Semester IV (Second year]
Branch/Course Mechanical Engineering

Semester-4	Code	Course Name	L	T	P	Credits
	PCC-ME 404	Applied Thermodynamics	3	1	2	5
	PCC-ME 405	Fluid Machines	3	1	2	5
	PCC-ME 406	Strength of Materials	3	1	2	5
	PCC-ME407	Manufacturing process	3	1	2	5
	MC-403	Environmental Sciences	3	0	0	0
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PCC-ME 404	Applied Thermodynamics	3L:1T:2P	5 credits

Objectives:

To learn about of I law for reacting systems and heating value of fuels
To learn about gas and vapor cycles and their first law and second law efficiencies

To understand about the properties of dry and wet air and the principles of psychrometry
To learn about gas dynamics of air flow and steam through nozzles
To learn the about reciprocating compressors with and without intercooling
To analyze the performance of steam turbines

Contents:.

Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.**(8)**

Vapor power cycles Rankine cycle with superheat, reheat and regeneration,exergy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Braytoncycle,effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.**(12)**

Properties of dry and wet air,use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. **(4)**

Basicsof compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables

for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle,supersaturation- compressible flow in diffusers, efficiency of nozzle and diffuser. **(8)**

Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. **(5)**

Analysis of steam turbines, velocity and pressure compounding of steam turbines **(3)**

Total number of hours (40 lecture hours + 12 tutorials)

Outcomes:

After completing this course, the students will get a good understanding of various practical power cycles and heat pump cycles.

They will be able to analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors

They will be able to understand phenomena occurring in high speed compressible flows

Text Books:

Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals ofThermodynamics*, John Wiley and Sons.

Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall of India

Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.

Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd

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PCC-ME 302	**Fluid Mechanics** **Fluid Machines**	**3L:1T:2P**	**5 credits**

Objectives:

To learn about the application of mass and momentum conservation laws for fluid flows
To understand the importance of dimensional analysis
To obtain the velocity and pressure variations in various types of simple flows
To analyze the flow in water pumps and turbines.

Contents:

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.**(9)**

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram. **(9)**

Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis. **(6)**

Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle. **(8)**

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of Turbines. **(8)**

Course Outcomes:

Upon completion of this course, students will be able to mathematically analyze simple flow situations

They will be able to evaluate the performance of pumps and turbines.

PCC-ME 406	Strength of Materials	3L:1T:2P	5 credits

Objectives:

To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads

To calculate the elastic deformation occurring in various simple geometries for different types of loading

Contents:

Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle. **(8)**

Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads. **(8)**

Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.**(8)**

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs. (**8)**

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure **(8)**

(Total: 40 lectures + 12 tutorials)

Course Outcomes:

After completing this course, the students should be able to recognise various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components

The students will be able to evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading

Text Books:

Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.

R. Subramanian, Strength of Materials, Oxford University Press, 2007.

Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGrawHill Publishing Co. Ltd., New Delhi 2005.

PCC-ME 407	Manufacturing Processes	3L:0T:2P	5 credits

Objectives:

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods

Contents:

Conventional Manufacturing processes:

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. **(5)**

Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.**(4)**

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.**(8)**

Additive manufacturing: Rapid prototyping and rapid tooling**(3)**

Joining/fastening processes: Physics of welding, brazing and soldering;design considerations in welding,Solid and liquid state joining processes;Adhesive bonding. **(4)**

Unconventional Machining Processes:

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters **(5)**

Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant &maskant, process parameters, MRR and surface finish. **(8)**

Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining **(3)**

Course Outcomes:

Upon completion of this course, students will be able to understand the different conventional and unconventional manufacturing methods employed for making different products

Text Books:

Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014

Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems

Degarmo, Black &Kohser, Materials and Processes in Manufacturing