Volume I, Tribology series, Elsevier Publications, 1978.

[2] Glaeser, J " Marerials for Tribology",Tribology series Vol. 20, Elsevier Publications, , 1992.

Reference Books

[1] Peterson M.B.,Winner W.O, "Wear control Handbook" sponsored by The Research Committee on Lubrication, Publsher, , 1980.

[2] Cameron A., "The principles of Lubrication", Longman, London, 2000.

MEC605P **MECHATRONICS LAB.** **CP(1 2)**

COURSE OUTCOMES (CO)

CO1: Identify and use basic modern tools for measurement of electrical and electronic signals

CO2: Identify and use different types of sensors and actuators for designing a mechatronic product.

CO3: Design basic circuits utilizing modern electrical and electronic components including operational amplifiers and integrated circuits.

CO4: Write basic microcontroller programs for controlling a mechatronic product

CO v/s PO/PSO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	-	3	1	-	2	2	1	-	2	3	3	1
CO2	2	1	1	-	3	-	1	3	2	1	1	2	3	3	2
CO3	1	-	-	3	3	1	1	3	1	2	-	-	2	-	-
CO4	-	-	-	1	1	2	1	3	1	2	2	3	1	3	3

List of Experiments

1. Sensor/Actuator - Interfacing, calibration, frequency domain characterization, MATLAB serial interface, and serial LCD display
2. Design of electropneumatic circuits for L (??) and square cyles using PLC's.
3. Sorting of components on an intelligent a conveyor system.
4. Modelling of DC Motor System.
5. DC Motor position tracking.
6. DC Motor position set-point control via PID controller, using relay automatic tuning technique7.
7. Disection of an existing system.
8. Demonstration of recent projects on Mechatronics

Mini Projecton Independent modeling, analysis, and design of a mechatronic control system (Select one "mechatronic plant" from the Quanser, rotary family).

CourseNo.:MEC701 **BASICFRACTUREMECHANICS** **C L T(3 21)**

COURSE OUTCOMES (COs)

1. Evaluate fracture toughness data for stationary and growing cracks using LEFM techniques.
2. Analyze the crack growth in materials subjected to both cyclic and static loads.
3. Identify and describe different failure mechanisms in materials and engineering structures.
4. Explain how a crack affect an engineering structure and describe the state of stress and strain that may arise in the vicinity of the crack front in different materials

CO PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1									1	2	
CO2	2	2	2	1									1	2	
CO3	2	2	2	1									1	2	
CO4	2	2	2	1									1	2	

UNIT I

Summary of basic problems and concepts in fracture, a crack in a structure, crack tip stresses, The Griffith criterion, crack opening displacement criterion, crack propagation. Mechanisms of fracture and crack growth, cleavage fracture, ductile fracture, fatigue cracking, Environmental assisted cracking, service failure analysis.

UNIT II

The elastic crack-tip stress field, solution to crack problems, the effect of finite size, Some special cases, elliptic cracks, the energy principles, The concept of energy release rate, The criterion for crack growth, The crack resistance, The concept of J-integral.

UNIT III

Crack-tip plastic zone, Irwin's plastic zone correction, The Dugdale approach, Plane stress versus plane strain, plastic constraint factor, the thickness effect, application of von Mises and Tresca yield criteria to obtain plasticity effected regions, Dynamics and crack arrest, Crack speed and kinetic energy, the dynamic stress intensity and elastic energy release rate, principles of crack arrest.

Text Books:

1. Prashant Kumar, Elements of Fracture Mechanics McGraw Hill Publications

Reference Book:

1. T L Anderson, Fracture Mechanics, Fundamentals and Applications, CRC Press

CourseNo.:MEC702 MEASUREMENT AND INSTRUMENTATION CLT (4 3 1)

Course Outcomes (COs)

CO1: Identify advantages and limitations of measuring systems and comment on their suitability for a particular application

CO2: Explain some of the typical methods employed to measure motion, temperature, force, pressure and flow.

CO3: Describe the various static and dynamic characteristics of instruments and explain their effect on instrument behaviour.

CO4: Explain the principle of sensors/transducers and describe a suitable calibration procedure for a particular instrument

CO PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1							2			2	1	1
CO2	3	2	1							2			2	1	1
CO3	3	2	1							2			2	1	1
CO4	3	1	1							2			2	1	1

UNIT I

MeasurementandInstrumentation;definitions,significance,Fundamentalmethods,generalizedmeasurementsystem,Functionalelements,Typesofinputquantities,standards,calibration,uncertainty,Errors,Classificationofinstruments,Input-outputconfiguration,Interfering and modifying inputs, methods of correction, Generalized performance characteristics, static characteristics, static calibration, Dynamic characteristics, zero and first order instruments ,time constant, Second-order instruments, transient response characteristics. Relative and absolute motion devices, relative displacement, Resistive potentiometers, bridge circuit, LVDT, Variable inductance and variable capacitance pick-ups, Piezoelectric transducers, fibre optic displacement transducer, Resistance strain gage, Relative velocity-translational and rotational, Mechanical revolution counters and timers, stroboscopic method, Moving coil and moving magnet pickups, DC and AC tachometers, Eddy current drag-cup tachometer, acceleration measurement.

UNIT II

Hydraulic and pneumatic load cells, flapper nozzle principle, Force transducers with elastic members, Proving ring transducer, cantilever beam transducer, electromagnetic balance, Dynamometers – Absorption, driving and transmission type, reaction forces in shaft bearings, prony brake, eddy current brake dynamometer, Instruments for high, mid and low pressure measurement, dead weight and null type, Elastic element gages, Differential pressure cell, high pressure measurement, Low pressure measurement–,Pirani gages &McLeod pressure gauge.

UNIT III

Orifice meters, Venturimeter, Pitot tube, Flow nozzle, Variable area meters, rotameter, design and accuracy, Positive displacement flow meter, turbine flow meter, Electromagnetic flow meter, ultrasonic flow meters, Temperature sensing techniques, liquid-in-glass and bimetallic thermometers, Pressure thermometers, electrical resistance thermometers, Thermistors, Thermocouples, thermopiles, Radiation pyrometers, Optical pyrometer.

Text Book:

1. Beckwith, B., "Mechanical Measurements", 6th Ed., Pearson Education Int. ,2008.
2. Morris, A., "Measurement and Instrumentation Principles", 3rd Ed, Butterworth Heinemann, 2010

Reference Book:

1. Nakra B.C. "Instrumentation, Measurements & Analysis", 2nd edition, Tata Mc Graw Hill, New Delhi, 2008.
2. Doeblin, E.O., "Measurement systems",5th edition, McGraw Hill, New Delhi, 2004

CourseNo.:MEC703 INDUSTRIAL ENGINEERING -II C LT(4 31)

Course Outcome

CO1 Grasp the concept of organizational design with emphasis on organization principles and work design.

CO2 Analyze and design facility location and layout using various techniques and software.

CO3 Demonstrate the ability to use the methods of statistical quality control (SQC) and process control (SPC) for effective designing of Industrial Quality Monitoring Systems.

CO4 Demonstrate the ability to apply the techniques of materials management and inventory control for effective designing and systematic implementation of various MM methods and inventory systems, in a manufacturing set up.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS1	PS2	PS3
C01	2	2	2	2	2	3	3	1	2	2	2	2	2	2	2
C02	3	3	3	3	3	3	3	1	2	2	2	2	2	2	2
C03	3	3	3	3	3	2	2	-	2	2	3	2	3	2	2
C04	2	3	3	3	3	3	3	1	2	2	3	2	3	2	2

UNIT I

Factory organization: Introduction to Plant organization, Principles of Organizational structure, Organization charts, Types of Organizations, Developing an organization structure, Results of good organization, Informal organization, advantages and disadvantages.

Location and Layout analysis: Introduction to Facility location problems, Factors affecting the plant location. Break even analyses and their application, Subjective, qualitative and semi-Quantitative techniques of facility location, Single facility Location problem, Minimax Location problem, Gravity problem and their applications. Line balancing, Introduction to facility layout and their objectives, Classification of Layouts, with advantages and disadvantages of each, Layout design procedures (CRAFT, CORELAP, ALDEP), Material handling systems, Make or Buy decisions, Planning and control of Batch Production,. Characteristics of Batch Production, Determination of Batch size, Minimum Cost batch Size, Maximum Profit Batch size, Sequencing and scheduling for Batch Production, Line of Balance technique.

UNIT II

Inspection and quality control: Concept and Definition of Quality, Concepts of Inspection and quality control, Objectives of inspection, Function of Inspection and their types, Concept of statistical quality control (SQC), Process variation, Sampling inspection. Concepts and types of Control charts, Acceptance sampling, application of control charts and sampling plans.

UNIT III

Materials management and inventory control: Integrated materials management and their components, Functions and objectives of material management, Introduction and concepts of Inventory management, Purchase model with instantaneous replenishment and without shortage, Manufacturing model without shortages, Purchase model with shortages, Manufacturing model with shortages, Probabilistic inventory concepts with lead time., Selective inventory management-ABC ,FSN, VED analyses.

Text Book:

1. Everett, E.A., Ronald J.E, "Production and Operations Management" Prentice Hall ofIndia,5th edition, New Delhi, 2001.

Reference Books:

Claude,S.G., "Management for Business &Industry" Prentice Hall of India, New Delhi, 2000.
Everett, E.A., Ronald J.E, "Production and Operations Management", Prentice Hall of India,5th Edition, NewDelhi,2001.
Grant, E.L; Leavenworth R.S, "Statistical Quality Control", Tata Mc graw Hill, 7th Edition, NewDelhi,1996.
Apple,J.M, "Plant Layout & Material Handling", John Wiley & Sons, New York.
Maynard, Industrial Engineering Hand Book, Mc Graw Hill, New York.

CourseNo.:MEC704 **APPLIED THERMODYNAMICS- II** **CLT(4 31)**

Course Outcome

1.Explain the Gas Dynamics and different energy equations.
2.Analyze the working and operations of the gas power plants.
3.Analyze the operations of centrifugal air compressor and axial air compressor
4. Develop the concept of the psychrometry and the refrigeration and air conditioning.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1		2		2	2	3	3	3	3
CO2	3	3	2	3	2	2		2		3	3	3	3	3	3
CO3	3	3	3	3	2	2		2		3	3	3	3	3	3
CO4	3	3	2	2	2	2	3	2		3	3	3	3	3	3

UNIT I

Gas dynamics, Definitions and basic relations, Energy equation, rate equations for a control volume, Isoentropic flow with variable area, wave motion, Flow with normal shock waves, Flow in Constant area ducts with friction, Flow in constant area ducts with heat transfer, Centrifugal compressor, Energy transfer in compressors and turbines, Euler's equation. Principles parts and description of centrifugal compressor, impeller diameter, number of blades, velocity diagram, sprewhirl (??) slip, factor work input, factor pressure coefficient, compressor efficiency.

UNIT II

Axial flow compressor, Stage velocity diagram, stage pressure ratio and number of stages, degree of reaction blade and stage efficiency, poly tropic and isentropic efficiency surging, Gas Turbines, Ideal gas turbine cycle, condition for maximum output, actual gas turbine cycles, reheating and regeneration velocity diagram for a stage, stage pressure ratio and number of staged polytropic efficiency, isoentropic efficiency, Jet propulsion, Turbojet cycle, net thrust, specific thrust, thermal efficiency of turbojet engine, propulsive efficiency, effect of forward speed.

UNIT III

Applications of Refrigeration and Air-conditioning, Thermal Principles for Refrigeration, Vapor Compression System, Reversed Carnot Cycle, Survey of Refrigerants, Designation of Refrigerants, Selection of Refrigerants, Thermodynamic Requirements, Multistage compression, multi-evaporator system, cascade systems, systems practices for multistage systems, Reciprocating Compressors, Rotary screw compressors, Vane compressors, Centrifugal compressors, Condensers, Heat Transfer in Condensers, Evaporators, Heat Transfer in Evaporators, Extended surface Evaporator, Cooling and Dehumidifying coils, Automatic or constant-pressure expansion valve, Psychometric properties, Wet bulb temperature, Psychometric chart, mixing process.

Text Book:

Cohen H, Rogers G.F.C. ,"Gas turbine Theory", Pearson Education,,2001.
Yahya,S.M., "Fundamentals of Compressible flow", New Age India, Place,2002.
Arora C.P., "Refrigeration and Airconditioning" ,McGraw Hill,NewDelhi,1990.

Reference Books:

Stoeker, W.F., "Refrigeration and Airconditioning", McGraw Hill,,1990.
Shapiro A.H., "The Dynamics and Thermodynamics of Compressible Fluid Flow", RonaldPress,1953.

Course No.: MEC705 COMPUTER APPLICATIONS IN MECH.ENGG.(CAME) CLP(321)

COURSE OUTCOMES:

CO1: Able to solve non-linear equations using, R.F, Newton Rapson methods.
CO2: Able to solve linear system of equations using Gauss elimination, Gauss-Jourdan, Gauss siedel & LU decomposition
CO3: Able to use interpolation formulas; and linear & nonlinear curve fitting.
CO4: Able to use numerical differentiation & integration methods. Solve ODEs & PDEs using numerical methods.
CO5: Able to develop computer programs for the above methods and interpret them graphically.

CO PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		1								2	1	1	
CO2	3	3		1								2	1	1	
CO3	3	3		1								2	1	1	
CO4	3	3		1								2	1	1	
CO5	3	3		1								2	1	1	

UNIT I

Overview of C++, Flow charts. Computer languages. Constants and variables. Arithmetic expressions. Input/ output, control and the Do and for statements. Introduction to programming. Types of errors. Computational algorithms and computer arithmetic. Iterative methods. Solution of equations: Bisection method, Regula-falsi method, Newton Raphson method. Solution of linear system of equations: Gauss elimination, Gauss-Jordan, Gauss- Siedel method, LU decomposition.

UNIT II

Interpolation and approximation of functions, Newton's forward formula (equal and unequal intervals) Curve fitting (straight line, nonlinear, exponential) differentiation, integration (Simpson's rule, Weddle's) and program.

UNIT III

Numerical solution of ordinary different equations. Runge- Kutta methods, Types of PDEs, boundary value problems, solution of parabolic PDEs using finite differences and program. Examples to be taken from Mechanical engineering applications

Text Book:

Sastry,S. "Numerical Methods", Printice Hall of India, New Delhi.

Reference Books:

Lafore,G, "C++Programming", Galgotia publishers, NewDelhi,2001.
Veerarajan, "Numerical Methods", Tata Mc-Graw Hill, NewDelhi,2000.

MEC 703P INDUSTRIAL ENGINEERING- II LAB. CP(12)

Course Outcome:

C703P.1: Present a numerical and graphical characterization of quantitative data assuming the quantitative data are observations from a normal distribution to compute the Probability of specific numerical outcomes. Construct and interpret normal Probability plots of quantitative data.

C703P.2: Construct, implement and interpret X-bar and R control charts for variables from Standards and from data; and demonstrate how to use the corresponding OC curves.

C703P.3: Construct, implement and interpret p, c, and u control charts for attributes from Standards or data; and demonstrate how to use the corresponding OC curves.

C703P.4: Demonstrate and simulate layouts to determine optimum material flow rate and cycle time of a job using witness software

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	3	3	2	3	1	1	1	3	3	3
CO 2	3	3	3	3	2	3	3	3	3	1	1	1	3	3	3
CO 3	3	3	3	3	3	2	2	2	3	3	2	1	3	3	3
CO 4	3	3	2	2	3	2	1	1	3	3	3	1	3	3	3

List of Experiments:

1. To study the layout of a shop in an organization and draw existing and proposed layouts.

2. To measure the variable characteristics (diameter of pins, with micrometer) and prepare a frequency histogram. Calculate values of X bar and sigma.

3. Verify that when random samples are taken from a lot with a certain percentage of defective, same %age lands to appear in random sampling by using Shewart's kit.

4. Simulate an inspection situation with the help of a Schewhart's bowl and plot X bar, and R charts using computed data.

5. To conduct Process capability study of a machine tool and to specify the tolerances for a job.

6. To verify the theorem "the standard deviation of the sum of any number of independent variables is the square root of the sum of the squares of the S.Ds of the independent variable. Determine statistically, the permissible tolerance of mating components, when the tolerance of the assembly is given.

7. To draw control chart for percent defectives after inspecting a sample and sorting out the defective units.

MEC 705P **CAME** **LAB** **CP (12)**

CO1 Able to develop computer program for solving non-linear equations using, R.F, Newton Raphson methods on computer programme
CO2 Able to develop computer program for solving linear system of equations using Gauss elimination, Gauss-Jordan, Gauss-Siedel & LU decomposition
CO3 Able to develop computer program for interpolation formulas; and linear & non linear curve fitting.
CO4 Able to develop computer program for numerical differentiation & integration methods and ODEs & PDEs
CO5 Able to interpret results from computer programs and comparing with the analytical solutions

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		1								2	1	1	
CO2	3	3		1								2	1	1	
CO3	3	3		1								2	1	1	
CO4	3	3		1								2	1	1	
CO5	3	3		1								2	1	1	

List of Experiments:

Develop programme and algorithm for:

1.Bi section method

2.Regula-Falsi method

3.Newton Raphson method

4.Gauss Elimination method

5.Gauss Jordon method

6.Gauss Seidel method

7.Integration by trapezoidal method

8.Integration by Simphson rule(1/3and3/8)

9.Solution of ordinary differential equations and Partial differential equations by

a. R.K methods

b. Solution of Parabolic partial differential equation.

CourseNo.: MEC 801 PRODUCTION&OPERATIONSMANAGEMENT C L T(4 3 1)

UNIT I

Managing and Planning Operations:
Introduction to operations management (OM), historical perspective and growth, operations strategies for competitive advantage. Forecasting (FC), nature and use of FC, sources of data, demand pattern, FC models. designing products, services and processes, new product design, product development, product life cycle, product development process, product reliability, process technology life cycle, flexible manufacturing systems,

UNIT II

Scheduling Systems and Aggregate Planning for Products and Services Operations planning and scheduling systems, the aggregate planning process, strategies for developing aggregate planning, master schedule and rough cut capacity planning, implementing aggregate plans and master schedules, material requirement planning(MRP)

UNIT III

Managing for World class Competition
Japanese contribution for World Class Manufacturing (WCM), JIT manufacturing, basic concepts of TQM, ISO, Poka Yoke and Kaizen. Business process re-engineering, lean manufacturing, concepts of supply chain management,

Text Books:

Panneerselvam R, " Production and Operations Management", 2nd Edition, New Delhi,2005

Reference Book:

Roberta S. Russell, Taylor B.W, "Operations Management", Pearson Prentice Hall,4thedition,2001.

Everett, E.A., Ronald J.E, "Production and Operations Management" Prentice Hall ofIndia,5thedition, New Delhi, 2001
Evans J.R., Collier D.A., "Operations Management, An Integrated Goods and Services Approach", Cengage Learning India, New Delhi, 2007.

CourseNo :MEC802 INTERNAL COMBUSTION ENGINES CL T(4 3 1)

CO1 Understand the design and application based classification of internal combustion engines
CO2 Understanding the geometrical properties of internal combustion engines needed to design an internal combustion engine.
CO3 Understanding the basic design and operating parameters of internal combustion engines needed for analysis and synthesis stages of the engine design and optimization processes with objective functions related to engine performance and emissions characteristics.
CO4 Understand the design of internal combustion engines as per possible future alternative fuels and emissions norms revised and regulated from time to time.

	POs												PSOs		
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Unit I

Thermodynamics of actual working fluids: Working fluid before combustion, valve and port timing diagrams. Thermodynamic properties of fuel-air mixture before combustion. Use of combustion charts for unburned mixture. Use of combustion charts for burned mixture Appropriate treatment of fuel air mixtures. Fuel air cycles: Definition, constants, volume fuel air cycle, limited pressure cycle, characteristics of fuel-air cycles, comparison of real and fuel cycles. Air capacity of four stroke engines: Ideal air capacity , Volumetric efficiency , ideal induction process , actual induction process, Effect of operating conditions on volumetric efficiency, Effect of design on volumetric efficiency , estimating air capacity.

Unit II

Two stroke engines: Scavenging process, ideal scavenging process, relationship of scavenging ratio and scavenging efficiency, power to scavenger, supercharged two stroke engines. Combustion and detonation: chemistry of combustion, normal combustion in S.I engines , pre- ignition and auto-ignition comparison, detonation in S.I engines, combustion in C.I engines, detonation in C.I engines, Methods of reducing detonation , preliminary detonation, preliminary facts about fuel and dopes, octane and cetane numbers, effect of design on detonation. Mixture requirements: Steady running, mixture requirements, transient mixture requirements, mixtures requirements for fuel injection engines, mixture requirements for S.I engines. Performance of supercharged engines: engine performance measures, commercial engine ratings, basic performance equations for un-supercharged engines, effect of atmospheric conditions, altitude and compression ratio on performance characteristics, performance curves. Supercharged engines: definitions, reasons for supercharging, supercharging of S.I engines, supercharging of diesel engines.

Unit III

Heat losses and cooling: Area of heat flow engines, temperature profile, Engine cooling system, Numericals on heat transfer in IC engines, Engine design: selection of type, engine speed and principles of similitude. Numerical on alternative fuels, Numerical on diesel fuel injection system, Numericals on engine specification and verification, Numerical on two stroke engines. General design of petrol and diesel engine. Numericals on engine design, determination of main dimensions, Comparative Numerical on two stroke engines and four stroke engines

Text Book:

1. Heywood, J.B., " Internal Combustion Engine fundamentals", Mc-Graw Hill Book Co., USA, 1989.

Reference Books:

1. Kevin L Hoag; "Vehicular Engine Design" , SAE International, USA
2. Richard L Bechtold ; "Alternative Fuels Guide Book", SAE International, USA
3. D E Winterbone And R J Pearson; " Design Techniques For Engine Manifolds Wave Action Methods For I C Engines", SAE International, USA
4. Domkundvar V.M., "A course in internal combustion engines", Dhanpat Rai and company, New Delhi, 1999.
5. MATHUR SHARMA
6. VASANDANI THERMODYNAMICA AND HEAT ENGINES

MEC802P I.C. ENGINESLAB. CP (12)

CO1 Understand the practical aspects of design and application-based classification of internal combustion engines

CO2 Understanding the practical aspects of geometrical properties of internal combustion engines needed to design an internal combustion engine.

CO3 Understanding the practical aspects of basic design and operating parameters of internal combustion engines needed for analysis and synthesis stages of the engine design and optimization processes with objective functions related to engine performance and emissions characteristics.

CO4 Understand the practical aspects of design of internal combustion engines as per possible future alternative fuels and emissions norms revised and regulated from time to time.

	POs												**PSOs**		
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1. Study of model of 4 stroke cycle petrol engine.
2. Study of model of 4 stroke cycle diesel engine.
3. Study of model of 2 stroke cycle petrol engine.
4. Study of working model of optical engine.
5. Study of cut section of single cylinder 4 stroke cycle diesel engine.
6. Study of five gas exhaust gas analyzer. [Gases - O_2, CO, CO_2, HC and NO_x]
7. Pollution check of 4 stroke petrol engine vehicle.
8. Heat balance or energy balance of three cylinder 4 stroke cycle petrol engine.
9. Heat balance or energy balance of single cylinder 4 stroke cycle diesel engine.
10. Study of characteristic performance curves of three cylinder 4 stroke cycle petrol engine.
11. Study of emissions characteristics of three cylinder 4 stroke cycle petrol engine.
12. Study of characteristic performance curves of single cylinder 4 stroke cycle diesel engine.
13. Study of emissions characteristics of single cylinder 4 stroke cycle diesel engine.
14. Study of characteristic performance curves of single cylinder 4 stroke cycle petrol engine generator.
15. Study of emissions characteristics of single cylinder 4 stroke cycle petrol engine generator.

Laboratory Manuals:

1. Single cylinder four stroke cycle diesel engine test rig.
2. Three cylinder four stroke cycle petrol engine test rig.
3. Five gas exhaust gas analyzer.
4. Single cylinder four stroke cycle petrol engine generator.

Text Book:

1. Heywood, J.B., " Internal Combustion Engine fundamentals", Mc-Graw Hill Book Co., USA, 1989.

Reference Books:

1. Richard L Bechtold ; "Alternative Fuels Guide Book", SAE International, USA
4. Domkundvar V.M., "A course in internal combustion engines", Dhanpat Rai and company, New Delhi, 1999.

CourseNo.:MEC-80* **VALUE ENGINEERING** **CLT(32 1)**

Course Outcome:

CO1 Design a system, component, or process effectively, by adding value to i.e by increasing its function at the same or lower cost.

CO2 Develop optimum designs and analyse production process as a whole.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3		3	2		2		2	2		2	2	3	2	1
2	2		3			2		2.5	1.5		2	2	3	2	1

UNIT I:

Introduction to value engineering (VE) & value analysis (VA), Life Cycle of a product, Methodology of VE, Reasons for the existence of unnecessary costs. Quantitative definition of Value, use Value and Prestige value, Estimation of product quality/ Performance, Types of functions, Relationship between use functions and Esteem Functions in product design, Functional cost and functional worth, Effect of value improvement on profitability, Tests for poor value, Aims of VE systematic approach.

UNIT II

Elementary introduction to VE, Job plan functional approach to value improvement, Various phases and techniques of the job plan, Factors governing project selection, Types of projects, Life cycle costing for managing the total value, concepts in LCC, Present value concept, Annuity concept, net present value, Pay Back period, internal rate of return on investment (1RR), Examples and Illustrations. Creative thinking and creative judgement, positive or constructive discontent, Tangible and intangible costs of implementation, False material, Labour and overhead saving, VE/VA yardsticks, Relationship between savings and probability of success, Reliability Estimation, system Reliability, Reliability elements in series and parallel.

UNIT III

PHASES AND TECHNIQUES OF VE JOB PLAN:

General Phase, Information phase, Function phase, Creativity/Speculation Phase, Evaluation Phase, Investigation Phase and Recommendation Phase***:*** Value improvement recommendation theory, determination of cut-off point (cop), road blocks in implementation. Decision Matrix/Evaluation Matrix, Quantitative comparison of Alternatives, Estimation of weights factors and efficiencies, Utility transformation functions, Bench marking, Perturbation of weight factors (sensitivity analysis), and Examples.

FAST Diagramming: Critical path of functions, HOW, WHY & WHEN Logic,Supporting and all time functions.

Reference Books:

1. Arthur E. Mudge, "Value Engineering- A Systematic Approach",*McGraw Hill Book Co.* 1971.
2. Miles L.D., "Techniques of value Analysis and Engineering", *McGraw Hill Book Co., New York, 1970.*
3. ASTME-American society for Tool and Manufacturing Engineers," Value engineering in Manufacturing", *Prentice Hall Inc. USA, 1967.*

Course No.: MEC80* THEORY OF ELASTICITY(TOE) CLT (32 1)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1								2	3	3	
2	2	3	2	3								1	3	3	
3	2	3	3	3								1	3	3	
	1	2	3	3								1	3	3	

UNIT I

Introduction: Elasticity, stress components of stress and strain, Hooks law. Equations in polar coordinates, Plane stress and plane strain: Strain at a point, Mohr circle for strain rosette, differential equation of equilibrium, boundary conditions, compatibility equations, overview of Airys stress functions.

UNIT II

Two dimensional problems in rectangular coordinates: solution by polynomials, St Venants principles, determination of displacement, bending of beams, solution by Fourier series. Two dimensional problems in polar coordinates: Equations in polar coordinates, equation about 1-axis, and pure bending in curved bars.

UNIT III

Determination of strains and displacement, effect of circular hole on stress distribution in plate concentrated and vertical loading of a straight boundary, circular disc, general solution and its applications, Analysis of stress and strain in three dimensions: stress at a point, principal stress, stress ellipsoid and stress director surface, homogenous deformation, strain at a point, principle strain rotation.

Text Books:

1. Timoshanko, S.P .and Goodier, J .N.,"TheoryofElasticity,"Mc-GrawHillBookCompany,N.Y.,USA,1970.

2. Love, A.E.H., "The Mathematical Theory of Elasticity, "Dover Publications, New York, USA,1944.

Course No. : MEC80* INTRODUCTIONTOACOUSTICS CLT (32 1)

UNIT I

Fundamentals of Vibrations: Introduction, The simple oscillator, Complex exponential method of solution, Transient response of an oscillator, Power relations, Equivalent electrical circuits for oscillators, The Fourier Transform.

Transverse Motion: Vibrations of extended systems, Transverse waves on a string, The one-dimensional wave equation, General solution of the wave equation, The wave nature of the general solution, Initial values and boundary conditions ,Reflection at a boundary, Forced vibration of an infinite string, Forced vibration of a string of finite length, Normal modes of the fixed string, Acoustic measurements.

UNIT II

The Two-Dimensional Wave Equation: Vibrations of a plane surface, The wave equation for a stretched membrane, Free vibrations of a rectangular membrane, Free vibrations of a circular membrane, Normal modes of membranes, The diaphragm of a condenser microphone, Vibration of thin plates.

The Acoustic Wave Equation and Simple Solutions: The equation of state, the equation of continuity, The Euler's equation, The linear wave equation, Speed of sound in fluids, Harmonic plane waves, Energy density, Acoustic intensity, Specific acoustic impedance, Spherical waves, The in homogeneous wave equation, The point source.

UNIT III

Radiation and reception of acoustic waves: Radiation from a pulsating sphere, Acoustic reciprocity and the simple source, The continuous line source, Radiation from a plane circular piston, Radiation impedance, Fundamental properties of transducers (directional factor, beam pattern, beam width, source level, directivity).

Reflection and Transmission of Acoustic Waves: Transmission from one fluid to another: normal incidence, and oblique incidence, Normal specific acoustic impedance, Reflection from the surface of a solid: normal incidence, oblique incidence.

Text Book:

1.Kinsler, L.ER., AustinR.Frey,A.B.,Coppens,J.V.,Sanders,"FundamentalsofAcoustics", 4thedition,JohnWiley &Sons.

Reference Book:

1.PhilipM.Morse,Ingard,K.U.,"TheoreticalAcoustics",PrincetonUniversityPress.

Course No.: MEC80# POWERPLANTENGINEERING (PPE) CL T (32 1)

Course Outcome

After the completion of course, students will be able,

CO1 Identify the different types of power plants and understand the layout of steam power plant.
CO2 Understanding of Hydroelectric power plant and Coordination of different types of power plants.
CO3 Able to describe the working operations of Nuclear, Diesel, Gas and Steam power plants.
CO4 To apply & analyses the economics of power plant and able to decides the tariffs for different power plants.

COs Mapping with PO and PSOs

	POs												PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2		2	1	2	2				2	3	2	3
2	3	2	2		2	2	2	2				2	3	2	3
3	3	2	2		2	2	2	2				2	3	2	3
4	3	3	3			3	1	2			3	2	3	1	3

UNIT I

Introduction: - Energy source for generation of electric power. Principle types of power plants, their special features and applications, major power plants in India.

Steam Power Plants: - Selection of site, general layout of the power plant, special features of the modern steam boilers, circulation principle, steam separation and purification, economizers and air pre-heater types and estimation of performance, super-heater and superheat control, feed water heaters, cooling tower, temperature and pressure control. Introduction to hydroelectric powerplant, types of hydro-electric plant in combination with steam plant, Run off river plant in combination with steam plant, storage plant in combination with steam or nuclear plant, Coordination of hydro-electric and gas turbine stations, coordination of different types of powerplants.

UNIT II

Nuclear Power Plants :- Nuclear fuel, nuclear energy by fission, main components of nuclear reactors, pressurized water, boiling water, liquid metal and gas nuclear reactors.

Diesel Power Plants: - Plant layout, two and four stroke cycle diesel engines, fuel injection, lubrication and cooling systems, supercharging and starting systems. Gas and Steam Turbine combined Cycles:-Simple gas and steam combined cycle power generation.

UNIT III

Economic Analysis of Power Plants and Tariffs :- The cost of electrical energy , selection of types of generating equipment , performance and operating characteristics of power plant , load division among generators , Tariff methods of electrical energy .Combined operation of differentpowerplants:-Advantagesofcombinedworking,Loaddivisionamongpowerstations,Storage

Text Book:

Rajput R.K., "A text book of power plant engineering", Laxmi Publication, Pvt. Ltd., New Delhi, 2007.

Reference Books:

Domkundwar, S.,"PowerPlantEngineering",S.C.Chandandcompany,NewDelhi,2000.
Joel W, Roy E, "Modern Power Plant Engineering", Prentice-Hall of India Ltd., New Delhi, 1985.

Course No.: MEC80# **CAD OF THERMAL SYSTEMS** **C L T (3 2 1)**

Course Outcomes (COs)

CO1. To understand thermal system engineering design process.

CO2. To learn the characteristics of the components of the thermal system and their effects on overall system performance.

CO3. To simulate a thermal system and solve for a workable solution.

CO4. To identify, formulate and solve a wide range of real world thermal related problems.

	POs												PSOs		
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2	2
1	3	3	2	2	2	2	2		2	2		2	2	2	2
2	3	3	3	2	2	2	2	2	2	2		2	2	2	2
3	3	3	3	2	2	2	2	2	2	2		2	2	2	2
4	3	3	3	3	2	3	1	2	2	2	3	2	1	1	2

Unit 1

Introduction, Design versus Analysis, Synthesis versus Design, Optimal and Nearly Optimal designs, Life Cycle Design, Thermal design aspects, Concept, creation and assessment, Thermal system (Basic Characteristics, Analysis), some typical examples, formulation of the design problem, Steps in design process, Material selection.

Unit 2

Modelling of thermal systems, types of models, Mathematical modeling, General procedure (Transient/steady state, spatial dimensions, lumped mass approximation, simplification of boundary conditions, negligible effects, idealizations, material properties, conservation laws, simplification of governing equations), final model and validation, physical modeling and dimensional analysis, curve-fitting, Numerical modeling and simulation, Solution procedures, methods for numerical simulation.

Unit 3

Formulation of problem for optimization, optimized design, objective function, constraints, operating conditions versus hardware, optimization methods (Calculus methods, Search methods, etc.), Optimization of thermal systems, Applications with Thermodynamics, Heat and Fluid flow, Thermal insulation, Fins, Electronic packages.

Text books:

Bejan, A., Tsatsaronius, G., Moran, M., "Thermal Design and Optimization", John Wiley, 2013.

Stoecker, W.F., "Design of Thermal Systems", McGraw Hill, 2017.

Reference Books:

Janna, W.S., "Design of Fluid Thermal Systems", Cengage Learning, 2015.

Balaji, C., Thermal System Design and Optimization, Ane Books Pvt Ltd, 2019.

CourseNo.: MEC80# INTRODUCTION TO MEMS CLT(3 21)

UNIT I

Definition of MEMS, MEMS devices, Silicon as a MEMS material, mechanical properties of silicon, Fabrication technologies, Introduction to micro-fabrication, Silicon based MEMS processes, Surface Micromachining, Sacrificial Etching Process, Bulk Micromachining and Silicon Anisotropic Etching, Bulk versus surface micromachining, mechanical components in MEMS.

UNIT II

Review of essential electrical and mechanical concepts, Conductivity of Semi conductors, Review of solid mechanics for design of mechanical components, Crystal Planes and Orientation, Mechanical properties of Silicon and their related thin films.

UNIT III

Review of electrostatics and electrodynamics for electrical domain calculations, Electrostatic Sensing and actuation, analysis of comb drives, Dynamics of comb drives, Piezoelectric Sensing and actuation, Piezo resitive Sensing, Scaling laws, Instrumentation for MEMS testing and characterization.

Reference Books:

Senturia,S.D.,"MicrosystemDesign",KluwerAcademicPublisher,2000.

NadimM,"AnIntroductiontoMicroElectromechanicalSystemsEngineering",Artechhouse,1999.

ANNEXURE-I

Courses offered in First and Second Semesters

First Semester		
Subject	Code	Credits
Physics	PHY101	3
Physic Lab.	101P	1
Chemistry	CHM102	3
Chemistry Lab.	102P	1
Math	MTH101	4
Engineering Drawing	CIV102	4
Humanities	HSS101	4
Computer Fundamentals	IT101	3
Workshops	WSP1	2
Second Semester		
Physics	PHY201	3
Physic Lab.	201P	1
Chemistry	CHM201	3
Chemistry Lab.	201P	1
Math	MTH201	4
Machine Drawing	MEC201	4
Humanities	HSS201	4
Computer Science	CSC201	3
Engineering Mechanics	CIV201	3
Workshop II	WSPII	2

ANNEXUREII

Courses offered by MED to students of the other departments / disciplines

Semester	Branch	Course	Code
3rd	Chemical	Design of Machine Elements	MEC307
3rd	Metallurgy	Mechanics of Solids	MEC308
3rd	Metallurgy	MOS Lab.	MEC308P
4th	Metallurgy	Machine Design & Instrumentation	MEC406
4th	Metallurgy	MD & I Lab.	MEC406P
4th	Metallurgy	Fluid flow &Heat transfer	MEC407
4th	Metallurgy	FF &HT Lab.	MEC407P
4th	Electrical	Mechanical Engg.	MEC408

CourseNo.MEC201 MACHINE DRAWING (2nd semester) CLP (41 6)

Principles of sectioning-Types of sections, standard sectioning practices

Principles of dimensioning: size and location of dimensions, incremental and absolute dimensioning, unidirectional aligned practices, tolerances, standard dimension practices
Screw and Screwed Fasteners (Temporary): representation of screws, threads and various types of screw threads, threaded fasteners, locking devices, foundation bolts
Permanent Fasteners: Rivet and riveted joints, welding symbols and welded joints

Pin and Cotter Joints (temporary fasteners): Spigot and socket type cotter joints, sleeve type cotter joint, knuckle joint, Gib and cotter joints.
Keys and shaft couplings (Temporary fasteners): Muff coupling (Pin type), Friction coupling.
Clutches: Oldham coupling and universal coupling.

Shaft Bearings: Types of bearings, Journal bearing, pivot bearing, thrust bearing, ball bearing, bearing bracket and hangers.
Drawing sheets to be prepared as practicals.

References:

1. Bhat, N.D., "Machine Drawing"

2. Gill, P.S., "Machine Drawing"

+Indian Std., BIS, for drawing