ME8391   **ENGINEERING THERMODYNAMICS**   **L T P C**
                                                                               3 2 0 4

OBJECTIVE:
- To familiarize the students to understand the fundamentals of thermodynamics and to perform thermal analysis on their behavior and performance.

  (Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

UNIT I   BASIC CONCEPTS AND FIRST LAW   9 + 6
Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive, total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work .P-V diagram. Zeroth law of thermodynamics – concept of temperature and thermal equilibrium- relationship between temperature scales -new temperature scales. First law of thermodynamics -application to closed and open systems – steady and unsteady flow processes.

UNIT II   SECOND LAW AND AVAILABILITY ANALYSIS   9 + 6
Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High and low grade energy. Available and non-available energy of a source and finite body. Energy and irreversibility. Expressions for the energy of a closed system and open systems. Energy balance and entropy generation. Irreversibility. I and II law Efficiency.

UNIT III   PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE   9 + 6
Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles.

UNIT IV   IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS   9 + 6
Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases-Reduced properties. Compressibility factor-.Principle of Corresponding states. -Generalised Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.

UNIT V   GAS MIXTURES AND PSYCHROMETRY   9 + 6
Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function. Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications
                                                                    TOTAL : 75 PERIODS

1

OUTCOMES:
Upon the completion of this course the students will be able to

CO1   Apply the first law of thermodynamics for simple open and closed systems under steady and unsteady conditions.

CO2   Apply second law of thermodynamics to open and closed systems and calculate entropy and availability.

CO3   Apply Rankine cycle to steam power plant and compare few cycle improvement methods

CO4   Derive simple thermodynamic relations of ideal and real gases

CO5   Calculate the properties of gas mixtures and moist air and its use in psychometric processes

TEXT BOOKS :
1. R.K.Rajput, "A Text Book Of Engineering Thermodynamics ",Fifth Edition,2017.
2. Yunus a. Cengel & michael a. Boles, "Thermodynamics", 8th edition 2015.

REFERENCES:
1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Borgnakke & Sonnatag, "Fundamental of Thermodynamics", 8th Edition , 2016.
3. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
4. Michael J. Moran, Howard N. Shapiro, "Fundamentals of Engineering Thermodynamics", 8th Edition.
5. Nag.P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, New Delhi, 2013.

CE8394	**FLUID MECHANICS AND MACHINERY**	**L T P C**
		4 0 0 4

OBJECTIVES
- The properties of fluids and concept of control volume are studied
- The applications of the conservation laws to flow through pipes are studied.
- To understand the importance of dimensional analysis
- To understand the importance of various types of flow in pumps.
- To understand the importance of various types of flow in turbines.

UNIT I   FLUID PROPERTIES AND FLOW CHARACTERISTICS   12
Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation.

UNIT II   FLOW THROUGH CIRCULAR CONDUITS   12
Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli- Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation -friction factor- Moody diagram- commercial pipes- minor losses – Flow through pipes in series and parallel.

UNIT III   DIMENSIONAL ANALYSIS   12
Need for dimensional analysis - methods of dimensional analysis - Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV   PUMPS   12

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies- velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps- working principle - work done by the impeller - performance curves - Reciprocating pump- working principle - Rotary pumps –classification.

UNIT V   TURBINES   12

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines – governing of turbines.

TOTAL: 60 PERIODS

OUTCOMES:

Upon completion of this course, the students will be able to
- Apply mathematical knowledge to predict the properties and characteristics of a fluid.
- Can analyse and calculate major and minor losses associated with pipe flow in piping networks.
- Can mathematically predict the nature of physical quantities
- Can critically analyse the performance of pumps
- Can critically analyse the performance of turbines.

TEXT BOOK:
1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.

REFERENCES:
1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", 2011.
4. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010

ME8351	MANUFACTURING TECHNOLOGY – I	L T P C
		3 0 0 3

OBJECTIVE:
- To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components.

UNIT I   METAL CASTING PROCESSES   9

Sand Casting : Sand Mould - Type of patterns - Pattern Materials - Pattern allowances -Moulding sand Properties and testing - Cores -Types and applications - Moulding machines- Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould - Pressure die casting - Centrifugal Casting - CO_2 process – Stir casting; Defects in Sand casting

UNIT II   JOINING PROCESSES   9
Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding - Thermit welding - Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

UNIT III   METAL FORMING PROCESSES   9
Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.

UNIT IV   SHEET METAL PROCESSES   9
Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning- Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming

UNIT V   MANUFACTURE OF PLASTIC COMPONENTS   9
Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications - injection moulding - Plunger and screw machines - Compression moulding, Transfer Moulding - Typical industrial applications - introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

TOTAL: 45 PERIODS

OUTCOMES:
CO1   Explain different metal casting processes, associated defects, merits and demerits
CO2   Compare different metal joining processes.
CO3   Summarize various hot working and cold working methods of metals.
CO4   Explain various sheet metal making processes.
CO5   Distinguish various methods of manufacturing plastic components.

TEXT BOOKS:
1. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008
2. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2013

REFERENCES:
1. Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2008
2. Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" Eight Edition, Prentice – Hall of India, 1997.
3. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013
4. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
5. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.

ME8451   **MANUFACTURING TECHNOLOGY – II**   L   T   P   C
                                                                        3   0   0   3

OBJECTIVES:
- To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
- To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming

UNIT I   THEORY OF METAL CUTTING   9
Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools- nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II   TURNING MACHINES   9
Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi automatic – single spindle : Swiss type, automatic screw type – multi spindle:

UNIT III   SHAPER, MILLING AND GEAR CUTTING MACHINES   9
Shaper - Types of operations. Drilling ,reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling ,hobbing and gear shaping processes -finishing of gears.

UNIT IV   ABRASIVE PROCESS AND BROACHING   9
Abrasive processes: grinding wheel – specifications and selection, types of grinding process- cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications – concepts of surface integrity, broaching machines: broach construction - push, pull, surface and continuous broaching machines

UNIT V   CNC MACHINING   9
Numerical Control (NC) machine tools - CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.

                                                              TOTAL : 45 PERIODS
OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Explain the mechanism of material removal processes.
CO2   Describe the constructional and operational features of centre lathe and other special purpose lathes.
CO3   Describe the constructional and operational features of shaper, planner, milling, drilling, sawing and broaching machines.
CO4   Explain the types of grinding and other super finishing processes apart from gear manufacturing processes.
CO5   Summarize numerical control of machine tools and write a part program.

TEXT BOOKS:
1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters 2014
2. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 3rd Edition, Tata McGraw-Hill, New Delhi, 2013.

REFERENCES:
1. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White "Machine Tool Practices", Prentice Hall of India, 1998
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984
3. HMT, "Production Technology", Tata McGraw Hill, 1998.
4. Roy. A.Lindberg, "Process and Materials of Manufacture," Fourth Edition, PHI/Pearson Education 2006.

ME8491	ENGINEERING METALLURGY	L	T	P	C
		3	0	0	3

OBJECTIVE:
- To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

UNIT I   ALLOYS AND PHASE DIAGRAMS   9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

UNIT II   HEAT TREATMENT   9

Definition - Full annealing, stress relief, recrystallisation and spheroidising - normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Hardenability, Jominy end quench test - Austempering, martempering - case hardening, carburizing, Nitriding, cyaniding, carbonitriding - Flame and Induction hardening - Vacuum and Plasma hardening. .

UNIT III   FERROUS AND NON-FERROUS METALS   9

Effect of alloying additions on steel- α and β stabilisers- stainless and tool steels - HSLA, Maraging steels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

UNIT IV   NON-METALLIC MATERIALS   9

Polymers - types of polymer, commodity and engineering polymers - Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ and SIALON -Composites-Classifications- Metal Matrix and FRP - Applications of Composites.

UNIT V   MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS   9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms.

TOTAL: 45 PERIODS

OUTCOMES

Upon the completion of this course the students will be able to

CO1 Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.

CO2 Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes.

CO3 Clarify the effect of alloying elements on ferrous and non-ferrous metals

CO4 Summarize the properties and applications of non metallic materials.

CO5 Explain the testing of mechanical properties. .

TEXT BOOKS:

1. Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Company,1997.
2. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, Revised Indian Edition 2014

REFERENCES:

1. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 2010.
2. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 2015.
3. U.C.Jindal : Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012
4. Upadhyay. G.S. and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt. Ltd., New Delhi, 2006.

CE8395   **STRENGTH OF MATERIALS FOR MECHANICALENGINEERS**

OBJECTIVES:
- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I   STRESS, STRAIN AND DEFORMATION OF SOLIDS   9
Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II   TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM   9
Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending- bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III   TORSION   9
Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts- Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV   DEFLECTION OF BEAMS   9
Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy - Maxwell's reciprocal theorems.

UNIT V   THIN CYLINDERS, SPHERES AND THICK CYLINDERS   9
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

TOTAL: 45 PERIODS

OUTCOMES
Students will be able to
- Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

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

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

ME8493	THERMAL ENGINEERING - I	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
- To apply the thermodynamic concepts into various thermal application like IC engines, Steam.
- Turbines, Compressors and Refrigeration and Air conditioning systems

(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

UNIT I   GAS AND STEAM POWER CYCLES   9
Air Standard Cycles - Otto, Diesel, Dual, Brayton - Cycle Analysis, Performance and Comparison – Rankine, reheat and regenerative cycle.

UNIT II   RECIPROCATING AIR COMPRESSOR   9
Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors.

UNIT III   INTERNAL COMBUSTION ENGINES AND COMBUSTION   9
IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control.

UNIT IV   INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS   9
Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common Rail Direct Injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms.

UNIT V   GAS TURBINES   9
Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations. Materials for Turbines.

TOTAL:45 PERIODS

OUTCOMES:
   Upon the completion of this course the students will be able to
   CO1   Apply thermodynamic concepts to different air standard cycles and solve problems.
   CO2   Solve problems in single stage and multistage air compressors
   CO3   Explain the functioning and features of IC engines, components and auxiliaries.
   CO4   Calculate performance parameters of IC Engines.
   CO5   Explain the flow in Gas turbines and solve problems.

TEXT BOOKS:
1. Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., "A course in thermal Engineering",
   Fifth Edition, "Dhanpat Rai & sons , 2016
2. Rajput. R. K., "Thermal Engineering" S.Chand Publishers, 2017

REFERENCES:
1. Arora.C.P, "Refrigeration and Air Conditioning ," Tata McGraw-Hill Publishers 2008
2. Ganesan V.." Internal Combustion Engines" , Third Edition, Tata Mcgraw-Hill 2012
3. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009.
4. Rudramoorthy, R, "Thermal Engineering ",Tata McGraw-Hill, New Delhi,2003
5. Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2007

ME8595	THERMAL ENGINEERING – II	L	T	P	C
		3	0	0	3

   OBJECTIVES:
   - To apply the thermodynamic concepts for Nozzles, Boilers, Turbines, and Refrigeration
     & Air Conditioning Systems.
   - To understand the concept of utilising residual heat in thermal systems.

UNIT I   STEAM NOZZLE   9
Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of
mass flow rate with pressure ratio. Effect of friction. Metastable flow.

UNIT II   BOILERS   9
Types and comparison. Mountings and Accessories. Fuels - Solid, Liquid and Gas. Performance
calculations, Boiler trial.

UNIT III   STEAM TURBINES   9
Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal
operating conditions. Multi-staging, compounding and governing.

UNIT IV   COGENERATION AND RESIDUAL HEAT RECOVERY   9
Cogeneration Principles, Cycle Analysis, Applications, Source and utilisation of residual heat. Heat
pipes, Heat pumps, Recuperative and Regenerative heat exchangers. Economic Aspects.

UNIT V   REFRIGERATION AND AIR – CONDITIONING   9
Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance
calculations, Working principle of air cycle, vapour absorption system, and Thermoelectric
refrigeration. Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load
calculations. Cooling towers – concept and types.

OUTCOMES:
Upon the completion of this course the students will be able to
CO1 Solve problems in Steam Nozzle
CO2 Explain the functioning and features of different types of Boilers and auxiliaries and calculate performance parameters.
CO3 Explain the flow in steam turbines, draw velocity diagrams for steam turbines and solve problems.
CO4 Summarize the concept of Cogeneration, Working features of Heat pumps and Heat exchangers
CO5 Solve problems using refrigerant table / charts and psychrometric charts

TEXT BOOKS:
1. Kothandaraman, C.P., Domkundwar .S and Domkundwar A.V.,"A course in Thermal Engineering", Dhanpat Rai & Sons, 2016.
2. Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata Mc Graw Hill Publications, 2010.

REFERENCES:
1. Arora .C.P., "Refrigeration and Air Conditioning", Tata Mc Graw Hill, 2008
2. Ballaney. P.L ." Thermal Engineering", Khanna publishers, 24th Edition 2012
3. Charles H Butler : Cogeneration" McGraw Hill, 1984.
4. Donald Q. Kern, " Process Heat Transfer", Tata Mc Graw Hill, 2001.
5. Sydney Reiter "Industrial and Commercial Heat Recovery Systems" Van Nostrand Reinhols, 1985.

ME8593   **DESIGN OF MACHINE ELEMENTS**   L   T   P   C
                                                                       3   0   0   3

OBJECTIVES
- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components
- (Use of P S G Design Data Book is permitted)

UNIT I   STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS   9
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading - curved beams - crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness - stress concentration - Design for variable loading.

UNIT II   SHAFTS AND COUPLINGS   9
Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

UNIT III   TEMPORARY AND PERMANENT JOINTS   9
Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

UNIT IV   ENERGY STORING ELEMENTS AND ENGINE COMPONENTS   9
Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT V   BEARINGS   9
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.
                                                                  TOTAL: 45 PERIODS
OUTCOMES:
   Upon the completion of this course the students will be able to
   CO1   Explain the influence of steady and variable stresses in machine component design.
   CO2   Apply the concepts of design to shafts, keys and couplings.
   CO3   Apply the concepts of design to temporary and permanent joints.
   CO4   Apply the concepts of design to energy absorbing members, connecting rod and crank shaft.
   CO5   Apply the concepts of design to bearings.

TEXT BOOKS:
1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 9th Edition, Tata McGraw-Hill, 2011.

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010
2. Ansel Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
3. P.C. Gope, "Machine Design – Fundamental and Application", PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, "Design of Machine Elements", MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
5. Robert C. Juvinall and Kurt M Marshek, "Fundamentals of Machine Design", 4th 2005 Wiley

ME8501   **METROLOGY AND MEASUREMENTS**   **L   T   P   C**
                                                                              3   0   0   3

OBJECTIVES:
- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

UNIT I   BASICS OF METROLOGY   9
Introduction to Metrology - Need - Elements - Work piece, Instruments - Persons - Environment - their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

UNIT II   LINEAR AND ANGULAR MEASUREMENTS   9
Linear Measuring Instruments - Evolution – Types – Classification – Limit gauges – gauge design – terminology - procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III   ADVANCES IN METROLOGY   9
Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness - Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

UNIT IV   FORM MEASUREMENT   9
Principles and Methods of straightness – Flatness measurement - Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V   MEASUREMENT OF POWER, FLOW AND TEMPERATURE   9
Force, torque, power - mechanical , Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.
                                                                              TOTAL : 45 PERIODS
OUTCOMES:
   Upon the completion of this course the students will be able to
   CO1   Describe the concepts of measurements to apply in various metrological instruments
   CO2   Outline the principles of linear and angular measurement tools used for industrial applications
   CO3   Explain the procedure for conducting computer aided inspection
   CO4   Demonstrate the techniques of form measurement used for industrial components
   CO5   Discuss various measuring techniques of mechanical properties in industrial applications

TEXT BOOKS:
1. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.
2. Jain R.K. "Engineering Metrology", Khanna Publishers, 2009.

REFERENCES:
1. Alan S. Morris, "The essence of Measurement", Prentice Hall of India 1996.
2. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education , 2014.
3. Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA,1990.
4. Donald Peckman, "Industrial Instrumentation", Wiley Eastern, 2004.
5. Raghavendra ,Krishnamurthy "Engineering Metrology & Measurements", Oxford Univ. Press, 2013.

ME8594	DYNAMICS OF MACHINES	L	T	P	C
		4	0	0	4

OBJECTIVES:
- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.

UNIT I   FORCE ANALYSIS   12
Dynamic force analysis - Inertia force and Inertia torque- D Alembert's principle -Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque - Turning moment diagrams -Fly Wheels - Flywheels of punching presses- Dynamics of Cam- follower mechanism.

UNIT II   BALANCING   12
Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines - Partial balancing in engines - Balancing of linkages - Balancing machines-Field balancing of discs and rotors.

UNIT III   FREE VIBRATION   12
Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration- Equations of motion – Natural frequency – Types of Damping – Damped vibration- Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT IV   FORCED VIBRATION   12
Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion -transmissibility – Vibration isolation vibration measurement.

UNIT V   MECHANISM FOR CONTROL   12
Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization - Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL : 60 PERIODS

15

OUTCOMES:
Upon the completion of this course the students will be able to
CO1 Calculate static and dynamic forces of mechanisms.
CO2 Calculate the balancing masses and their locations of reciprocating and rotating masses.
CO3 Compute the frequency of free vibration.
CO4 Compute the frequency of forced vibration and damping coefficient.
CO5 Calculate the speed and lift of the governor and estimate the gyroscopic effect on automobiles, ships and airplanes.

TEXT BOOKS:
1. F. B. Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
2. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2014.
3. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, 2014.

REFERENCES:
1. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2014
2. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3. Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2005.
4. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
5. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
6. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.

ME8651	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues
  (Use of P S G Design Data Book permitted)

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9
Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9
Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane-Equivalent number of teeth-forces for helical gears.

UNIT III   BEVEL, WORM AND CROSS HELICAL GEARS   9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits-terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV   GEAR BOXES   9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT V   CAMS, CLUTCHES AND BRAKES   9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches -axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

TOTAL : 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   apply the concepts of design to belts, chains and rope drives.
CO2   apply the concepts of design to spur, helical gears.
CO3   apply the concepts of design to worm and bevel gears.
CO4   apply the concepts of design to gear boxes .
CO5   apply the concepts of design to cams, brakes and
clutches

TEXT BOOKS:
1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.

REFERENCES:
1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.
2. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005
5. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.

ME8691   **COMPUTER AIDED DESIGN AND MANUFACTURING**   **L T P C**
                                                                                3 0 0 3

OBJECTIVES:
- To provide an overview of how computers are being used in mechanical component design
- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

UNIT I   INTRODUCTION   9
Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - Line drawing -Clipping- viewing transformation-Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM –CAD/CAM concepts –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance

UNIT II   GEOMETRIC MODELING   9
Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling - surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG andB-rep

UNIT III   CAD STANDARDS   9
Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

UNIT IV   FUNDAMENTAL OF CNC AND PART PROGRAMING   9
Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure-   Drives and CNC controllers- 2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros- Introduction of CAM package.

UNIT V   CELLULAR MANUFACTURING AND FLEXIBLE
**   MANUFACTURING SYSTEM (FMS)   9**
Group Technology(GT),Part Families-Parts Classification and coding-Simple Problems in Opitz Part Coding system-Production flow Analysis-Cellular Manufacturing-Composite part concept-Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control- Quantitative analysis in FMS

                                                                        TOTAL : 45 PERIODS
OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and
             Metrics
CO2   Explain the fundamentals of parametric curves, surfaces and Solids
CO3   Summarize the different types of Standard systems used in CAD
CO4   Apply NC & CNC programming concepts to develop part programme for Lathe &
             Milling Machines
CO5   Summarize the different types of techniques used in Cellular Manufacturing and FMS

TEXT BOOKS:
1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill PublishingCo.2007
2. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
3. Radhakrishnan P, SubramanyanS.andRaju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000.

REFERENCES:
1. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management " Second Edition, Pearson Education, 1999.
2. Donald Hearn and M. Pauline Baker "Computer Graphics"'. Prentice Hall, Inc,1992.
3. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003
4. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.

ME8693	HEAT AND MASS TRANSFER	L	T	P	C
		3	2	0	4

OBJECTIVES:
- To understand the mechanisms of heat transfer under steady and transient conditions.
- To understand the concepts of heat transfer through extended surfaces.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer.
  (Use of standard HMT data book permitted)

UNIT I   CONDUCTION   **9+6**
General Differential equation of Heat Conduction- Cartesian and Polar Coordinates - One Dimensional Steady State Heat Conduction – plane and Composite Systems - Conduction with Internal Heat Generation - Extended Surfaces - Unsteady Heat Conduction - Lumped Analysis - Semi Infinite and Infinite Solids -Use of Heisler's charts.

UNIT II   CONVECTION   **9+6**
Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes .

UNIT III   PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS   **9+6**
Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.

UNIT IV   RADIATION   **9+6**
Black Body Radiation - Grey body radiation - Shape Factor - Electrical Analogy - Radiation Shields. Radiation through gases.

UNIT V   MASS TRANSFER   **9+6**
Basic Concepts - Diffusion Mass Transfer - Fick's Law of Diffusion - Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

TOTAL : 75 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems
CO2   Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems
CO3   Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems
CO4 Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems
CO5 Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications

TEXT BOOKS:
1. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000
2. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition 2015

REFERENCES:
1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998.
2. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002
4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
5. R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2009

	L	T	P	C
FINITE ELEMENT ANALYSIS				
ME8692	3	0	0	3

OBJECTIVES:
- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

UNIT I   INTRODUCTION   9
Historical Background - Mathematical Modeling of field problems in Engineering - Governing Equations – Discrete and continuous models - Boundary, Initial and Eigen Value problems– Weighted Residual Methods - Variational Formulation of Boundary Value Problems - Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II   ONE-DIMENSIONAL PROBLEMS   9
One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements - Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation -Transverse deflections and Natural frequencies of beams.

UNIT III   TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS   9
Second Order 2D Equations involving Scalar Variable Functions - Variational formulation -Finite Element formulation – Triangular elements - Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts -Quadrilateral elements – Higher Order Elements.

UNIT IV   TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS   9

Equations of elasticity - Plane stress, plane strain and axisymmetric problems - Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V   ISOPARAMETRIC FORMULATION   9

Natural co-ordinate systems - Isoparametric elements - Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques - Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

TOTAL : 45 PERIODS

OUTCOMES
CO1   Summarize the basics of finite element formulation.
CO2   Apply finite element formulations to solve one dimensional Problems.
CO3   Apply finite element formulations to solve two dimensional scalar Problems.
CO4   Apply finite element method to solve two dimensional Vector problems.
CO5   Apply finite element method to solve problems on iso parametric element and dynamic Problems.

TEXT BOOKS:
1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

REFERENCES:

1. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013)*
2. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990
3. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002
4. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.

ME8694	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

UNIT I   FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS   9

Introduction to Fluid power - Advantages and Applications - Fluid power systems - Types of fluids - Properties of fluids and selection – Basics of Hydraulics - Pascal's Law - Principles of flow - Friction loss - Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary - Fixed and Variable displacement pumps - Problems.

UNIT II   HYDRAULIC ACTUATORS AND CONTROL COMPONENTS   9

Hydraulic Actuators: Cylinders - Types and construction, Application, Hydraulic cushioning - Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves - Types, Construction and Operation - Servo and Proportional valves - Applications - Accessories : Reservoirs, Pressure Switches - Applications - Fluid Power ANSI Symbols - Problems.

UNIT III   HYDRAULIC CIRCUITS AND SYSTEMS   9

Accumulators, Intensifiers, Industrial hydraulic circuits - Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV   PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS   9

Properties of air – Perfect Gas Laws – Compressor - Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit - Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V   TROUBLE SHOOTING AND APPLICATIONS   9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL:45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Explain the Fluid power and operation of different types of pumps.
CO2   Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
CO3   Explain the different types of Hydraulic circuits and systems
CO4   Explain the working of different pneumatic circuits and systems
CO5   Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

TEXT BOOKS:
1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw-Hill, 2001.

REFERENCES:
1. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
2. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
3. Majumdar S.R., "Pneumatic systems - Principles and maintenance", Tata McGraw Hill, 1995
4. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
5. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.

ME8792   **POWER PLANT ENGINEERING**   **L   T   P   C**
                                                                          3   0   0   3

OBJECTIVE:
- Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

UNIT I   COAL BASED THERMAL POWER PLANTS   9
Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT II   DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS   9
Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III   NUCLEAR POWER PLANTS   9
Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : B*oiling Water Reactor* (BWR), P*ressurized Water Reactor* (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV   POWER FROM RENEWABLE ENERGY   9
Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, *Solar* Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT V   ENERGY, ECONOMIC AND ENVIRONMENTAL
                  ISSUES OF POWER PLANTS   9
Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

                                         TOTAL : 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1 Explain the layout, construction and working of the components inside a thermal power plant.
CO2 Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
CO3 Explain the layout, construction and working of the components inside nuclear power plants.
CO4 Explain the layout, construction and working of the components inside Renewable energy power plants.

CO5 Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

TEXT BOOK:
1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.

REFERENCES:
1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.

ME8793	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

OBJECTIVE:
- To introduce the process planning concepts to make cost estimation for various products after process planning

UNIT I   INTRODUCTION TO PROCESS PLANNING   9
Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection

UNIT II   PROCESS PLANNING ACTIVITIES   9
Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

UNIT III   INTRODUCTION TO COST ESTIMATION   9
Importance of costing and estimation -methods of costing-elements of cost estimation -Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost

UNIT IV   PRODUCTION COST ESTIMATION   9
Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

UNIT V   MACHINING TIME CALCULATION   9
Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

TOTAL: 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   select the process, equipment and tools for various industrial products.
CO2   prepare process planning activity chart.
CO3   explain the concept of cost estimation.
CO4   compute the job order cost for different type of shop floor.
CO5   calculate the machining time for various machining operations.

TEXT BOOKS:
1. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.
2. Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995.

REFERENCES:

1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley, 1998.
3. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.
4. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.
5. K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 1990.

ME8791	MECHATRONICS	L	T	P	C
		3	0	0	3

OBJECTIVE:
- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

UNIT I   INTRODUCTION   9
Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics - Emerging areas of Mechatronics - Classification of Mechatronics. Sensors and Transducers**:** Static and dynamic Characteristics of Sensor, Potentiometers - LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors

UNIT II   MICROPROCESSOR AND MICROCONTROLLER   9
Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,.

UNIT III   PROGRAMMABLE PERIPHERAL INTERFACE   9
Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT IV   PROGRAMMABLE LOGIC CONTROLLER   9
Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT V   ACTUATORS AND MECHATRONIC SYSTEM DESIGN   9
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

TOTAL : 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1 Discuss the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology.
CO2 Discuss the architecture of Microprocessor and Microcontroller, Pin Diagram, Addressing Modes of Microprocessor and Microcontroller.
CO3 Discuss Programmable Peripheral Interface, Architecture of 8255 PPI, and various device interfacing

25

CO4 Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.

CO5 Discuss various Actuators and Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies

TEXT BOOKS:
1. Bolton, "Mechatronics", Prentice Hall, 2008
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Prentice Hall, 2008.

REFERENCES:
1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, "Mechatronics", Chapman and Hall, 1993.
2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company, 2007.
4. Krishna Kant, "Microprocessors & Microcontrollers", Prentice Hall of India, 2007.
5. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", McGraw Hill International edition, 2007.

ME8091	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system

UNIT I   VEHICLE STRUCTURE AND ENGINES   9
Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components-functions and materials, variable valve timing (VVT).

UNIT II   ENGINE AUXILIARY SYSTEMS   9
Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT III   TRANSMISSION SYSTEMS   9
Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV   STEERING, BRAKES AND SUSPENSION SYSTEMS   9
Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

UNIT V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required -Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

TOTAL: 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   recognize the various parts of the automobile and their functions and materials.
CO2   discuss the engine auxiliary systems and engine emission control.
CO3   distinguish the working of different types of transmission systems.
CO4   explain the Steering, Brakes and Suspension Systems.
CO5   predict possible alternate sources of energy for IC Engines.

TEXT BOOKS:
1. Jain K.K. and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
2. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014..

REFERENCES:
1. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012.
2. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
3. Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
4. Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA ,1978.
5. Newton ,Steeds and Garet, "Motor Vehicles", Butterworth Publishers,1989.

REFERENCES:
1. Besterfield D.H., "Quality Control", Prentice Hall, 2013.
2. Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 2012
3. Danny Samson, "Manufacturing & Operations Strategy", Prentice Hall, 1991
4. Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 2017
5. Gupta. R.C, "Statistical Quality control", Khanna Publishers, 2001.

ME8073	UNCONVENTIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVE:
● To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications

UNIT I   INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES   9

Unconventional machining Process – Need – classification – merits, demerits and applications. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT II   THERMAL AND ELECTRICAL ENERGY BASED PROCESSES   9

Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing –– Applications. Laser Beam machining and drilling, (LBM), plasma, Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques – Applications.

UNIT III   CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES   9

Chemical machining and Electro-Chemical machining (CHM and ECM)- Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipments-Surface Roughness and MRR Electrical circuit-Process Parameters-ECG and ECH - Applications.

UNIT IV   ADVANCED NANO FINISHING PROCESSES   9

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations.

UNIT V   RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES   9

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

TOTAL: 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1 Explain the need for unconventional machining processes and its classification
CO2 Compare various thermal energy and electrical energy based unconventional machining processes.
CO3 Summarize various chemical and electro-chemical energy based unconventional machining processes.
CO4 Explain various nano abrasives based unconventional machining processes.
CO5 Distinguish various recent trends based unconventional machining processes.

TEXT BOOKS:
1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007
2. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2007.

REFERENCES:
1. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.
2. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998.
3. Paul De Garmo, J.T.Black, and Ronald. A.Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001.

ME8099   **ROBOTICS**   **L   T   P   C**
                                                                         3   0   0   3

OBJECTIVES:
- To understand the functions of the basic components of a Robot.
- To study the use of various types of End of Effectors and Sensors
- To impart knowledge in Robot Kinematics and Programming
- To learn Robot safety issues and economics.

UNIT I   FUNDAMENTALS OF ROBOT   9
Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT II   ROBOT DRIVE SYSTEMS AND END EFFECTORS   9
Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III   SENSORS AND MACHINE VISION   9
Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data-Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications-Inspection, Identification, Visual Serving and Navigation.

UNIT IV   ROBOT KINEMATICS AND ROBOT PROGRAMMING   9
Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT V   IMPLEMENTATION AND ROBOT ECONOMICS   9
RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

                                                                          TOTAL: 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Explain the concepts of industrial robots, classification, specifications and coordinate
       systems. Also summarize the need and application of robots in different sectors.
CO2   Illustrate the different types of robot drive systems as well as robot end effectors.
CO3   Apply the different sensors and image processing techniques in robotics to improve the
       ability of robots.
CO4   Develop robotic programs for different tasks and familiarize with the kinematics motions of
       robot.
CO5   Examine the implementation of robots in various industrial sectors and interpolate the
       economic analysis of robots.

TEXT BOOKS:
1. Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2012.
2. Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach",Prentice Hall, 2003.

REFERENCES:
1. Craig J.J., "Introduction to Robotics Mechanics and Control", Pearson Education, 2008.
2. Deb S.R., "Robotics Technology and Flexible Automation" Tata McGraw Hill Book Co., 2013.
3. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book Co., 1987.
4. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill, 1995.
5. Koren Y., "Robotics for Engineers", Mc Graw Hill Book Co., 1992.

ME8097	**NON DESTRUCTIVE TESTING AND EVALUATION**	L	T	P	C
		3	0	0	3

OBJECTIVE:
- To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

UNIT I   OVERVIEW OF NDT   9
NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

UNIT II   SURFACE NDE METHODS   9
Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III   THERMOGRAPHY AND EDDY CURRENT TESTING (ET)   9
Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT IV   ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)   9
Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications.

UNIT V   RADIOGRAPHY (RT)   9
Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

TOTAL : 45 PERIODS

OUTCOMES:
Upon the completion of this course the students will be able to
CO1   Explain the fundamental concepts of NDT
CO2   Discuss the different methods of NDE
CO3   Explain the concept of Thermography and Eddy current testing
CO4   Explain the concept of Ultrasonic Testing and Acoustic Emission
CO5   Explain the concept of Radiography

TEXT BOOKS:
1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

REFERENCES:
1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
3. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005

ORO551 RENEWABLE ENERGY SOURCES   **L T P C**
                                                                          3 0 0 3

OBJECTIVES:

☐ Toget exposure on solar radiation and its environmental impact to power.

☐ To know about the various collectors used for storing solar energy.

☐ To know about the various applications in solar energy.

☐ To learn about the wind energy and biomass and itseconomic aspects.

☐ To know about geothermal energy with other energy sources.

UNITIPRINCIPLESOFSOLARRADIATION

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNITIISOLARENERGYCOLLECTION

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNITIIISOLARENERGYSTORAGEANDAPPLICATIONS

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNITIWINDENERGY

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

UNIT VGEOTHERMAL ENERGY:

Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. Direct energy conversion: Need for DEC, Carnot Cycle, Limitations, Principles Of DEC.

OUTCOMES: **TOTAL : 45 PERIODS**

☐ Understanding the physics of solar radiation.

☐ Ability to classify the solar energy collectors and methodologies of storing solar energy.

☐ Knowledge in applying solar energy in a usefulway.

☐ Knowledge in wind energy and biomass with its economic aspects.

☐ Knowledge in capturing and applying other forms of energy sources like wind, biogas and geothermal energies.

Text Books:

1. Rai G.D. , Non-Conventional Energy Sources, Khanna Publishers, 2011
2. Twidell and Wier, Renewable Energy Resources, CRC Press (Taylor and Francis), 2011

References:

1. Tiwari and Ghosal, Renewable energy resources, Narosa Publishing House, 2007
2. Ramesh R and Kumar K.U , Renewable Energy Technologies,Narosa Publishing House, 2004
3. Mittal K M , Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, New Delhi, 2003
4. Kothari D.P, Singhal ., K.C., Renewable energy sources and emerging technologies, P.H.I, New Delhi, 2010