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**

Course No.: MEC 501 **THEORY OF MACHINES -II** **C L T (4 3 1)**

COURSE OUTCOMES:

1. **Develop the mathematical models ofvibrating systems, determine their DOF, and determine the free and forced vibration response of such systems.**
2. **Determine the response of linear time-invariant systems to arbitrary forcing conditions using the convolution intergral and the Laplace Transform method.**
3. **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.**
4. **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.**
5. **Appreciate the need of static and dynamic balancing of rotating machinery, determine the unbalance and provide the corrections necessary to eliminate the unbalance.**

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

UNIT II

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.

UNIT III

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.

Text Book:

1. Grover, G. K. "Mechanical Vibrations, 7th edition, *Nem Chand and Bros, New Delhi, India 1996.*

Reference Books:

1. Meirovitch, "Elements of vibration analysis," 2nd edition, Mc *Graw Hill, 1998*.
2. Thomson, W. T., "Theory of Vibrations with applications" 5th edition, *Pearson Education, 2004*.

Course No.: MEC 502 **MACHINE DESIGN –I** **C L T (4 3 1)**

COURSE OUTCOMES:

1. **Demonstrate knowledge on basic machine elements usedin machine design.**
2. **Understand the stress and strain on machine components and identify and quantify failure modes for machine parts.**
3. **Design machine elements to withstand the loads and deformations for a given application.**
4. **Approach a design problem successfully, taking decisions when there is not a unique answer.**

UNIT I

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

UNIT II

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 multivariable optimization.

UNIT III

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, screw jack, efficiency of screw jack.

Text Books:

1. Ullman D.G., "The Mechanical Design process", *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. Brown T., "Standard Hand book of Machine Design"

McGraw Hill.

Reference Books:

1. Shigley, J.E., “Hand Book of Machine Design”, *McGraw Hill, 2004.*

Course No.: MEC 503 **HYDRAULIC MACHINERY** **C L T (3 2 1)**

COURSE OUTCOMES:

1. **Evaluate the forces exerted by a jet of fluid on vanes of different shapes, stationary or moving.**
2. **Discuss the construction features and working of different hydraulic turbines and pumps.**
3. **Aalyse the working principle of various hydraulic systems.**
4. **Evaluate the performance characteristics of hydraulic turbnes and pumps.**

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.

UNIT II

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.

UNIT III

Roto dynamic pumps, classification, centrifugal pumps, specific speed, velocity diagrams, heads, power and efficiency, special features of propeller and mixed flow pumps, Positive displacement 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, torque converter and dynamometer. Hydraulic power transmission

Text Book:

1. Massey, B.S., “Mechanics of Fluid”, 6th Edition, *Van Nostrand Reinhold co., 1968.*
2. Jagdish, L., “Hydraulic Machines including Fluidics”, *Mertopolitan Books co. Pvt. Ltd., 1997*

Reference Books:

1. Guthrie, Brown, “Hydroelectric Engineering Practice, *CBS Publishers, New Delhi, 1993.*
2. Douglas, Gasiorek, Swaffield, “Fluid Mechanics”, *Pearson Education, , 2007.*
3. Kumar, D.S., “Fluid Mechanics & Fluid Power Engineering”, *S.K. Kataria & Sons., New Delhi, 2008.*

Course No.: MEC 504 **HEAT TRANSFER** **C L T (3 2 1)**

COURSE OUTCOMES:

1. **Identify, formulate and solve steady, transient and multidimensinal heat conduction problems.**
2. **Understand the phenomenon of convection and be able to evaluate heat transfer coefficients for natural and forced convection.**
3. **Calculate radiation heat exchange between black as well as non-black surfaces.**
4. **Be able to solve a wide range of real world problems involving conduction, convection and radiation.**

UNIT I

Introduction, Fourier's law of heat conduction, Thermal conductivity of solids, liquids and gases, combined heat transfer problems, One dimensional steady heat conduction, Thermal resistance, General three dimensional heat conduction equation in Cartesian, cylindrical and spherical coordinates, heat conduction with heat generation, Fins, Two dimensional steady state heat conduction through plane wall, Unsteady heat conduction with negligible internal temperature 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.

UNIT II

Free and forced convection, hydrodynamic and thermal boundary layer, Empirical relations for convection heat transfer, Heat transfer with change of face, film and drop wise condensation, empirical equations, fundamental of boiling heat transfer, pool boiling.

UNIT III

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, Introduction to Temperature measurements

Text Book:

1. Incropera, F.P., " Fundamentals of Heat and Mass Transfer ", *John Wiley, 2005*.
2. Kreith F., Bohn, "Principles of Heat Transfer", *Cengage publishers, 2006*.
3. Holman, J.P., " Heat Transfer", *McGraw Hill,2009*.

Reference Book:

1. Bejan, A., "Heat Transfer", *John Wiley, 1998*.

Course No.: MEC 505 **INDUSTRIAL ENGINEERING -I** **C L T (4 3 1)**

COURSE OUTCOMES:

1. **Understanding the concept and applications of industrial engineering with a focus on productivity, work design and work study.**
2. **Analysing & applying the method study techniques in relation to a particular job environment.**
3. **Analysing & 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.**
4. **Attain a grasp of the fundamental principles of experimental design, collection of data related to work study, their analysis and interpretation.**

UNIT I

Concept of industrial productivity**:** Introduction and significance of Industrial engineering with brief explanation of its techniques, Functions of Industrial Engineering, Definitions and explanation 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.

UNIT II

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,

UNIT III

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., "Motion and Time Study, Design & Measurement of Work*" 7th edition, John Wiley & Sons, New York, 1980.*

Reference Books:

1. International Labor Office, Geneva, "Introduction to Work Study" 4th Edition, Geneva, *1985*.
2. Currie R.M, "Work study", ELBS *& Pitman, London, 1977.*
3. Mundel, M.E., "Motion and Time Study", 5th Edition, *Prentice Hall, EnglewoodCliff, NewYork, 1978.*

Course No.: ECE507 /8 **INDUSTRIAL ELECTRONICS** **C L T (3 2 1)**

COURSE OUTCOMES:

1. **Utilize the knowledge of diodes, transistors and their characterisrics in design of mechatronic systems.**
2. **Discuss the basic principles of operational amplifiers and their applications.**
3. **Explain the fundamentals of oscillators, modulation and power supplies.**
4. **Discuss the basic principles of power electronic devices such as SCR.**

UNIT I

Introduction to Semi conductors; 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.

UNIT II

BJT's: Types, Operations and characteristics, CE, CB, CC configurations, Transistor circuits, transistor as an amplifier, transistor as a switch, Operational amplifier basis, OP amp as uneverting and non uneverting amplifier and its applications.

UNIT III

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., "Basic Electronics", *Tata McGraw Hill, New Delhi, 1998.*

MEC 501P THEORY OF MACHINES –II LAB. C P (1 2)

COURSE OUTCOMES:

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

1. Determine the time period of a simple pendulum. Verify that the time period is independent of the mass of the bob.

2. Determine the radius of gyration of a compound pendulum.

3. Determine the radius of gyration of a given bar by using a Bifilar suspension.

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

5. Study the forced vibration of an equivalent spring mass system.

6. Study the torsional vibration of a single rotor shaft system.

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

8. Pressure profile measurement on Journal bearing

MEC 504P HEAT TRANSFER LAB. C P (1 2)

COURSE OUTCOMES:

1. **Acquire a thorough outlook regarding the steps to design and conduct experiments for measuring specific physical variables.**
2. **Calculate thermal conductivity of commonly used engineering materials.**
3. **Calculate heat transfer coefficient of fluids.**
4. **Be able to verify Stefan's Boltzmann law and calculate emissivity.**

1. Determination of Fin efficiency and effectiveness of a pin fin in forced convection and natural convection
2. Determination of thermal conductivity of a plate by two slab guarded hot plate method
3. Determination of thermal conductivity of pipe insulation and insulation powder
4. Determination of thermal conductivity of a liquid by the guarded hot plate method
5. Determination of thermal conductivity of a good conductor of heat (metal rod)
6. Determination of overall resistance of a composite wall
7. Determination of heat transfer coefficient in forced convection through a horizontal tube
8. Determination of heat transfer coefficient for heat vertical cylinder in natural convection
9. Determination of LMTD and NTU in parallel flow and counter flow heat exchanger
10. Determination of Stefan Boltzmann's constant
11. Determination of Emissivity.

MEC505 INDUSTRIAL ENGINEERING-I LAB. C P (1 2)

COURSE OUTCOMES:

1. **Demonstrate human factors/ergonomic principles (HF/E) that influence the design, performance and safety of work systems.**
2. **Apply HF/E guidelines and use standard HF/E in the design of work systems.**
3. **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.**
4. **Determine the time required to do a job using standard data, occurrence sampling, time study, and predetermined time systems.**

1. 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)
2. To assembly a product (electrical holder, etc.), record the cycle time and draw learning curve of the operator performing the assembly.
3. Draw Out line process chart and two hand flow process charts for the assembly performed in experiment no. 2, and analyse the present method and also suggest improved method/s.
4. Study and draw of flow process charts (some suitable assembly operation)
5. Study and draw multi activity chart of a suitable method and propose better

method/s.(Man and machine)

6. Study suitable movements/travel of man, material or equipment, and draw string diagram, travel chart and flow diagrams.
7. To calculate the standard time of a suitable job, using predetermined time standard techniques.

ECE 508P **INDUSTRIAL ELECTRONICS LAB.** **C P (1 2)**

COURSE OUTCOMES:

1. **Discuss the basic principles and utility of CRO.**
2. **Discuss the basic working of power electronic circuits and devices.**
3. **Describe the working principle of IC chips and differential amplifier.**

1. Study of CRO Measurement of Voltage, frequency and Phase of a given waveform.
2. To obtain diode characteristics.
3. a) To assemble a half wave and a full wave rectifier and to study their performance.

   b) To suppress the ripple using RC filter.
4. To obtain Zener diode characteristics and to use Zener diode as a voltage regulator.
5. To assemble and observe the performance of clipping and clamping circuits.
6. To obtain transistor characteristics in the following configurations:

   i.) Common base. ii.) Common emitter

7. To assemble a CE amplifier and observe the performance.
8. To assemble a differential amplifier and obtain in CMRR circuits (??) .
9. To study different application of OP AMPS.
    - OP – AMP as an inverting amplifier.
    - OP – AMP as a Non inverting amplifier.
    - OP – AMP as an integrator
    - OPAMP as a differentiator.
10. To study the performance of a voltage regulator IC Chip.