SYLLABUS STRUCTURE AND END SEMESTER EXAMINATIONS QUESTION PAPER PATTERN (For 5th and 6th Semester)

Syllabus Structure

1. Complete syllabus is prescribed in Two (02) sections viz. Section A and Section B. Each section consists of Unit 1, Unit 2 and so on.
2. In most of courses, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructor/s. Course instructor/s will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in Assignments ONLY.***

Pattern of End Semester Examinations Question Paper

a) Question paper will consist of total Nine (09) questions distributed among three parts: Part A, Part B and Part C.

b) Part A will consist of One (01) question having Ten (10) parts, each of Two (02) marks. Five (05) questions will be asked from each section of the syllabus i.e. Section A and Section B, covering maximum units of respective section. Candidate has to attempt all parts of this question.

c) Part B will consist of Five (05) questions, each of Five (05) marks. Minimum Two (02) questions have to be asked from each section of syllabus i.e. Section A and Section B. Candidate has to attempt any Four (04) questions out of these Five questions.

d) Part C will consist of Three (03) questions, each of Ten (10) marks. Out of these Three questions, Two (02) questions have to be asked taking One (01) from each section of syllabus i.e. Section A and Section B and **the third question has to be from that section of syllabus from which two questions have been asked in Part B of question paper**. Candidate has to attempt any Two (02) questions out of these three questions.

e) The above points (a) to (d) will not be applicable for courses related to Machine Design/ Drawing. For pattern of question paper of such courses reference may be made to the note given in the syllabus of these courses.

3rd Semester B.Tech. (Mech.)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
ME 14301	Strength of Materials- I	3	1	-	40	60	**100**	4
ME 14302	Theory of Machines-I	3	1	-	40	60	**100**	4
ME 14303	Machine Drawing	2	-	4	40	60	**100**	4
ME 14304	Applied Thermodynamics -I	3	1	-	40	60	**100**	4
ME 14305	Manufacturing Processes – I	4	-	-	40	60	**100**	4
ME 14306	Engg. Materials and Metallurgy	4	-	-	40	60	**100**	4
ME 14307	Manufacturing processes and Metallurgy Lab	-	-	2	30	20	**50**	1
ME 14308	Strength of Materials Lab.	-	-	2	30	20	**50**	1
ME 14309	Applied Thermodynamics Lab	-	-	2	30	20	**50**	1
	Advisory meeting	-	-	1	-	-	-	-
TR 14301	Workshop Training*	-	-	-	60	40	**100**	2
	Total	**19**	**3**	**11**	**390**	**460**	**850**	**29**

Total Contact Hours = 33

***** Workshop Training will be imparted in the Institution at the end of 2nd semester for Four (04) weeks duration.

4th Semester B.Tech. (Mech.)								
Code	**Title of the Course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
ME 14401	Strength of Materials – II	3	1	-	40	60	**100**	4
ME 14402	Theory of Machines – II	3	1	-	40	60	**100**	4
ME 14403	Fluid Mechanics	3	1	-	40	60	**100**	4
ME 14404	Applied Thermodynamics - II	3	1	-	40	60	**100**	4
ME 14405	Manufacturing Processes-II	4	-	-	40	60	**100**	4
ME 14406	Fluid Mechanics Lab	-	-	2	30	20	**50**	1
ME 14407	Manufacturing Processes Lab	-	-	2	30	20	**50**	1
ME 14408	Theory of Machines Lab	-	-	2	30	20	**50**	1
	Advisory Meeting	-	-	1	-	-	**-**	
GF 14401	General Fitness	-	-	-	100	-	**100**	1
	Total	**16**	**4**	**7**	**390**	**360**	**750**	**24**

Total Contact Hours per week = 27

Note:

During the semester, each student has to visit the selected local industry five times in such a way that he/she has to make at least one visit in the same industry each month.

He/She has to maintain a record of each visit in a diary. The evaluation of these Industrial visits will be done by a committee consisting of faculty members at the end of the semester out of 20 marks. These marks will be part of internal marks for the Industrial Training/ Institutional Training given in 5th semester study scheme.

5th Semester B.Tech (Mechanical)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
ME 14500	Mathematics-III	3	1	-	40	60	**100**	4
ME 14501	Design of Machine Elements – I	4	-	-	40	60	**100**	4
ME 14502	Computer aided Design and Manufacturing	4	-	-	40	60	**100**	4
ME 14503	Mechanical Measurement and Metrology	4	-	-	40	60	**100**	4
ME 14504	Industrial Automation and Robotics	4	-	-	40	60	**100**	4
ME 14505	Computer aided Design and Manufacturing Lab	-	-	2	30	20	**50**	1
ME 14506	Mechanical Measurement and Metrology Lab.	-	-	2	30	20	**50**	1
ME 14507	Industrial Automation and Robotics Lab.	-	-	2	30	20	**50**	1
ME 14508	Design of Machine Elements – I Practice	-	-	2	-	-	**-**	2
DEME 14-	Department Elective-I (Specialisation Group)	4	-	-	40	60	**100**	4
	Advisory meeting	-	-	1	-	-	-	
TR 14501	Industrial/Institutional Training*	-	-	-	60	40	**100**	2
	Total	**23**	**1**	**9**	**390**	**460**	**850**	31

Total Contact Hours = 33

i. *The marks of Industrial Training or Institutional Training (IITs/NITs/GNDEC only) imparted at the end of 4th Semester will be included here.

ii. * Evaluation scheme of industrial training shall be as under:

Internal: Out of 60 marks, 20 marks will be given on the basis of industrial visits made by the student during 4th semester. The students have to visit the selected local industry five times in the semester in such a way that in each month he has to make at least one visit in the same industry. He has to maintain a diary for recording the report of each visit. 40 marks shall be given on the basis of evaluation as per the rubrics.

External: External examiner should be essentially from industry and will evaluate the students on the basis of oral viva for 40 marks.

6th Semester B.Tech (Mechanical)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
ME 14601	Design of Machine Elements –II	4	-	-	40	60	**100**	4
ME 14602	Heat Transfer	3	1	-	40	60	**100**	4
ME 14603	Hydraulic Machines	3	1	-	40	60	**100**	4
ME 14604	Heat Transfer Lab.	-	-	2	30	20	**50**	1
ME 14605	Hydraulic Machines Lab	-	-	2	30	20	**50**	1
ME 14606	Minor Project**	-	-	1	30	20	**50**	1
ME 14607	Design of Machine Elements –II Practice	-	-	2	30	20	**50**	2
DEME 1461-	Department Elective-II (Materials Group)	4	-	-	40	60	**100**	4
OEME 1460-	Open Elective*	4	-	-	40	60	**100**	4
	Advisory meeting	-	-	1	-	-	-	
GF 14601	General Fitness	-	-	-	100	-	**100**	1
	Total	**18**	**2**	8	420	380	**800**	26

Total Contact Hours = 28

*The open elective will be offered by other departments

**The project work will be carried out in parts as minor project in 6th semester and major project in 7/8th semester. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology for the project shall be decided in 6th semester. The same project problem is to be extended in the major project in 7th/8th semester. The minor project may be carried out by a group of students (2 to 4). The evaluation of the minor project will be held as per the rubrics. For writing the report the students have to follow the concerned guidelines.

7^{th} /8^{th} Semester B.Tech. (Mechanical) * Industrial Training (One Semester)					
Code	**Title of the course**	**Maximum Marks**		**Total Marks**	**Credits**
		Internal	**External**		
TR 14701	Orientation of Industrial Training	-	-	**100**	**1**
	Industrial Training	450	450	**900**	**14**

Total Contact Hours per Week = 36 (minimum)

***Duration for Orientation of Industrial training is 01 week.**

*** The students will undergo industry training in reputed industries/organizations of national repute for one semester.**

7^{th} /8^{th} Semester B.Tech. (Mechanical)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
ME 14801	Refrigeration & Air Conditioning	3	1	-	40	60	**100**	4
ME 14802	Mechanical Vibrations	3	1		40	60	**100**	4
ME 14803	Automobile Engg	4	-	-	40	60	**100**	4
ME 14804	Refrigeration & Air Conditioning Lab	-	-	2	30	20	**50**	1
ME 14805	Mechanical Vibration Lab	-	-	2	30	20	**50**	1
ME 14806	Major Project*	-	-	3	100	50	**150**	3
ME 14807	Automobile Engineering Lab.	-	-	2	30	20	**50**	1
DEME 14--	Department Elective-III (Specialisation Group)	4	-	-	40	60	**100**	4
DEME 147--	Department Elective-IV (General Group)	4	-		40	60	**100**	4
	Advisory meeting	-	-	1	-	-	-	-
GF 14701	General Fitness	-	-	-	100	-	**100**	1
	Total	**18**	**2**	**10**	**490**	**410**	**900**	27

Total Contact Hours = 30

***** The problem of the minor project "formulated" during 6th Semester is to extended and executed in major project by the same group of students. The design/construction/fabrication/computer modeling/experimentation etc. is to be carried out. The results and analysis followed by discussion regarding suitability /non suitability of the project or any positive gain in the project made with conclusions and recommendations for future extension of the project must be covered. The evaluation of major project will be done as per the rubrics. For writing the report the students have to follow the concerned guidelines.

Department Electives

I. SPECIALIZATION GROUP

(1) THERMAL

DEME 14101	I.C Engines
DEME 14102	Cryogenic Technologies
DEME 14103	Non Conventional Energy resources
DEME 14104	Energy Conservation and Management
DEME 14105	Fluid Mechanics-II
DEME 14106	Solar Energy
DEME 14107	Heat Exchanger Design
DEME 14108	Power Plant Engg.
DEME 14109	Gas Dynamics

(2) MANUFACTURING

DEME 14201	Non-Traditional Machining
DEME 14202	Modern Welding and Forming Processes
DEME 14203	Computer integrated Manufacturing
DEME 14204	Computer Aided Process planning
DEME 14205	Machining Science
DEME 14206	Rapid Prototyping
DEME 14207	Modern Casting Processes
DEME 14208	Micromachining Technologies
DEME 14209	Manufacturing Systems

(3) DESIGN

DEME 14301	Design for X
DEME 14302	Product Design and Development
DEME 14303	Machine Tool Design
DEME 14304	Tool Design
DEME 14305	Experimental Stress Analysis
DEME 14306	Industrial Tribology
DEME 14307	Theory of plasticity
DEME 14308	Mechatronics

II. MATERIALS GROUP

DEME 14611	Non -Destructive Testing
DEME 14612	Heat Treatment Processes
DEME 14613	Plastic technologies
DEME 14614	Characterization of Materials
DEME 14615	Degradation of Materials
DEME 14616	Composite materials
DEME 14617	Surface Science

III. GENERAL GROUP*

DEME 14711	Modeling and Simulation
DEME 14712	Optimization Techniques
DEME 14713	Finite Element Method
DEME 14714	Operations Management
DEME 14715	Management Information System
DEME 14716	Entrepreneurship
DEME 14717	Industrial Engg. and Management
DEME 14718	Maintenance and Reliability Engg.
DEME 14719	Industrial Safety and Environment
DEME 14720	Disaster Management
DEME 14721	Material Management

*The subjects in General Group may be offered as Open electives for other Departments

Note:

1. A Department Elective subject may normally be offered only if at least 10 students of the class have opted for it.
2. The student shall select both the specialized elective courses from the same sub- group out of the three specializations i.e Thermal, Manufacturing and Design.

3th Semester **ME 14301 STRENGTH OF MATERIALS-I**

Internal Marks: 40 **L T P**

External Marks: 60 **3 1 2**

Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Formulate mechanics problems using calculus and differential equations.
- Solve, analyze and design beams under bending stresses.
- Understand the design considerations of structures subjected to different / wide range of loading conditions including thermal loads.
- Relate the design problems with practical applications.
- Solve problem involving simple and combined modes, including torsion.

Detailed Contents:

Unit –I (08 Hours)

Simple Stresses and Strains: Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Thermal stresses and strains: Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars.

Unit –II (05 Hours)

Principal Stresses and Strains : Two dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle for stresses and strains, principal stresses related to principal strains

Unit –III (09 Hours)

Bending Moment (B.M) and Shear Force (S.F) Diagrams: Shear force and Bending Moment definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of maximum bending moment, Shear force and Point of contra flexure under the following type of loads: a) Concentrated loads b) Uniformity distributed loads over the whole span or part of span c) Combination of concentrated and uniformly distributed load d) Uniformly varying loads e) Application of moments

Unit –IV (05 Hours)

Bending Stresses in Beams: Bending theory; assumptions, derivation of bending equation and its application to beams of rectangular, circular and channel, I and T- sections. Combined, direct and bending stresses in afore-mentioned sections, composite / flitched beams.

Unit –V (06 Hours)

Torsion: Derivation of torsion equation, its assumptions and application on the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts, principal stresses and maximum shear stresses under combined loading of bending and torsion.

Unit –VI (06 Hours)

Columns and struts: Introduction to columns and struts, failure of columns, Euler's formula, Rankine-Gordon's formula, and Johnson's empirical formula for axially loaded columns and their applications.

Unit –VII (09 Hours)

Deflection in beams: Relationship between moment, slope and deflection, Double integration method, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for the following:

a) Cantilevers

b) Simply supported beams with or without overhang under concentrated loads, uniformly distributed loads or combination of concentrated & Uniformly distributed loads.

Suggested Readings / Books:

1. Kirpal Singh **Mechanics of Materials**, Standard Publishers
2. S.S.Rattan **Strength of Materials,** Tata McGraw Hill.
3. Timoshenko, **Mechanics of Materials,** CBS Publication.
4. Sadhu singh, **Strength of Materials,** Khanna Publication.
5. S.Ramamurtham and R.Narayanan **Strength of Materials**, Dhanpat Rai publishing Company
6. James M Gere and Barry J. Goodno, **Strength of Materials,** Cengage Learning.

3th Semester **ME 14302 THEORY OF MACHINES-I**

Internal Marks: 40 **L T P**

External Marks: 60 **3 1 2**

Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Understand the basic concepts of kinematics and kinetics of machine elements.
- Understand the complete (translational and rotational) mechanism of Velocity and acceleration and do analysis.
- Understand the function of belt drives, cams, flywheels and governors and solve related problems.

Detailed Contents:

Unit –I (9 hours)

Basic Concept of machines: Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms (including Corliolis Components).

Unit –II (6 hours)

Lower and higher Pairs: Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs with Examples.

Unit –III (9 hours)

Belts, Ropes and Chains: Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and its effect on power transmission.

Unit –IV (6 hours)

Cams: Types of cams and follower, definitions of terms connected with cams. Displacement, velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation, cycloidal Motion). Analysis of follower motion for circular, convex and tangent cam profiles.

Unit –V (7 hours)

Friction Devices: Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Braking of front and rear tyres of a vehicle. Determination of braking capacity, Types of dynamometers, (absorption, and transmission), Anti-friction bearings, Greasy Friction, Greasy Friction at a Journal, Film friction.

Unit –VI (5 hours)

Flywheels: Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel used for engines and punching machines.

Unit –VII (6 hours)

Governors: Function, types and characteristics of governors. Watt, Porter and Proell governors. Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect of sleeve friction.

Suggested Readings / Books:

1) V.P. Singh, **Theory of Machines** Dhanpat Rai publishing Co.
2) Jagdish Lal, **Theory of Mechanisms & Machines**, Metropolitan Book Co.
3) Thomas Beven, **Theory of Machines**, Longman's Green Co.
4) W. G. Green, **Theory of Machines**, Blackie & Sons
5) S. S. Rattan, **Theory of Machines**, McGraw Hill

3rd Semester **ME 14303 MACHINE DRAWING**

Internal Marks: 40 **L T P**
External Marks: 60 **2 - 4**
Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Read, draw and interpret the machine drawings and related parameters.
- Understand and monitor the manufacturing of components at shop floor level as per the information in the given drawing.
- Understand the concept of limits, fits and tolerances in various mating parts.
- Visualize and generate different views of a component with detailed internal information in the assembly and disassembly.

Detailed Contents: (72 hours)

Unit –I

Introduction: Requirements of machine drawing, Sectioning and conventional representation, Dimensioning, concept of limits, fits & tolerances and their representation, Machining Symbols, introduction and Familiarization of Code SP 46:2003. (10 hours)

Unit –II

Fasteners: Various types of screw threads, types of nuts and bolts, screwed fasteners, locking devices, welding joints and riveted joints. (10 hours)

Unit –III

Free Hand Sketches of :

a) Couplings: Solid or Rigid Coupling, Protected Type Flange coupling, Pin type flexible coupling, muff coupling, universal coupling, cone friction clutch, single plate friction clutch. (7 hours)

b) **Pulleys:** fast and loose pulleys, stepped pulleys. (3 hours)

c) Knuckle and cotter joints, keys, spline shafts. (3 hours)
d) Pipe and Pipe Fittings: Flanged joints, Spigot an socket joint, Union joint, Hydraulic and expansion joint. (3 hours)

Unit –IV

Assembly of:

a) IC Engine Parts: Piston, connecting rod, Spark Plug (9 hours)
b) Boiler Mountings: Steam stop valve, blow off cock. (9 hours)
c) Bearings: Swivel bearing, Plummer block, foot step bearing. (9 hours)
d) Miscellaneous: Screw Jack, Drill Press Vice, Tail Stock. (9 hours)

Note :

I. Drawing Practice is to be done as per IS code SP 46 : 2003.
II. The Question paper shall be having following structure / weightage :
Section A-Short type questions based upon whole syllabus-10 Questions of 2 marks each. (All questions are compulsory 10 x 2 =20 marks).
Section B- Free Hand sketching of machine parts etc.-3 Questions of 5 marks each (2 Questions are to be attempted 2 x 5 =10 marks).
Section C- Assembly drawing of machine parts with at least two views -2 Questions of 30 marks each 1 question is to be attempted 1 x 30 = 30 marks).

Suggested Readings / Books:

1. Ajit Singh, **Machine Drawing (including Auto CAD**), Tata McGraw Hill.
2. N.D. Bhatt, **Machine Drawing**, Charotar publications.
3. P.S. Gill, **Machine Drawing**, BD Kataria and Sons.
4. B. Bhattacharyya, **Machine Drawing**, Oxford University Press
5. IS code SP 46 : 2003.

3th Semester **ME 14304 APPLIED THERMODYNAMICS-I**

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**2**
Total Marks: 100			

Course Outcomes

After studying this course, students shall be able to:

- Understand and analyze the combustion phenomenon in boilers and I.C. engines.
- Use steam table and Mollier charts to solve various vapour power cycle problems.
- Explain the constructional features and working of major components of steam power plant and will be able to evaluate their performance.

Detailed Contents

Unit –I (14 Hours)

Thermodynamics of Combustion in Boilers and IC Engines: Principle of Combustion; Stoichiometric and non-stoichiometeric combustion; Calculations of air fuel ratio: analysis of combustion, conversion of volumetric analysis into gravimetric analysis and vice versa, Actual weight of air supplied, use of mole for solution of combustion problems; Enthalpy of formation; Enthalpy of reaction/combustion and its, evaluation; first law analysis of reacting system: steady flow and closed system, adiabatic flame temperature and its determination; Various stages of combustion in IC engines; Pressure-time/crank - Angle diagrams; various phenomenon such as turbulence, squish and swirl, dissociation, pre-ignition/auto- ignition, and after burning etc.; Theory of knocking (i.e., detonation) in SI and CI Engines; Emission from boilers and IC engines (SI and CI) and methods to reduce/control them; Heat balance of boiler &IC engines; Types of draught and Calculation of chimney height.

Unit –II (08 Hours)

Steam: Properties of Steam Pure substance; Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat (enthalpy), latent heat and total heat (enthalpy) of steam; dryness fraction and its determination; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Chart; Basic thermodynamic processes with steam (isochoric, isobaric, isothermal, isentropic and adiabatic process) and their representation on T-S Chart and Mollier Charts (h-s diagrams). Significance of Mollier Charts.

Unit –III (10 Hours)

Vapour Power Cycle: Carnot Cycle and its limitations; Rankine steam power cycle, Ideal and actual; Mean temperature of heat addition; Effect of pressure, temperature and vacuum on Rankine Efficiency; Rankine Cycle Efficiency and methods of improving Rankine efficiency: Reheat cycle, Bleeding (feed-water-heating), Regenerative Cycle, Combined reheat-regenerative cycle; Ideal working fluid; Binary vapour cycle, Combined power and heating cycles.

Unit –IV (08 Hours)

Steam Nozzles: Definition, types and utility of nozzles; Flow of steam through nozzles; Condition for maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on discharge; Area of throat and at exit for maximum discharge; Effect of friction; Nozzle efficiency; Calculation of Nozzle dimensions (length and diameters of throat and exit); Supersaturated (or metastable) flow through nozzle.

Unit –V (10 Hours)

Steam Turbines (Impulse Turbine): Introduction; Classification; Impulse versus Reaction turbines. Simple impulse turbine: pressure and velocity variation, Compounding of impulse turbines: purpose, types and pressure and velocity variation, Velocity diagrams/triangles; Combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency overall efficiency and relative efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition for axial discharge.

Unit –VI (08 Hours)

Reaction Turbine: pressure and velocity variation, velocity diagrams/triangles, Degree of reaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height; Multistaging: Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines; Back pressure and extraction turbines; Co-generation; Economic assessment; Governing of steam turbines.

Unit –VII (06 Hours)

Steam Condensers: Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity; Cooling towers: function, types and their operation.

Suggested Readings / Books:

1. R. Yadav, Sanjay and Rajay, **Applied Thermodynamics**, Central Publishing House.
2. D.S. Kumar and V.P. Vasandani, **Heat Engineering**, Metropolitan Book Co. Pvt. Ltd.
3. G. Rogers and Y. Mayhew, **Engineering Thermodynamics**, Pearson.
4. J.S. Rajadurai, **Thermodynamics and Thermal Engineering**, New Age International (P) Ltd. Publishers.
5. W.A.J. Keartan**, Steam Turbine**: Theory and Practice, ELBS Series.
6. V. Ganeshan, **Internal Combustion Engines**, Tata McGraw Hill.

3rd Semester **ME 14305 MANUFACTURING PROCESSES –I**

Internal Marks: 40 **L T P**
External Marks: 60 **4 0 2**
Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Use the Knowledge of Fundamental principles of Castings and Welding processes for their practical applications.
- Identify and suggest equipments, tools and accessories required for performing the casting and welding processes.
- Supervise the technicians to execute the casting and welding processes in industrial applications.
- Test the products made by casting and welding processes using destructive and non-destructive means so as to appreciate their utility.
- Suggest a suitable process for manufacturing of components
- Understand the latest technologies in Casting and Welding Processes

Detailed Contents:

Unit –I (03 Hours)

Introduction: Classification of manufacturing processes, selection criteria for manufacturing processes, general trends in manufacturing.

Unit –II (22 Hours)

Casting Processes: Introduction to metal casting. patterns: types, materials and allowances. moulding materials: moulding sand compositions and properties, sand testing, types of moulds, moulding machines. Cores: function, types, core making process, core-prints, chaplets. Gating system design, riser design (any one method in detail). Melting furnaces, cupola furnace, charge calculations, induction furnaces. Casting processes: sand casting, shell mould casting, investment casting, permanent mould casting, full mould casting, vacuum casting, die casting, centrifugal casting, and continuous casting. Metallurgical considerations in casting, Solidification of metals and alloys, directional solidification, segregation, nucleation and grain growth, critical size of nucleus. Cleaning and finishing of castings.

Unit –III **(**17 Hours)

Welding Processes: Introduction and classification of welding processes, to welding processes, weldability, welding terminology, general principles, welding positions, and filler metals. Gas welding: principle and practice, oxy-acetylene welding equipment, oxy-hydrogen welding. Flame cutting. Electric arc welding: principle, equipment, relative merits of AC & DC arc welding. Welding processes: manual metal arc welding, MIG welding, TIG welding, plasma arc welding, submerged arc welding. Welding arc and its characteristics, arc stability, and arc blow. Thermal effects on weldment: heat affected zone, grain size and its control. Electrodes: types, selection, electrode coating ingredients and their function. Resistance welding: principle and their types i.e. spot, seam, projection, up-set and flash. Spot welding machine. Advanced welding processes: friction welding, friction stir welding, ultrasonic welding, laser beam welding, plasma arc welding, electron beam welding, atomic hydrogen welding, explosive welding, thermit

welding, and electro slag welding. Considerations in weld joint design. Other joining processes: soldering, brazing, braze welding , adhesive bonding.

Unit –IV **(**04 Hours)

Inspection and Testing: Casting defects, their causes and remedies. Welding defects, their causes and remedies. Destructive and non destructive testing: visual inspection, x-ray radiography, magnetic particle inspection, dye penetrate test, ultrasonic inspection, eddy current testing and micro hardness testing.

Suggested Readings / Books:

- H.S. Shan, Manufacturing Processes, Vol.I. , Pearson Publishers.
- P. N. Rao, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill.
- R.S. Parmar ,Welding Engineering & Technology, Khanna Publishers.
- Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.

3rd Semester ME 14306 ENGINEERING MATERIALS & METALLURGY

Internal Marks: 40 **L T P**
External Marks: 60 **4 0 -**
Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

1. Understand the significance of the metallurgical characteristics of engineering materials (both ferrous and nonferrous).
2. Explain the use and significance of various heat treatment processes and their applications for different materials.
3. Understand the structural changes in metals with respect to time temperature transformations.
4. Understand the role of Fe-C and TTT diagram for controlling the desired structure and properties of the materials.

Detailed Contents:

Section-A

Unit –I (10 Hours)

Crystallography: Atomic structure of metals, atomic bonding in solids, crystal structures, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and non crystalline materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and non steady-state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery, re-crystallization.

Unit –II (14 Hours)

Phase Transformation: General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Types of equilibrium diagrams: Eutectic (Two metals completely soluble in the liquid state but completely insoluble in the solid state & Two metals completely soluble in the liquid state but partly soluble in the solid state), Peritectic, Eutectoid and Peritectoid system. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications.

Unit –III (12 Hours)

Heat Treatment: Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburizing, nitriding and cyaniding. Harden-ability: determination of harden-ability. Jominy end-quench test. Defects due to heat treatment and their remedies.

Unit –IV (10 Hours)

Ferrous Metals and Their Alloys: Introduction, classification and composition of alloy steels, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. **Non-Ferrous Metals & Alloys:** Aluminum, Magnesium and Copper alloys: Composition, Properties and Applications.

Suggested Readings / Books:

1. Sidney H Avner, **Introduction to Physical Metallurgy**, Tata McGraw-Hill.
2. Y. Lakhtin , **Engineering Physical Metallurgy,** Mir Publishers
3. V. Raghavan**, Physical Metallurgy: Principles and Practice**, PHI Learning.
4. B. Zakharov**, Heat Treatment of Metals**, University Press.
5. O.P. Khanna, **A Text book of Materials Science & Metallurgy**, Dhanpat Rai & Sons.

3rd Semester ME 14307 MANUFACTURING PROCESSES & METALLURGY LAB

Internal Marks: 30 **P**
External Marks: 20 **2**
Total Marks: 50

Course Outcomes

After studying this course, students shall be able to:

- Conduct various tests and to determine major characteristics of moulding sand
- Use the equipment required in various welding processes (like TIG MIG, Spot/Seam, welding) and understand the effect of various process parameters on weld quality.
- Check the micro-structure of various materials
- Conduct heat treatment processes on various materials

List of Experiments

1. To determine grain fineness number, clay content and moisture content of a given sample of moulding sand. (2hrs)
2. To Prepare a specimen of moulding sand on a standard Rammer and to carry out following tests:
   a. Tensile, compressive and transverse strength (4hrs)
   b. Mould Hardness
   c. Shatter index
   d. Permeability
3. To study the effect of process parameters of Seam Welding (Air pressure, current, travel speed of electrode/workpiece) on weld quality in pulsed and plain modes. (2hrs)

4. To study the effect of process parameters of MIG Welding (Voltage, wire feed, gas flow) on welding of Mild steel sheet. (2hrs)
5. To study the effect of process parameters of TIG welding (Pulse, Gas flow, current) on welding of Stainless steel and Mild steel sheets. (2hrs)
6. To prepare specimen involving cutting, mounting, polishing and etching of Mild steel/Aluminum/Hardened steel and to study microstructure of prepared specimen (4hrs)
7. To determine Hardenability of steel by Jominy End Quench test. (2hrs)
8. To conduct Normalizing and Hardening of steel specimen and to study the effect of Normalizing time and Quenching medium on hardness of the specimen (2 hrs)

3rd Semester ME 14308 STRENGTH OF MATERIALS LAB

Internal Marks: 30 **P**
External Marks: 20 **2**
Total Marks: 50

Course Outcomes

After studying this course, students shall be able to:

- Conduct mechanical testing (Tensile, compression, Impact, bending, torsion of various materials)
- Compare mechanical properties of various materials
- Determine buckling load of long columns
- Understand load –deflection relation of helical spring
- Conduct fatigue testing of the materials

List of Experiments

1. To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2. To perform compression test and impact tests on the given specimen
3. To perform hardness tests on three materials (Aluminium, Mild steel and Hardened steel)
4. To perform torsion test and to determine various mechanical properties of the given material
5. To perform bending test on beam and to determine the Young's modulus and modulus of rupture
6. To determine buckling load of long columns with different end conditions.
7. To draw load/ defection curve for helical spring
8. To perform Fatigue test on circular test piece.

3rd Semester ME 14309 APPLIED THERMODYNAMICS LAB.
Internal Marks: 30 **P**
External Marks: 20 **2**
Total Marks: 50

Course Outcomes

After studying this course, students shall be able to:

1. Identify different type of I.C. Engines and their parts, understand construction and working of I.C engines, and evaluate their performance.
2. Demonstrate the construction, working and utility of different types of steam generators and their parts. Also evaluate performance of steam generators and steam power system.

3. Demonstrate the construction, working and utility of power plant parts like condenser.

List of Experiments

1. Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models.
2. To plot actual valve timing diagram of a 4 stroke petrol and diesel engines and study its impact on the performance of engine.
3. Study working construction of various boilers (Cochran, Lancashire, Babcock and Wilcox, Benson, Lamont, once through boiler tower type).
4. Study of working, construction, mountings and accessories of various types of boilers.
5. To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.
6. Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
7. Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
8. Performance testing of a diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the smoke density. Draw/obtain power consumption and exhaust emission curves. Also make the heat balance sheet.
9. Performance testing of a petrol engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emissions. Also draw/obtain power consumption and exhaust emission curves.
10. Study of construction and operation of various types of steam condensers and cooling towers.

4th Semester **ME 14401 STRENGTH OF MATERIALS – II**

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Analyze strain energy in bean under different kinds of loads
- Perform design analysis of pressure vessels
- Use Application of failure theory for safe design of mechanical components
- Analyze and design beam under shearing stresses.
- Analyze rotational stresses in various sections of machine component

Detailed Contents:

Unit –I (08 hours)

Strain energy: Introduction to strain energy, strain energy in simple tension and compression. Stresses develop due to different type of loads. Strain energy in pure shearing, torsion, and due to bending. Strain energy due to principal stresses, energy of dilation and energy of distortion. Castigliano's and Maxwell's theorem of reciprocal deflection.

Unit –II (06 Hours)

Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to problems related to two dimensional stress systems.

Unit –III (11 Hours)

Springs: Introduction to different type of springs, closed coil helical springs under axial load and axial twist. Open coiled helical spring under axial load and twist. Springs in series and springs in parallel, Flat Spiral springs. Derivation to calculate deflection strain energy and stresses in leaf (laminated) spring. Applications of afore mentioned springs.

Unit –IV (05 Hours)

Thin cylinders and spheres: Calculation of Hoop stress, longitudinal stress in a cylinder, efficiency of joints, change in dimensions due to internal pressure. Principal stresses in spherical shell, change in diameter and internal volume.

Unit –V (08 Hours)

Thick cylinders: Derivation of Lame's equations, calculation of radial, longitudinal and hoop Stresses and strains due to internal pressure. Pre-stressing, purpose and its methods, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress.

Unit –VI (06 Hours)

Shear stresses in beams: Introduction to shearing stesses, variation of shear stress in beam cross-section Shear stress distribution in rectangular, circular, I, T and channel section beams. Shear centre and its importance.

Unit –VII (06 Hours)

Rotational discs: Derivation for Stresses in rotating thin disc and stresses in rotating ring, Expression for disc of uniform strength.

Unit –VIII (10 Hours)

Bending of curved beams: Derivation of Winkler-Bach theory, Calculation of stresses in crane hooks and rings for circular and trapezoidal sections.

Suggested Readings / Books:

1. Kirpal Singh **Mechanics of Materials** :, Standard Publishers
2. S.S.Rattan **Strength of Materials;** Tata McGraw Hill.
3. Timoshenko, **Mechanics of Materials;** CBS Publication.
4. Sadhu singh, **Strength of Materials,** Khanna Publication.
5. S.Ramamurtham and R.Narayanan **Strength of Materials** ;Dhanpat Rai publishing Company
6. James M Gere and Barry J. Goodno, **Strength of Materials,** Cengage Learning

4th Semester ME 14402 THEORY OF MACHINES – II

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**2**
Total Marks: 100			

Course Outcomes

After studying this course, students shall be able to:

- Understand the concept and compute inertia forces and couples applied to the reciprocating parts of machines.
- Understand the concept of Static and dynamic balancing of rotating and reciprocating masses.
- Understand the function and application of gears and transmission system in machines.
- Understand the concept of gyroscopic couple and effect in two and four wheelers.

Detailed Contents:

Unit –I (08 Hours)

Static and dynamics force analysis: Introduction, Concept of force and couple, free body diagram, condition of equilibrium, Static equilibrium of mechanisms, methods of static force analysis of simple mechanisms, Power transmission elements, and consideration of frictional forces. Inertia force and couple, Determination of forces and couples for a crank, inertia of reciprocating Parts. Dynamically equivalent system with analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four bar linkage

Unit –II (10 Hours)

Balancing: Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses**,** partial balancing of locomotives, swaying couple, variation of tractive effort and hammer blow condition of balance in multi cylinder in line and V-engines, concept of direct and reverse crank, introduction to balancing of machines, rotors and reversible rotors.

Unit –III (6 Hours)

Gyroscope:- Introduction, axis of spin, axis of precession, gyroscopic couple**,** Gyroscope effect on stabilization of ships and planes, stability of automobile (two and four wheeled) taking a turn.

Unit –IV (10 Hours)

Gears: Toothed gears **and their applications,** types of toothed gears and its terminology. Conditions for correct gearing, forms of teeth, length of Path of contact, length of arc of contact, contact ratio, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth required on pinion and wheel for helical, spiral, bevel, worm gears and involute rack. Center distance for spiral gears and efficiency of spiral gears.

UNIT V (08 Hours)

Gear Trains: Types of gear trains such as simple, compound and epicyclic. Problems involving in their applications. Estimation of velocity ratio for worm and worm-wheel.

Unit –VI (06 Hours)

Kinematic synthesis of Mechanism: Freudenstien equation, Function generation errors in synthesis, two and three point synthesis, Transmission angles, least square techniques.

Suggested Readings / Books:

1. S.S. Rattan, **Theory of Machines**, McGraw Hill.
2. John, Gordon, and Joseph, **Theory of Machines and Mechanisms**, Oxford University Press.
3. Bevan, Thomas, **Theory of Machines,** Longmans Green And Co Ltd**.**
4. Shigley, **Theory of Machines**, Tata McGraw Hill.
5. V.P. Singh, **Theory of Machines**, Dhanpat Rai and Sons.

4th Semester **ME 14403 FLUID MECHANICS**

Internal Marks: 40 **L T P**

External Marks: 60 **3 1 2**

Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Understand the concept of fluids and their properties.
- Understand the concept and solve the problems related to statics, dynamics and kinematics of fluids.
- Use and apply dimensional analysis and similitude techniques to various physical fluid phenomena.
- Distinguish various types of flows and learn flow measurement methods.

Detailed Contents:

Unit –I

Fundamentals of Fluid Mechanics: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids.

Unit –II

Fluid Statics: Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre of pressure; Force on a curved surface due to hydrostatic pressure; Buoyancy and flotation; Stability of floating and submerged bodies; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subjected to : (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii) constant rotation.

Unit –III

Fluid Kinematics: Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them; Flow net.

Unit –IV

Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation (using principle of conservation of energy and equation of motion) and its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forced vortex motions.

Unit –V

Dimensional Analysis and Similitude: Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froudes, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similarity model laws.

Unit –VI

Internal Flows: Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes, Moody's chart.

Unit –VII

Pressure and Flow Measurement: Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters.

Suggested Readings / Books:

1. S.K. Som, G. Biswas and S. Chakraborty, **Introduction to Fluid Mechanics and Fluid Machines**, Tata McGraw Hill.

2. D.S. Kumar, **Fluid Mechanics and Fluid Power Engineering**, S.K. Kataria and Sons Publishers.

3. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, **Fluid Mechanics and Machinery**, Oxford University Press.

4. Y.A. Cengel and J.M. Cimbala, **Fluid Mechanics - Fundamentals and Applications**, Tata McGraw Hill.

5. V.L. Streeter, E.B. Wylie and K.W. Bedford, **Fluid Mechanics**,

6. Frank M. White, **Fluid Mechanics**, Tata Mc Graw Hill

4th Semester **ME 14404 APPLIED THERMODYNAMICS-II**

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**2**
Total Marks: 100			

Course Outcomes

After studying this course, students shall be able to:

- Demonstrate the constructional & design features, understand working principles & performance parameters and conduct thermodynamic analysis of reciprocating, centrifugal and axial flow compressors.
- Conduct thermal analysis of gas turbines
- Conduct thermal analysis of jet propulsion and rocket propulsion systems.

Detailed Contents:

Unit –I (09 Hours)

Air Compressors:- Introduction, Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places; Complete representation of compression process (Reciprocating and rotary) on P-v and T-s coordinates with detailed description of areas representing total work done and polytropic work done; Areas representing energy lost in internal friction, energy carried away by cooling water and additional flow work being done for un-cooled and cooled compression on T-S coordinates; Best value of index of compression; Isentropic, polytropic and isothermal efficiencies and their representation in terms of ratio of areas representing various energy transfers on T-s coordinates. Applications of Steady Flow Energy Equation and thermodynamics of dynamic (i.e., centrifugal and axial flow m/cs) compressors; Stagnation and static values of pressure, Temperature and enthalpy etc. for flow through dynamic rotary machines.

Unit –II **(**08 Hours)

Reciprocating Air Compressors:- Single stage single acting reciprocating compressor (with and without clearance volume): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic, mechanical efficiency, Clearance Volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; Multistage compressors: purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; isothermal, overall thermal, isentropic, polytropic and mechanical efficiencies; Performance curves.

Unit –III (06 Hours)

Positive Displacement Rotary Compressors introduction: - Comparison of rotary positive displacement compressors with reciprocating compressors; Classification of rotary compressors; Construction, operation, work input and efficiency of positive displacement type of rotary compressors like Roots blower, Lysholm compressor and Vane type Blower.

Unit –IV (10 Hours)

Centrifugal Compressors:- Complete thermodynamic analysis of centrifugal compressor stage; Polytropic, isentropic and isothermal efficiencies; Complete representation of compression process in the centrifugal compressor starting from ambient air flow through the suction pipe, Impeller, Diffuser and finally to delivery pipe on T-S coordinates; Pre-guide vanes and pre-whirl; Slip factor; Power input factor; Various modes of energy transfer in the impeller and diffuser; Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of slip factor; Efficiency and out-coming velocity profile from the impeller; Derivation of non-dimensional parameters for plotting compressor characteristics; Centrifugal compressor characteristic curves; Surging and choking in centrifugal compressors.

Unit –V (09 Hours)

Axial Flow Compressors:- Different components of axial flow compressor and their arrangement; Discussion on flow passages and simple theory of aerofoil blading; Angle of attack; coefficients of lift and drag; Turbine versus compressor blades; Velocity vector; Vector diagrams; Thermodynamic analysis; Work done on the compressor and power calculations; Modes of energy transfer in rotor and stator blade flow passages; Detailed discussion on work done factor, degree of reaction, blade efficiency and their derivations; Isentropic, polytropic and isothermal efficiencies; Surging, Choking and Stalling in axial flow compressors; Characteristic curves for axial flow compressor; flow parameters of axial flow compressor like Pressure Coefficient, Flow Coefficient, Work Coefficient, Temperature-rise Coefficient and Specific Speed; Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors.

Unit –VI (10 Hours)

Gas Turbines:- Classification and comparison of the Open and Closed cycles; Classification on the basis of combustion (at constant volume or constant pressure); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Effect of changes in specific heat and that of mass of fuel on power and efficiency; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter-cooling and re-heating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle, Multistage compression and expansion; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials. Gas turbine fuels.

Unit –VII (08 Hours)

Jet Propulsion:- Principle of jet propulsion; Description of different types of jet propulsion systems like rockets and thermal jet engines, like (i) Athodyd (ramjet and pulsejet), (ii) Turbojet engine, and (iii) Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal (internal) efficiencies; Overall thermal efficiency; Specific fuel consumption; Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors (e.g. solid propellant and liquid propellant systems); Various common propellant combinations (i.e. fuels) used in rocket motors; Cooling of rockets; Advantages and disadvantages of jet propulsion over other propulsion systems; Brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units.

Suggested Readings / Books:

1. R. Yadav, Sanjay and Rajay, **Applied Thermodynamics**, Central Publishing House.

2. D.S. Kumar and V.P. Vasandani, **Heat Engineering**, Metropolitan Book Co. Pvt. Ltd

3. J.S. Rajadurai, **Thermodynamics and Thermal Engineering** New Age International (P) Ltd. Publishers.

4. K. Soman**, Thermal Engineering**, PHI Learning Pvt. Ltd.

5. D.G. Shephered, **Principles of Turbo machinery** Macmillan.

6. H. Cohen, G.F.C. Rogers and M. Sarvan, **Gas Turbine Theory**, Longmans.

4th Semester ME 14405 MANUFACTURING PROCESSES-II

Internal Marks: 40 **L T P**
External Marks: 60 **4 0 2**
Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

1. Understand the fundamental principles of metal forming, Metal Cutting, and Powder Metallurgy and recognize related machine tools and parameters of the processes for analyzing the effect of process parameters on performance.
2. Select metal machining and metal forming processes needed for the manufacturing of various geometrical shapes of products.

3. Know about cutting tools and their materials and related concepts like tool life, wear, and coolants/lubricants.
4. Aware about techniques, skills and modern machine tools used in conventional manufacturing processes.

Detailed Contents

Unit –I (23 Hours)

Metal Forming: Introduction and classification. Plastic deformation and yield criteria Rolling process: introduction, classification, rolling mills, products of rolling, rolling defects and remedies. Forging: open and closed die forging, forging operations, hammer forging, press forging and drop forging, forging defects, their causes and remedies. Extrusion: classification, equipment, defects and remedies. Drawing: drawing of rods, wires and tubes, draw benches, drawing defects and remedies. Sheet metal forming operations: piercing, blanking, embossing, squeezing, coining, bending, drawing and deep drawing, and spinning. Punch and die set up. Press working: press types, operations, press tools, progressive and combination dies. Process variables and numerical problems related to load calculation in Rolling, Forging, Extrusion, Drawing and Sheet metal forming. High velocity forming of metals: introduction, electro-hydraulic forming, mechanical high velocity forming, magnetic pulse forming and explosive forming. **Powder Metallurgy:** Introduction, advantages, limitations, and applications methods of producing metal powders, briquetting and sintering Introduction to Selective Laser Melting and Selective Laser Sintering,3-D Printing.

Unit –II (15 Hours)

Metal Cutting: Introduction to machining processes, classification, Mechanics of chip formation process, concept of shear angle, chip contraction and cutting forces in metal cutting, Merchant theory, tool wear, tool life, machinability. Numerical problems based on above mentioned topics, Fundamentals of measurement of cutting forces and chip tool interface temperature. Cutting tools: types, geometry of single point cutting tool, twist drill and milling cutter, tool signature. Cutting tool materials: high carbon steels, alloy carbon steels, high speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN. Selection of machining parameters. Coolants and lubricants: classification, purpose, function and properties.

Unit III (10 Hours)

Machine Tools Lathe:classification, description and operations, kinematic scheme of lathe, and lathe attachments. Shaping and planing machine: classification, description and operations, drive mechanisms. Milling machine: classification, description and operations, indexing devices, up milling and down milling. Drilling machine: classification, description and operations. Boring machine: classification, description and operations. Grinding machines: classification, description and operations, wheel selection, grinding wheel composition and nomenclature of grinding wheels, dressing and truing of grinding wheels. Broaching machine: classification, description and operations. Speed, feed and machining time calculations of all the above machines.

Suggested Readings / Books:

1. B. L. Juneja and G. S. Sekhon, Fundamentals of Metal Cutting & Machine Tools, New Age International (P) Ltd.
2. H.S. Shan, Manufacturing Processes, Vol. I&II, , Pearson Publishers
3. PC Sharma, A Text Book of Production Technology, S. Chand & Company Ltd.
4. P. N. Rao, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill.
5. P. N. Rao, Manufacturing Technology, Metal Cutting and Machine Tools, Tata McGraw Hill
6. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.

4th Semester ME 14406 FLUID MECHANICS LAB

Internal Marks: 30 **P**
External Marks: 20 **2**
Total Marks: 50

Course Outcomes

After studying this course, students shall be able to:

1. Demonstrate practical application of the bernaulli's equation.
2. Distinguish various type of flows and flow measurement methods and concept of statics and dynamics of liquids.
3. Determine discharge, hydraulic and friction coefficient for different types of flows in notch, orifice and venturimeter.
4. Determine the head loss in pipe line and calibrate various flows measuring devices in pipe and open channel flow.
5. Determine metacentre of a floating vessel.

List of Experiments

1. To determine the meta-centric height of a floating vessel under loaded and unloaded conditions.
2. To study the flow through a variable area duct and verify Bernoulli's energy equation.
3. To determine the coefficient of discharge for an obstruction flow meter (venturi meter/ orifice meter)
4. To determine the discharge coefficient for a V- notch or rectangular notch.
5. To study the transition from laminar to turbulent flow and to ascertain the lower critical Reynolds number.
6. To determine the hydraulic coefficients for flow through an orifice.
7. To determine the friction coefficients for pipes of different diameters.
8. To determine the head loss in a pipe line due to sudden expansion/ sudden contraction/ bend.
9. To determine the velocity distribution for pipeline flow with a pitot static probe.
10. To visualise the forced and free vortex phenomena and to plot shape of vortex profile.

4th semester **ME 14407 MANUFACTURING PROCESS LAB**

Internal Marks: 30 **P**
External Marks: 20 **2**
Total Marks: 50

Course Outcomes

After studying this course, students shall be able to:

1) Know the constructional details and working of major equipment used in metal forming and press tools.
2) Learn about grinding practice of single and multipoint cutting tools for efficient use of grinding equipment.
3) Use conventional cutting machine tool like lathe shaper milling for given jobs /work pieces.
4) Apply the fundamentals of metal cutting for determining cutting forces with the use of tool dynamometer.

List of Experiments

Forming

1. To study constructional features of following machines through drawings/ sketches:
   a. Grinding machines (Surface, Cylindrical)
   b. Hydraulic Press
   c. Draw Bench
   d. Drawing and Extrusion Dies
   e. Rolling Mills

Note: At least one industrial visits/Live demonstration of above machines must be arranged in the concerned industry

Machining (02 hrs each)

- To grind single point and multipoint cutting tools and to prepare introductory report on cutting inserts
- To prepare job on Lathe involving specified tolerances; cutting of V- threads and square threads.
- To prepare job on shaper involving plane surface.
- To generate plain surface, spur gears and helical gears by the use of milling machines and suitable milling cutters.
- To determine cutting forces with dynamometer for turning, drilling and milling operations.

4th Semester **ME 14408 THEORY OF MACHINES LAB**

Internal Marks: 30 **P**
External Marks: 20 **2**
Total Marks: 50

Course Outcomes

After studying this course, students shall be able to:

- Conceptualise the function and applications of kinematic chains, mechanisms.

- Understand the role of materials/type of belt in reducing coefficient of friction.
- Understand the role and applications of various gears.
- Perform balancing of rotating masses.
- Analyse cam profile.
- Understand function of gear trains.
- Understand the function of journal bearing.
- Understand the function of governors and flywheels.

List of Experiments

1. To fabricate various inversions of the kinematic chains.
2. To draw displacement, velocity & acceleration diagrams of single slider/double slider crank & four bar mechanism by using working models.
3. To determine coefficient of friction for a belt pulley material combination.
4. To demonstrate various types of gears.
5. To perform the balancing of rotating masses.
6. To analyse the profile of a cam with various followers.
7. To determine gear train value of compound gear trains & epicyclic gear trains.
8. To draw circumferential & axial pressure profile of journal bearing.
9. To conduct experiments on various types of governors & to co-relate equilibrium height & speed of the governor.
10. To determine moment of inertia of a fly wheel.

5th Semester **ME -14500 Mathematics-III**

	L	T	P	C
Internal Marks: 40				
External Marks: 60	**3**	**1**	**0**	**4**

Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Decompose periodic functions or periodic signals into the sum of a (possibly infinite) set of simple oscillating functions namely sines and cosines (or complex exponentials).
- Identify Laplace and inverse Laplace transforms of several known functions and uses them for solving differential equations.
- Use power series method to solve differential equation and its application to Bessel's and Legendre's equations.
- Analyze Partial differential equations and learn simplest means to solve them.
- Use the concepts of limit, continuity and derivative of complex variables and use analytic functions which are widely applicable to two dimensional problems in engineering.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 70% - 90% numerical problems.

Detailed Contents:

Section - A

1. **Fourier Series**: Periodic functions; Euler's formula. Even and odd functions; Change of Interval; half range expansions. Fourier series of different wave forms. **4 hrs**
2. **Laplace Transforms:** Definition; Laplace transforms of various standard functions; properties of Laplace transforms; inverse Laplace transforms; transform of derivatives and integrals; Transform of multiplication and division by t; convolution theorem; Laplace transform of unit step function. Applications to solution of ordinary linear differential equations with constant coefficients. **6 hrs**
3. **Special Functions**: Frobenius method for power series solution of differential equations. Bessel's equation; Bessel functions of the first and second kind. Legendre's equation; Legendre polynomial. **6 hrs**

Section - B

4. **Partial Differential Equations**: Formation of partial differential equations; Equations solvable by direct integration; Linear partial differential equations; homogeneous partial differential equations with constant coefficients. Solution by method of separation of variables. Applications: Wave equation and Heat conduction equation in one dimension. Solution of two dimensional Laplace equations (Cartesian co- ordinates). **6 hrs**
5. **Functions of Complex Variable**: Definition of Limit; continuity; derivative of complex functions and analytic function. Necessary and sufficient conditions for analytic function (without proof); Cauchy-Riemann equation (Cartesian and polar co-ordinates); harmonic

functions; orthogonal system; determination of conjugate functions. Miller's Thomson method; Applications to fluid flow problems. Brief introduction to basic transformations; Bilinear transformations; complex integration: Line integrals in the complex plane; Cauchy's integral theorem; Cauchy's integral formula for analytic function and its derivatives. Taylor's and Laurent's expansions; singular points; poles; residue; Cauchy's Residue theorem; evaluation of real integrals by contour integration; F (cosx; sinx) **8 hrs**

Suggested Reading/ Books:

1. Erwin Kreyszing, "*Advanced Engineering Mathematics*", Wiley Eastern, 10th Edition, 2010.
2. Grewal B. S, "*Higher Engineering Mathematics*", Khanna Publishers, 43rdEdition, 2014.
3. Jain N. K, "*Numerical Solutions of Differential Equations*", Prentice Hall.
4. Sharma J. N. and Gupta R.K., "*Differential Equations*", Krishna Prakashan Media, 47th Edition, 2009.
5. Bali N. P, "*Text book of Engg. Mathematics*", Laxmi Publishers, 9th Edition, 2011.

Topics for Self Learning (TSL)

1. ***Fourier Series****: Fourier series of differential wave forms.*
2. ***Laplace Transforms****: Solution of simultaneous differential equations using Laplace Transforms.*
3. ***Special Functions****: Recurrance relations of Bessel's Functions.*
4. ***Partial Differential Equations****: Equations solvable by direct integration; Solution of Two dimensional Laplace Equation (Cartesian Co-ordinates).*
5. ***Functions of Complex Variable****: Determination of Conjugate functions; brief introduction of basic transformations.*

5th Semester **ME - 14501 Design of Machine Elements-I**

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

L	T	Pr	C
4	0	2	6

Course Outcomes

After studying this course, students shall be able to:

- Understand the meaning of machine design process and types of design processes.
- Understand various design considerations like stress concentration factor, factor of safety and to be able to segregate components and design them independently.
- Design various basic machine components under different loading conditions.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. Use of Design Data/ Hand Book is not allowed.
3. Duration of End Semester Examination is 3 hrs.
4. The Question Paper of End Semester Examinations shall contain 60% - 80% numerical problems.
5. Pattern of End Semester Examinations Question Paper is as follows:

a) Question paper will consist of total seven (07) questions distributed among two parts Part A and Part B.

b) Part A will consist of ONE (01) question having TEN (10) sub parts, each of TWO (02) marks. From each section of the syllabus i.e. Section A and Section B, sub parts of this question have to be asked covering maximum units of syllabus. Candidate has to attempt all sub parts of this question.

c) Part B will consist of Six (06) questions each of TEN (10) marks. Three questions have to be asked from each section of syllabus i.e. Section A and Section B. Candidate has to attempt any FOUR questions out of these Six questions.

Detailed Contents:

Section-A

1. **Introduction:** Meaning of design with special reference to machine design; definition and understanding of various types of design; design process; design and creativity; general design considerations; concept of tearing; bearing; shearing; crushing; bending and fracture. Designation of materials according to Indian standards code; basic criteria of selection of materials; mechanical properties of materials. **6 hrs**
2. **Design Considerations**: Concept of concurrent engineering in design; Manufacturing considerations in machine design; stress concentration; factor of safety under different loading conditions; design for static loading; design for variable loading for both limited and unlimited life; concept of fatigue and endurance strength. **8 hrs**
3. **Design of Keys and Couplings**: Design of keys; design of splines; design of sleeve and solid muff coupling; clamp or compression coupling; rigid and flexible flange coupling; design of universal joint. **8 hrs**

Section-B

4. **Design of Fasteners:** Design of rivets for boiler joints; lozenge joints; eccentrically loaded riveted joints. Design of spigot and socket cotter joint; gib and cotter joint and knuckle joint. Design of welded joints for various loading conditions in torsion; shear or direct loads; eccentrically loaded welded joints. **8 hrs**
5. **Design of Shaft**: Design of solid and hollow shafts for transmission of torque; bending moment & axial forces; Design of shaft for rigidity. **8 hrs**
6. **Design of Levers**: Design of foot lever, hand lever, cranked lever, bell crank lever, safety valve lever and shoe brake lever. **5 hrs**
7. **Design of Pipe Joints**: Stresses in pipe joints; design of pipe joints with oval flange; square flange. **5 hrs**

Suggested Reading/ Books:

1. Shigley Joseph E., Mischke Charles Russell, Budynas Richard Gordon, "*Mechanical Engineering Design*", McGraw-Hill, 8th Edition, 2006.
2. Khurmi R. S., Gupta J. K., "*Machine Design*", S.Chand and Co.,1st Multicolor Edition , 2014
3. Robert C. Juvinall, "*Fundamentals of machine component design*", John Wiley & Sons, 3rd Edition, 2003.
4. Sharma P.C., Aggarwal D. K., "*Machine Design*", S. K. Kataria and Sons, 9th Edition, 1999.
5. Bhandari V. B, "*Design of Machine elements*", Tata McGraw - Hill, 3rd Edition, 2010.

Topics for Self Learning (TSL)

1. ***Introduction****: Designation of materials according to Indian standards code.*
2. ***Design Considerations****: Validation of Stress Analysis using CAD software.*
3. ***Design of keys and couplings****: Applications of different Keys and Couplings.*
4. ***Design of fasteners****: Design of Sleeve and Cotter Joint.*
5. ***Design of shaft****: A.S.M.E (American Society of Mechanical Engineers) Code for Design of Shaft.*
6. ***Design of pipe joints****: Design of circular flange pipe joint.*

5th Semester **ME-14502 Computer Aided Design and Manufacturing**

	L	T	P	C
Internal Marks: 40				
External Marks: 60	**4**	**0**	**0**	**4**
Total Marks: 100				

Course Outcomes

After studying this course, students shall be able to:

- Describe the role of computer systems in design and manufacturing.
- Understand geometric models, geometric modeling and apply various techniques
- Describe the key concept of NC / CNC / DNC and part programming to establish FMS
- Conceptualize the integration of CAD/CAM and business aspects in an industry.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 10% - 20% numerical problems.

Detailed Contents:

Section- A

1. **Introduction to CAD/CAM**: Introduction to CAD/CAM and its role in Product design and development cycle; CAD/CAM system and its evaluation criteria ; advanced input and output devices, Display devices; Functions of a graphics package and Graphics standard GKS; IGES and STEP; Application areas of CAD . **5 hrs**

2. **Geometric Modeling**: Need and types of Geometric Modeling: Wireframe; surface and solid modeling; Geometric Modeling Techniques: Boundary Representation (B-rep); Constructive Solid Geometry (CSG); Parametric Modeling Technique ; Mass; volumetric properties calculations; concepts of hidden-line removal and shading; Mechanical Assembly Kinematics analysis and simulation. **6 hrs**

3. **Geometric Transformations**: Overview of Mathematics preliminaries; matrix representation of 2 and 3 dimensional transformation for translation; scaling; rotation about principal axes; mirror imaging about a plane; principal axes and origin; Concatenation of transformation matrices. Applications of geometric transformations. **6 hrs**

4. **Representation of curves and surfaces**: Non-parametric and parametric representation of curves; Parametric representation of Hermite Cubic; Bezier curves; Uniform and Non-uniform B-spline curves; Surface and its analysis. Representation of Analytical and synthetic

surfaces(Bilinear Surface; Coons Surface Patch; Bi-cubic Surface Patch; Bezier Surface; B-spline surface). **8 hrs**

Section - B

5. **NC/CNC/DNC Machine Tools**: NC machine tools- basic components coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment; flexible tooling; tool length compensation; tool path graphics; NC motion control system; Direct Numerical Control. Adaptive control in machining system. **7 hrs**

6. **CNC Part Programming**: Basic terminology of Parts programming; Block format; Coordinate system; fixed/floating zero; types and classification of machine codes; Manual part programming; Computer aided and computer assisted part programming. **8 hrs**

7. **Group Technology (GT)**: Basic fundamentals of Group Technology; Part families; part classification and coding system: Group technology machine cells: Advantages of Group Technology. **4 hrs**

8. **Computer Aided Process Planning**: Introduction and benefits of CAPP. Types of CAPP systems; machinability data selection systems in CAPP. **4 hrs**

Suggested Readings/Books:

1. Groover Mikell P., Emory W. Zimmer's, "*CAD/CAM: Computer-Aided Design and Manufacturing*", PHI, 2nd Edition, 1984.
2. Bedworth D. D., Henderson M. R& P.M. Wolfe, "*Computer Integrated Design and Manufacturing*", Tata McGraw Hill,2nd Edition, 1991.
3. Ibraham Z., "*CAD/CAM - Theory and Practice*", Tata McGraw Hill, 2nd Edition, 2009.
4. Rao P. N, "*CAD/CAM Principles and Applications*", Tata McGraw Hill,2nd Edition, 2004.
5. Elanchezhian C., Selwyn Sundar T., Shanmuga Sunder G., "*Computer Aided Manufacturing*", Laxmi Publication, 2nd Edition,2007.

Topics for Self Learning (TSL)

1. ***Introduction to CAD/CAM****: Salient features of any two CAD/CAM software and their comparison on the basis of user interface and various tools.*
2. ***Geometric Modeling****: Half Space Modeling.*
3. ***Geometric Transformations****: Projection Transformations.*
4. ***NC/CNC/DNC Machine Tools****: Classification of CNC m/c tools based on number of axis.*
5. ***CNC Part Programming****: Execution of part program using any simulator.*
6. ***Group Technology (GT)****: Case Study.*
7. ***Computer Aided Process Planning****: Role of artificial intelligence in manufacturing.*

5th Semester **ME-14503 Mechanical Measurements and Metrology**

	L	T	P	C
Internal Marks: 40				
External Marks: 60	**4**	**0**	**0**	**4**

Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Understand the classification of measurements and measurement standards used in industrial applications
- Understand the concept of static and dynamic characteristic of a measuring instrument.
- Understand about various errors in measuring systems and evaluate the errors by statistical methods.
- Know about functions and types of sensors and transducers and their utility in instrumentation.
- Use various instruments for measurements like pressure, flow, temperature etc. in manufacturing or process industry.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 0% - 10% numerical problems.

Detailed contents

Section - A

1. **General Concepts**: Need and classification of measurements and instruments; basic and auxiliary functional elements of a measurement system. Mechanical versus electrical / electronic instruments; primary; secondary and working standards. **3 hrs**
2. **Static and Dynamic Characteristics of Instruments**: Range and span; accuracy and precision; calibration; hysteresis; dead zone; sensitivity and linearity; threshold and resolution; speed of response; lag; fidelity and dynamic error; dead time and dead zone. Zero and first order systems and their response to step; ramp and sinusoidal input signals. **5 hrs**
3. **Errors in Measurement**: Sources of errors; Gross, Systematic and Random errors; Statistical analysis of test data- single sample test and multi sample test; Probable error –average and standard deviation for normal curves; Rejection of test data. **4 hrs**
4. **Metrology:** Line; end and wavelength standards. Linear measurements; comparators - their types; relative merits and limitations. Angular measurements - sine bar; clinometers; angle gauge. Concept and measurement of straightness and flatness by interferometry. Surface roughness - specifications and measurement. Measurement of major diameter; minor diameter; effective diameter; pitch; angle and form of threads for internal and external threads. Measurement of tooth thickness; pitch and checking of profile for spur gears. **10 hrs**

Section - B

5. **Functional Elements**: Introduction to sensors and transducers; types of sensors; review of electro-mechanical sensors and transducers - variable resistance; inductance and capacitive pickups; photo cells and piezoelectric transducers and application of these elements for measurement of position/displacement; speed / velocity / acceleration; force and liquid level.

Resistance strain gauges; gauge factor; bonded and unbounded gauges; temperature compensation; application of strain gauges for direct; bending and torsional loads. Introduction to amplifying transmitting and recording devices. **10 hrs**

6. **Pressure and Flow Measurement**: Bourdon tube; diaphragm and bellows; Vacuum measurement –McLeod gauge; thermal conductivity gauge and ionization gauge; dead weight gauge tester. Electromagnetic flux meters; ultra-sonic flow meters and hot wire anemometer. Flow visualization techniques. **5 hrs**
7. **Temperature Measurement**: Thermal expansion methods - bimetallic thermometers; liquid-in-glass thermometer and filled-in-system thermometers; thermo-electric sensors - common thermo couples; reference junction considerations; special materials and configurations; metal resistance thermometers and thermistor; optical; total radiation pyrometers; calibration standards. **6 hrs**
8. **Speed; Force; Torque and Shaft Power Measurement**: Mechanical tachometers; vibration reed tachometer and stroboscope; proving ring; hydraulic and pneumatic load cells; torque on rotating shafts; Absorption; transmission and driving dynamometers. **5 hrs**

Suggested Reading/ Books

1. Doebelin E. O., "*Measurement System: Application and Design*", McGraw- Hill, 5th Edition, 2008.
2. Bewoor A. and Kulkarni V., "*Metrology and Measurement*", McGraw-Hill, 1st Edition, 2009.
3. Rajput R. K, "*Mechanical Measurement and Instrumentations*", SK Kataria Publishers, 2nd Edition, 2012.
4. Morris Alan S., "*The Essence of Measurement*", Prentice Hall of India, 1996.
5. Nakra B. C., Chaudhry K. K.., "*Instrumentation, Measurement and Analysis*", Tata McGraw-Hill, 2nd Edition, 2006.

Topics for Self Learning (TSL)

1. ***General Concepts****: Utility of measurement standards in workspace.*
2. ***Metrology:*** *Industrial applications for measurements of straightness and flatness.*
3. ***Functional Elements****: Knowledge for calibration of various measurement gauges.*
4. ***Temperature Measurement****: Industrial applications thermometers and thermocouples.*

5th Semester **ME-14504 Industrial Automation and Robotics**

	L	T	P	C
Internal Marks: 40				
External Marks: 60	**4**	**0**	**0**	**4**
Total Marks: 100				

Course Outcomes

After studying this course, students shall be able to:

- Understand the concept, need and application of hard automation, soft automation and their advantages.
- Describe the constructional features, working and use of valves and their application in automation.
- Conceptualize and design the pneumatic and hydraulic circuits for industrial automation applications.
- Describe the working of fluidic sensors for their industrial applications.
- Describe the details and working of various transfer devices and feeders in manufacturing industry.
- Know about the programming of robotic arm and its industrial applications.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 0% - 10% numerical problems.

Detailed Contents

Section-A

1. **Introduction**: Concept and scope of automation; Socio-economic impacts of automation; Types of Automation; Low Cost Automation. **3 hrs**
2. **Fluid Power**: Fluid power control elements; Standard graphical symbols. Hydraulic and pneumatic Cylinders; construction; design and mounting. Hydraulic and pneumatic Valves for pressure; flow and direction control. **8 hrs**
3. **Basic hydraulic and pneumatic circuits**: Direct and Indirect Control of Single/Double Acting Cylinders. Designing of logic circuits for a given time displacement diagram & sequence of operations; Hydraulic & Pneumatic Circuits using Time Delay Valve; Quick Exhaust Valve & Speed Control of a Cylinder. Troubleshooting; Causes & Effects of Malfunctions. Basics Circuit Design Problems. Designation of specific Elements in a Circuit. **12 hrs**
4. **Fluidics**: Boolean algebra; Commutative law & Distributive law. Truth Tables & Logic Gates; AND gate; OR gate; XOR gate; NAND gate; NOR gate; NOT gate; XNOR gate. Fluidic devices; Coanda effect; Fluidic sensors and Fluidic amplifiers (Construction; Working and Applications). **6 hrs**

Section - B

5. **Electrical and Electronic Controls**: Basics of Programmable logic controllers (PLC) Architecture & Components of PLC; Ladder Logic Diagrams. Microprocessor – Introduction; structure of micro-controller. **5 hrs**
6. **Transfer Devices and feeders**: Classification; Constructional details and Applications of Transfer devices. Vibratory bowl feeders; reciprocating tube; Centrifugal hopper feeders.**6 hrs**
7. **Robotics**: Introduction; Classification based on geometry; control and path movement. Robot Specifications; Robot Performance Parameters; Robot Programming; Machine Vision; Teach pendants; Industrial Applications of Robots. **8 hrs**

Suggested Reading/ Books:

1. Groover Mikell P., "*Industrial Robotics*", McGraw- Hill, 4th Edition 2008.
2. Majumdar S. R., "*Pneumatic Control*", Tata McGraw- Hill, 1stEdition, 2004.
3. Craig John, "*Introduction to Robotics: Mechanics & Control*", Prentice Hall of India, 3rd Edition, 2007.
4. Bolton W, "*Mechatronics*", Pearson Education, 4th Edition, 2011.
5. Deb S. R., "*Robotic Technology and Flexible Automation*", McGraw Hill, 2nd Edition, 1994

Topics for Self Learning (TSL)

1. ***Introduction****: Current advancements in industrial automation.*
2. ***Fluid Power****: Fluid power generators used in pneumatic/hydraulic systems.*
3. ***Basic hydraulic and pneumatic circuits****: Design pneumatic/hydraulic circuits for industrial application.*
4. ***Electrical and Electronic Controls****: Sensors used in industrial automation.*
5. ***Transfer Devices and feeders****: Recent advancements in automated assembly systems.*
6. ***Robotics****: Recent developments in Robotics.*

5th Semester **ME-14505 Computer Aided Design and Manufacturing Lab.**

	L	T	P	C
Internal Marks: 30				
External Marks: 20	**0**	**0**	**2**	**1**
Total Marks: 50				

Course Outcomes

After undergoing this course, students shall be able to:

- Model, assemble and draft mechanical part using state of art CAD system.
- Efficiently use advanced features of CAD/CAM systems (e.g. Solid Works and Solid Cam).
- Write manual part programme (G-Code) for CNC turning and milling and simulate the tool path.
- Execute machining of simple profiles on CNC turning and milling trainer.

Experiments involving:

A. Introduction to modeling (using any CAD software):

1. 2D drawing using sketcher – 2 Drawings
2. 3D modeling using 3D features (Modeling of Crane Hook; Bench Vice; Screw Jack components)
3. Assembling and drafting (any 2 above mentioned assemblies) with proper mating conditions and interference checking.
4. Surface modeling – (Computer mouse; Plastic bottles with spraying Nozzle)

B. Computer Aided Manufacturing:

1. Manual part programming on CNC Lathe and CNC Milling – (4 programs; 2 for each)
2. Computer Aided Part programming for CNC Lathe and CNC Milling to generate tool path; NC code; and Optimization of tool path (to reduce machining time) using any CAM software.

5th Semester **ME-14506 Mechanical Measurements and Metrology Lab.**

	L	T	P	C
Internal Marks: 30				
External Marks: 20	**0**	**0**	**2**	**1**
Total Marks: 50				

Course Outcomes

After undergoing this course, students shall be able to:

- Understand the basics of measurements and their needs in industry.
- Measure dimensions; angles and shaft speed.
- Measure the surface roughness of any metallic flat surface; pipe and rod.
- Calibrate the pressure gauge and prepare a thermocouple and its calibration.
- Measure threads elements and gear elements.
- Plot the velocity profile by using Pitot tube.

Experiments involving:

1. Measurement of an angle with the help of sine bar.
2. Measurement of surface roughness of a machined Plate; Rod and Pipe.
3. Measurement of gear elements using profile projector.
4. Measurement of effective diameter of external threads using Three wire method.
5. Measurement of thread element by Tool maker's microscope.
6. Calibration of a pressure gauge with the help of a dead weight gauge tester.
7. Use of stroboscope for measurement of speed of shaft.
8. Use of Pitot tube to plot velocity profile of a fluid through a circular duct.
9. Preparation of a thermocouple; its calibration and application for temperature Measurement.

5th Semester **ME-14507 Industrial Automation and Robotics Lab.**

	L	T	P	C
Internal Marks: 30				
External Marks: 20	**0**	**0**	**2**	**1**
Total Marks: 50				

Course Outcomes

After undergoing this course, students shall be able to:

- Understand the working of hydraulic and pneumatic valves.
- Develop the basic hydraulic and pneumatic circuits using different types of valves.
- Know the constructional features and operation of direction and flow control valves in circuit design.
- Understand and describe different robotic configurations and end effectors.

Experiments involving:

1. Demonstration of different types of hydraulic and pneumatic valves and their symbols.
2. Study of the Design and assembly of hydraulic / pneumatic circuits.
3. Demonstration of the working of reciprocating movement of single acting and double acting cylinder using pneumatic/ hydraulic direction control valves.
4. Use of direction control valve and pressure control valves in the design of clamping devices for jigs and fixture.
5. Demonstration of the working of power steering mechanism.
6. Demonstration of the working of robotic arm and its end effectors.

5th Semester ME - 14508 Design of Machine Elements-I Practice

Pr
2

Following is a list of sample problems which may be used for Tutorials/Assignments:-

1. Select a product of daily used and design the conceptual design by applying the design process taking the controlling parameters. (Study general design procedure, check recognition of need of the product, then takes any sample product like (e.g. Chair, Table, Blackboard, Duster, Pen etc.). Then find drawbacks in the existing design and suggest new proposed design.)
2. Select some engineering components such as Gear, Pulley, Shaft, Belt, Chain, Rivet, Nut, Bolt, Connecting rod, Piston etc.. Find out the material used and the material properties required for each of the components. Considering stresses and strains experienced by each component, suggest alternate material with better mechanical properties.
3. Design a wall bracket (having (i)Welded joints (ii) Riveted and bolted joints) , which can be used for a given load condition.

   (Take a live example of wall bracket, and justify your findings.)
4. Find a flange coupling in the college laboratory and justify its design by actual measurements. (Take an example of engine and generator assembly and justify its findings.)
5. Design a shaft used in some practical application, by actual working and loading conditions. (Take an example of a line shaft in the machine shop and justify your findings.)
6. Design a pipe joint used in some practical applications. (Take an example of a pipe joint in the fluid machinery laboratory and justify your findings.)

6th Semester **ME-14601 Design of Machine Elements -II**

	L	T	Pr	C
Internal Marks: 40				
External Marks: 60	**4**	**0**	**2**	**6**
Total Marks : 100				

Course Outcomes

After of studying this course, students shall be able to:

- Understand about the various modes to transmit power (like: Belt drives, rope drives, chain drives, gears etc.
- Understand about the various bearings and bearing housings and will be able to suggest suitable bearings for different applications.
- Know about the lubrication in the transmission system and will be able to solve various problems regarding it.
- Design various machine members like: springs, flywheel, clutches and brakes etc. as per different requirements in the industry.
- Analyse the design and suggest/apply suitable modifications in the design.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The use of any one of the following Design Data Book/Hand Book is allowed ONLY:-

a) Design Data Book, PSG College of Engineering and Technology, Coimbatore, Revised Edition, 1978, Reprint in 2010.

b) Design Data Handbook for Mechanical Engineers, Mahadevan, K. and Reddy Balveera, K., CBS Publishers and Distributors Pvt. Ltd., 4th Edition, 2013.

c) Design Data Book, Jadon, V.K., I.K. International Publishers, 2nd Edition, 2010.

3. Duration of End Semester Examination is 4 hrs.
4. The Question Paper of End Semester Examinations shall contain 70% - 90% numerical problems.
5. End Semester Examinations Question Paper Pattern is as follows:

a) Question paper will consist two parts, Part A and Part B having total Eight (08) questions.

b) Part A will consist of Four (04) questions each of TEN (10) marks from Section A of syllabus. Candidate will be required to attempt 03 questions from this Part.

c) Part B will consist of Four (04) questions each of TEN (10) marks from Section B of syllabus. Candidate will be required to attempt 03 questions from this Part.

Detailed Contents:

Section-A

1. **Transmission Drives**: Belt and rope drives: Basics; Characteristics of belt drives; selection of flat belt; Design of Flat belt; V-belt and rope (steel wire) .Design of the pulley for the same Chain Drives: Basics; Roller chains; polygonal effect; power rating; Selection of chain. Gear drives: Standard system of gear tooth and gear module; gear tooth failure; strength of gear tooth; terminology of spur; helical; bevel; worm and worm wheel; Design of spur; helical; straight bevel gears; worm and worm wheel. **12 hrs**

2. **Spring Types**: End styles of helical compression spring; stress and deflection equation; surge in spring; nipping of leaf spring; Design of close-coil/open-coil helical spring and multi leaf spring. **8 hrs**
3. **Design of Flywheel**: Introduction; Types of flywheel and their applications; Energy stored in a flywheel; stresses in a rim; design considerations. **6 hrs**

Section-B

4. **Bearings Slider**: Principle of hydrodynamic lubrication; modes of lubrication; Reynolds equation; bearing performance parameters; slider bearing design. Roller: Types; selection guidelines; static and dynamic load carrying capacity; equivalent bearing load; load life relationship; selection of bearing; comparison of roller and slider bearing. **9 hrs**
5. **Clutches**: Design of contact clutches i.e. plate; multi-disc; cone and centrifugal clutches.**7 hrs**
6. **Brakes**: Design of band; band and block; block with shoe and internal expanding brakes.**6 hrs**

Suggested Reading/ Books:

1. Shigley J. E., Russell M.C., Gordon B.R., "*Mechanical Engineering Design*", McGraw-Hill, 8th Edition, 2006.
2. Khurmi R. S., Gupta J. K., "*Machine Design*", S. Chand and Co. , 1st Multicolor edition , 2014
3. Juvinall R.C., "*Fundamentals of Machine Component Design*", John Wiley & Sons, 3rd Edition, 2003.
4. Sharma P.C., Aggarwal D. K., "*Machine Design*", S. K. Kataria and Sons, 9th Edition, 1999.
5. Bhandari V. B, "*Design of Machine Elements*", Tata McGraw - Hill, 3rd Edition, 2010.

Topics for Self Learning (TSL)

1. ***Transmission Drives****: AGMA (American Gear Manufacturer Association) Standards for different gears.*
2. ***Spring Types****: Surging of Helical Springs.*
3. ***Bearings Slider****: Gaskets and Oil Seals.*
4. ***Clutches****: Study of friction materials.*
5. ***Brakes****: Disc Brakes.*

Following is a list of sample problems which may be used for Tutorials/Assignments:-

6th Semester **ME-14602 Heat Transfer**

	L	T	P	C
Internal Marks: 40				
External Marks: 60	**3**	**1**	**0**	**4**
Total Marks: 100				

Course Outcomes

After studying this course, students shall be able to:

- Recognize the predominant mode of heat transfer and apply the knowledge of basic laws of heat transfer to solve and analyze various engineering problems (mainly one dimensional under steady state conditions.
- Develop mathematical relations to solve heat transfer problems.
- Select and design the use of fins under different circumstances as well as optimum conditions.
- Formulate convective (simple and with phase change) heat transfer problems and solve them using dimensional analysis and analytical/empirical relations.
- Use electrical analogy to solve one dimensional conduction and radiation problems.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 50% - 70% numerical problems.

Detailed Contents:

Section - A

1. **Introduction**: Concept of heat transfer; Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics"; Different modes of heat transfer –conduction; convection and radiation. **2 hrs**
2. **Conduction**: Fourier's law of heat conduction; Coefficient of thermal conductivity; Effect of temperature and pressure on thermal conductivity of solids, liquids and gases; Three dimensional general conduction equations in rectangular, cylindrical and spherical coordinates; Deduction of one dimensional steady state heat conduction equation in rectangular; cylindrical and spherical coordinates with and without internal heat generation for uniform thermal conductivity of material; Concept of variable thermal conductivity; Electrical network analysis for heat transfer through composite/multilayer material. Application of heat conduction with internal heat generation in case of piston crown and in nuclear fuel rod with/ without cladding. Concept of equivalent area; Conduction shape factor; Conduction through edges and corners of walls; Critical thickness of insulation layers on electric wires and pipes carrying hot fluids; Introduction to unsteady heat transfer; Newtonian heating and cooling of solids; Physical significance of thermal diffusivity. **18 hrs**
3. **Theory of Fins**: Concept of fin; Classification of fins and their applications; Straight fins of uniform cross-section; Straight fins with varying cross-sectional area (triangular/trapezoidal profile); Circumferential fins of rectangular cross-section; Fin performance: fin effectiveness; fin efficiency; total fin effectiveness and total fin efficiency; Application of fins in temperature measurement of flow through pipes and determination of error in its measurement. **4 hrs**

Section - B

4. **Convection**: Free and forced convection; Derivation of three-dimensional mass, momentum and energy conservation equations (Vector and Tensor form); Boundary layer formation: laminar and turbulent boundary layers (no derivation); Determination of heat transfer coefficient for free and forced convection by dimensional analysis method; Physical significance of dimensionless numbers related to convective heat transfer; Use of analytical/empirical formulae for convective heat transfer in laminar and turbulent flow over vertical and horizontal plate, cylinder / pipe and sphere; Newton's law of cooling; Overall coefficient of heat transfer; Different design criterion for heat exchangers; Log mean temperature difference (LMTD) for parallel and counter flow heat exchangers; Calculation of length and number of tubes in a heat exchanger using LMTD and effectiveness-NTU method. **10 hrs**
5. **Convection with Phase Change (Boiling and Condensation)**: Boiling: definition and types of boiling, different regimes and heat transfer during pool boiling of a liquid, nucleation and

different theories accounting for increased h.t.c. during nucleate phase of boiling; Condensation: definition and types of condensation, film wise condensation on a vertical and inclined surface. **4 hrs**

6. **Radiation**: Process of heat flow due to radiation; Definition of emissivity, absorptivity, reflectivity and transmissivity; Concept of black and grey bodies; Plank's law of non chromatic radiation; Wien's displacement law; Kirchoff's law; Stefan Boltzmann's law; Lambert's Cosine law; Definition of intensity of Radiation (only), irradiation, radiation density and radiosity; Geometric/ configuration factor and its use in heat exchange between two black bodies; Electrical network analysis for radiation exchange between two, three or four bodies (e.g. boiler or other furnaces); simplification of electrical network analysis for its application to simple bodies like two parallel surfaces, concentric cylinders/spheres and a body enveloped by another body etc.; Use of radiation shields. **10 hrs**

Suggested Reading/ Books:

1. Incropera F.P. and De Witt D.P., *"Fundamentals of Heat and Mass transfer",* John Wiley, 7th Edition, 2011.
2. Cengel, A. Yunus, *"Heat and Mass Transfer",* Tata McGraw Hills Education Private Ltd, 4thEdition, 2013.
3. Kumar, D.S. *"Fundamentals of Heat and Mass Transfer",* S K Kataria & Sons, 7th Edition, 2013.
4. Chapman. A. J, *"Heat Transfer",* McGraw Hill, 7th Edition, 1990.
5. Holman, J.P. *"Heat Transfer"*, Tata McGraw-Hill Publishing Company Ltd, 9th Edition, 2008.

Topics for Self Learning (TSL)

1. ***Introduction****: Use of basic laws of heat transfer for conduction, convection and radiation to solve simple numerical problems.*
2. ***Conduction****: Finite difference method (FDM) formulations of conduction equations and boundary conditions to solve simple conduction heat transfer problems.*
3. ***Theory of Fins****: Optimum design of straight fin of rectangular and triangular profile area*
4. ***Convection****: Boundary layer formation inside pipe/ tube; Use of correlations for free convection and forced convection inside pipes/ tubes etc.*
5. ***Convection with Phase Change (Boiling and Condensation)***: *Different phases of flow boiling (theory only).*
6. ***Radiation****: Multiple reflection and absorption method for radiative heat exchange between surfaces; Error in Temperature measurement by a thermocouple probe due to radiation losses.*

6th Semester **ME-14603 Hydraulic Machines**

Internal Marks: 40 **L T P C**

External Marks: 60 **3 1 0 4**

Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Recognize basic components of turbo machines and understand related fundamental laws/ principles and apply these for calculation of various parameters like work done, force efficiency etc.
- Know about constructional details, working and design aspects of runner/wheel and evaluate the performance of various turbines like Pelton, Kaplan and Francis.
- Know about constructional details, working and evaluate the performance of centrifugal pump under different vane shape conditions.
- Know about constructional details, working and evaluate the performance of reciprocating pump and evaluate the effect of various deviations from the ideal conditions on the work done.
- Know about constructional details and working of hydraulic devices like fluid coupling, accumulator and intensifier.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 50% - 70% numerical problems.

Detailed Contents:

Section - A

1. **General Concepts**: Impulse momentum principle; jet impingement on stationary and moving flat plates; and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted; work done and efficiency of jet. Basic components of a turbo machine and its classification on the basis of purpose; fluid dynamic action; operating principle; geometrical features; path followed by the fluid. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes. **7 hrs**
2. **Pelton Turbine**: Component parts and operation; velocity triangles; work output; Effective head; available power and efficiency; design aspects such as mean diameter of wheel; jet ratio; number of jets; number of buckets with working proportions; governing of Pelton turbine. **5 hrs**
3. **Francis and Kaplan Turbines**: Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks; governing of reaction turbines. **6 hrs**

Section - B

4. **Centrifugal Pumps**: Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump; Heads of a pump - suction; delivery; static; manometric; total; net positive suction head and Euler's head; vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; model testing and Priming and priming devices; Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems; causes and remedies. **6 hrs**
5. **Similarity Relations and Performance Characteristics**: Unit quantities; specific speed and model relationships; scale effect; Cavitation and Thomas's cavitation number; Concept of Net Positive Suction Head (NPSH) and its application. **4 hrs**
6. **Reciprocating Pumps**: Introduction to single acting and double acting reciprocating pumps; their components; and parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Functions of Air vessels. **5 hrs**
7. **Hydraulic Devices and Systems**: Construction; operation and utility of simple and differential accumulator; intensifier; fluid coupling and torque converter; Air lift and jet pumps; gear; vane and piston pumps; Hydraulic Ram; Hydraulic lift; Hydraulic crane and Hydraulic press. **3 hrs**

Suggested Reading/ Books:

1.Lal Jagdish;*"Hydraulic Machines"*, Metropolitan Book Co., 2016
2.Ojha C. S. P., Berndtsson R, Chandramouli P, *"Fluid Mechanics and Machinery",* Oxford University Press, 2010
3.Subramania K*, "Hydraulic Machines",*Tata Mc-Graw Hill Education, 2013
4.Purohit, R. K., *"Hydraulic Machines"*, Scientific Publishers, 2007
5.Kumar D.S., *"Fluid Mechanics and Fluid Power Engineering"*, S K Kataria and Sons, 2016

Topics for Self Learning (TSL)

1. ***Pelton Turbine****: Study of various installations of Pelton wheel in India.*
2. ***Francis and Kaplan Turbines****: Study of various installations of Francis and Kaplan Turbines in India.*
3. ***Centrifugal Pumps****: Study of various types of centrifugal/submersible pumps available in market.*
4. ***Centrifugal Pumps / Reciprocating Pumps****: Study of pumps (centrifugal/ submersible/reciprocating) and other devices used by city water supply/pumping station.*
5. ***Hydraulic Devices and Systems****: Current advancement in hydraulic devices.*

6th Semester **ME-14604 Heat Transfer Lab.**

Internal Marks: 30 **L T P C**
External Marks: 20 **0 0 2 1**
Total Marks: 50

Course Outcomes

After undergoing this course, students shall be able to:

- Design and fabricate the experimental setups related to heat transfer phenomena.
- Measure and analyse different heat transfer parameters.
- Apply finite difference methods to solve simple heat transfer problems.

A. Two to three students in a group are required to do one or two practicals in the form of Lab. Project in the topic/s related to the subject matter of Heat Trasfer and in consultation with teacher. The complete theoretical and experimental analysis of the concerned topic is required to be performed (including design and fabrication of new experimental set up; if required; or modifications/retrofitting in the existing experimental set ups).

B. Each student is required to use Finite Difference Method for analysis of steady state one dimensional and two dimensional conduction problems (Minimum two problems one may be from the Lab. Project) such as conduction through plane/cylindrical/spherical wall with or without internal heat generation; heat transfer through fins; bodies with irregular boundaries subjected to different boundary conditions.

The following topics can be taken as reference:

1. Determination of thermal conductivity of:
   - a solid insulating material by slab method.
   - powder materials by concentric spheres method / or by some transient heat transfer technique.
   - a metal by comparison with another metal by employing two bars when kept in series and / or in parallel under different boundary conditions.
   - liquids by employing thin layer.
2. Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder / plate when kept:
   a) Along the direction of flow b) perpendicular to the direction of flow
   c) Inclined at an angle to the direction of flow
3. Plotting of the pool boiling curves for water and to determine its critical point
4. Determination of heat transfer coefficient for
   i) film wise condensation ii) drop-wise condensation
5. Determination of heat transfer coefficient by radiation and hence find the Stefan Boltzmann's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.
6. Determination of shape factor of a complex body by an analog technique.
7. Plotting of the temperature profile and determination of fin effectiveness and fin efficiency for
   i) a rod fin when its tip surface is superimposed by different boundary condition like.
   a) Insulated tip b) Cooled tip c) Temperature controlled tip
   ii) Straight triangular fins of various sizes and optimization of fin proportions
   iii) Circumferential fins of rectangular/triangular section

6th Semester **ME-14605 Hydraulic Machines Lab**

Internal Marks: 30	**L**	**T**	**P**	**C**
External Marks: 20	**0**	**0**	**2**	**1**

Total Marks: 50

Course Outcomes

After undergoing this course; students shall be able to:

- Conduct experiments on scaled down models or on actual size hydraulic machines and evaluate results in terms of unit or specific quantities for comparison purpose.
- Suggest different hydraulic machines for different conditions in order to have maximum efficiency.
- Utilize various combinations of hydraulic systems to enhance overall efficiency of the system.
- Suggest installations of hydraulic machines depending on different requirements.
- Understand working of various pumps and can suggest remedial solutions for different faults.

Experiments involving:

1. Drawing of the performance/ characteristics curves of Pelton Turbine.
2. Drawing of performance /characteristics curves of Francis turbine/Kaplan Turbine.
3. Drawing of the performance/ characteristics curves of Centrifugal pump.
4. Study of the constructional features of reciprocating pump and determination of pump performance.
5. Determination of various efficiencies of Hydraulic Ram.
6. A visit to any Hydroelectric Power Station

6th Semester **ME-14607 Design of Machine Elements –II Practice**

Internal Marks: 30	**Pr**
External Marks: 20	**2**

Total Marks: 50

Take a practical application, and then carry out the design using design data book:

1.Take an assembly containing the belt and pulley mechanism and do the complete design calculations and then justify the existing design. Taking input parameters like Power to be transmitted centre distance, angle of contact etc. design the belt and pulley. Compare and comment on outcomes from the design and actual dimensions of the mechanism currently in use.

2.Design a transmission system involving the chain drives / gear drives by specifying inputs, and then justify design.

3.Design flywheel for industrial application and suggest its suitability. Take an example of power press. Study the mechanism of working of power press. Taking input parameters like Power, stroke etc. design the flywheel. Compare and comment on outcomes from the design and actual dimensions of flywheel currently in use.

4.Design completely a hydrodynamic journal bearing and specify its suitability by using heat balance equation.

5.Design springs for automobile application by specifying conditions and constraints. An application of spring can be taken and some input parameters can be assumed.

Design a clutch and brakes of an automobile and justify its suitability

DEME-14103 **Non-Conventional Energy Resources**

	L	T	P	C
Internal Marks: 40				
External Marks: 60	**4**	**0**	**0**	**4**
Total Marks: 100				

Course Outcomes

After studying this course, students shall be able to:

- Know various types of energy resources.
- Describe about design aspects of various types of solar collectors.
- Use solar energy applications for different systems.
- Understand principles of wind energy generation and various direct energy conversion systems and analyze forces acting on blades and estimate power output.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 0% - 20% numerical problems.

Detailed Course

Section A

1. **Introduction**: Renewable and non-renewable energy sources; their availability and growth in India; energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements. **4 hrs**
2. **Solar Energy**: Solar radiation - beam and diffuse radiation; earth sun angles; attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles; general description and design procedures of flat Plate and concentrating collectors; Solar energy storage systems - their types; characteristics and capacity; solar ponds. Applications of solar energy in water; space and process heating; solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar photovoltaic system; economic analysis of solar systems. **10 hrs**
3. **Wind Energy**: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components; various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations. **10 hrs**

Section B

4. **Direct Energy Conversion Systems**:

i) Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle; types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields.

ii) Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration.

iii) Thermionic generators: thermo- ionic emission and materials; working principle of thermionic convertors.

iv)Fuel Cells: thermodynamic aspects; types; components and working of fuel cells.

v) Performance; applications and economic aspects of above mentioned direct energy conversions systems. **12 hrs**

5. **Miscellaneous Non-Conventional Energy Systems**:

i) Bio-mass: Concept of bio-mass conversion; photo-synthesis and bio-gasification; Bio gas generators and plants - their types constructional features and functioning; digesters and their design; Fuel properties of bio gas and community bio gas plants

ii) Geothermal: Sources of geothermal energy - types; constructional features and associated prime movers.

iii) Tidal and wave energy: Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices Advantages/disadvantages and applications of above mentioned energy systems. **12 hrs**

Suggested Readings/Books:

1. Garg H. P. and Prakash Jai, "*Solar Energy: Fundamentals and Applications"*, Tata McGraw - Hill, 2000.
2. Sukhatme S. P., "*Solar Energy: Principles of Thermal Collection and Storage"*, Tata McGraw Hill, Third Edition 2008.
3. Duffic John A. and Beckman W. A., "*Solar Engineering of Thermal Processes"*, John Wiley, Fourth Edition 2013.
4. Chang, Sheldon S. L., "*Energy Conversion"*, Prentice Hall, 1963, Reprinted in 2015.
5. Bockris J. O M. and Srinivasan S., "*Fuel Cells: Their Electrochemistry"*, McGraw Hill, 1969.

Topics for Self Learning (TSL)

1.***Introduction****: Prospects of Renewable energy.*

*2.**Solar Energy:** Applications of solar energy, Visit to a solar powered electric supply unit and enlist the component and their specifications.*

*3.**Wind Energy:** Site selection considerations for wind plants.*

*4.**Direct Energy Conversion Systems:** Thermo electric refrigeration;Types of fuel cells*

5.***Miscellaneous Non-Conventional Energy Systems:*** *Types of bio gas generators, Applications of tidal and wave energy*

DEME-14201 **Non-Traditional Machining**

Internal Marks: 40 **L T P C**

External Marks: 60 **4 0 0 4**

Total Marks: 100

Course Outcomes

After studying this course, students shall be able to:

- Understand the concept of latest technologies and Non Traditional machining processes needed for manufacturing of components.
- Select suitable technology or process for stringent requirement of manufacturing industry.
- Describe and demonstrate the constructional features of machines/set ups related to major non-conventional machining.
- Analyze the effect of process parameters on performance of major non-conventional machining.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 0% - 20% numerical problems.

Detailed Contents

Section - A

1. **Introduction**: Latest trends in Manufacturing; Introduction to Flexible manufacturing system; Introduction to computer integrated manufacturing; Limitations of conventional machining processes; Development of Non conventional machining processes; their classification; advantages and major applications. **4 hrs**

2. **Advanced Mechanical Processes**: Ultrasonic machining; Water Jet Machining and Abrasive Flow Machining-elements of process; Applications and limitations. **8 hrs**

3. **Electrochemical & Chemical Removal Processes**: Principle of operation; elements and applications of Electrochemical Machining; Electro-chemical grinding; Electro-chemical deburring; Electro-chemical honing; Chemical machining; Photo-chemical machining. **8 hrs**

Section - B

4. **Thermal Metal Removal Processes**: Electric Discharge Machining- Mechanism of metal removal; electrode feed control; die electric fluids flushing; selection of electrode material; applications. Plasma Arc Machining- Mechanism of metal removal; PAM parameters; Equipment's for unit; safety precautions and applications. Laser Beam machining- Material removal; limitations and advantages. Hot machining- method of heat; Applications and limitations. Electron-Beam Machining-; Generation and control of electron beam; process capabilities and limitations. **14 hrs**

5. **Hybrid Machining Processes**: Concept; classification; application; Advantages. **6 hrs**

Suggested Readings/Books:

1.Panday P. C. and Shan H. S. ,"*Modern Machining Processes*", Tata McGraw Hill , 33rd Re-print , 2008.
2.Boothroyd G. and Knight W.A., "*Fundamentals of Machining and Machine Tools*", Taylor and Francis, 3rd Edition, 2006.
3.Benedict G.F., "*Non-traditional Manufacturing Processes*", Marcel Dekker Inc., 1987.
4.Jain V.K., "*Advanced Machining Processes*", Allied Publishers, 1stEdition, 2007.
5.Abdel Hassan, El-Hofy Gawad , "*Fundamentals of Machining Processes: Conventional and Nonconventional Processes*", Taylor& Francis, 2014.

Topics for Self Learning (TSL)

1. ***Introduction:*** *Industrial applications of CIM.*
2. ***Advanced Mechanical processes:*** *Action/material removal mechanism with free abrasives*
3. ***Electrochemical and Chemical Removal Processes:*** *Industrial applications of chemical machining.*
4. ***Thermal Metal Removal processes:*** *Surface integrity of thermally processed surfaces.*

DEME-14611 **Non Destructive Testing**

	L	T	P	C
Internal Marks: 40				
External Marks: 60	**4**	**0**	**0**	**4**
Total Marks: 100				

Course Outcomes

After studying this course, students shall be able to:

- Understand and recognize various Non Destructive Testing Methods (NDT) used for testing engineering products.
- Use NDT methods for detecting the flaws in specimen.
- Suggest suitable NDT techniques for engineering products.
- Understand the role and benefit of NDT for improving the quality of product.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 0% - 10% numerical problems.

Detailed Contents

Section - A

1. **Introduction**: Classification of techniques of material testing; Need and Significance of Non Destructive Testing methods; type of Non Destructive testing methods. **4 hrs**
2. **Radiographic Examination**: Radiant energy and radiography; practical applications; X-ray and Gamma –ray equipment; effect of variables on radiographs; requirement of a good radiograph; interpretation of radiograph; safety precautions; Xero -radiography. **10 hrs**

3. **Magnaflux Methods**: Basic principles; scope and applications; magnetic analysis of steel bars and tubing magnetization methods; equipment; inspection medium; preparation of surfaces Fluorescent Penetration inspection; Demagnetization. **12 hrs**

Section - B

4. **Electrical and Ultrasonic Methods**: Basic principles; flaw detection in rails and tubes (Sperry Detector); Ultrasonic testing surface roughness; moisture in wood; Detection of defects in ferrous and non ferrous metals; plastics; ceramics; measurement of thickness; hardness; stiffness; sonic material analyzer; proof tests; concrete test hammer. **8 hrs**
5. **Photo-elasticity**: Concept and applications of Plane and circular polarization; Photo stress; models. **6 hrs**

Suggested Readings/Books:

1. Davies H.E., Troxell G. E. and Hauck G. F. W., "*The Testing of Engg. Materials*", McGraw Hill, 1982.
2. Armstrong W. H., "*Mechanical Inspection*", Literary Licensing, 1st Edition Reprint, 2012.
3. Baldev R., "*Practical Non – Destructive Testing*", Narosa Publishing House, 1997.

Topics for Self Learning (TSL)

1. ***Radiographic Examination****: Process Variants and parameters in Radiographic Testing.*
2. ***Magnaflux methods****: Testing of rolling, casting, forging, extrusion and drawing products.*
3. ***Electrical and ultrasonic Methods****: Advancements in Ultrasonic Testing and its application in Pressure Vessel testing.*

DEME - 14302 **Product Design and Development**

Internal Marks: 40 **L T P C**

External Marks: 60 **4 0 0 4**

Total Marks: 100

Course Outcomes

After studying this course, a student is able to:

- Use basic principles/elements of visual design.
- Understand the concept of color and form in the context of ergonomics.
- Apply and conceptualize the knowledge in product graphics and detailing/fabrication.
- Design and develop the product in effective and innovative ways.

NOTE:

1. In the syllabus, there are topics under the heading **Topics for Self Learning (TSL).** These are the topics to be learnt by the student on their own under the guidance of the course instructors. Course instructors will inform the students about the depth to which TSL components are to be studied. ***The evaluation of TSL will be done in assignments ONLY.***
2. The Question Paper of End Semester Examinations shall contain 0 – 10 % numerical problems.

Detailed Contents

Section - A

1. **Introduction to Product Design:** Definition and Need of Product Design, Design by evolution and innovation, Essential factors of product design, the morphology of design.

Product and market. Product characteristics and economic analysis of product in terms of standardization, simplification and specialization. Challenges faced by industrial designers. **7 hrs**

2. **Aesthetic and Strength Consideration in Design:** Aesthetics and product design: Product Aesthetics Analysis**,** Basic Form Elements, Integrating Basic form. Concepts of size, texture, and colour in Design. Basic principles of graphic design. Balanced Design, Materials and their strength consideration based on Impact, Stiffness and Rigidity. **7 hrs**
3. **Economic and Human Factor Consideration in Design**: Product Costing, Profit and Competiveness, Design for Reliability. Break even analysis, Profit-Volume chart Approach. Economics of a new product design (Samuel Eilon Model). Anthropometry, seating design, displays and controls, man/machine information exchange. Rights and wrongs of control and display design. **9 hrs**

Section - B

4. **Product Development and Optimization:** Role of designer in product development; Manufacturing and economic aspects of product development, Product promotions. Standard fastening and joining details in different materials; Temporary and permanent joints: Detailing for fabricated products in sheet metal and plastic products. Introduction to Different Production Processes, Design for manufacturing and assembling. **9 hrs**
5. **Value Engineering and modern approaches to product design and development:** Define value, nature and measure of value, the value analysis job plan. Problem solving and value analysis. Material and process selection. Concurrent engineering in design. Quality function deployment. **8 hrs**

Suggested Readings/Books:

1. A.K.Chitale, R.C.Gupta, *"Product Design and Manufacturing"*, Prentice-Hall of India, 6th Edition, 2013.

2. Karl T. Ulrich, Steven D. Eppinger, "*Product Design and Development*", McGraw-Hill, 6th Edition, 2013.

3. Kevin Otto & Kristin Wood Product Design: "*Techniques in Reverse Engineering and new Product Development.*" 1 / e 2004 , Pearson Education New.

4. N.L. Svensson, "*Introduction to Engineering Design*", Kensington, N.S.W.: New South Wales University Press, 3rd Revised Edition, 1981.

5. R. Matousek, "*Engineering Design: A Systematic Approach"* Published by Blackie and Son, 1969.

Topics for Self Learning (TSL)

1. ***Introduction to Product Design:*** *Product Life Cycle and need of Redesigning a Product.*
2. ***Aesthetic and Strength Consideration in Design:*** *Design Informative Graphics using principles of graphic design*
3. ***Economic and Human Factor Consideration in Design****: The role of computer in Product Design.*
4. ***Product Development and Optimization:*** *Study the standards related to fastening and joining.*
5. ***Value Engineering and modern approaches to product design and development:*** *Perform a case study on value analysis.*