Course Number	Course Name	L-T-P-Credits	Year of Introduction
ME200	Fluid mechanics and Machinery	3-1-0-4	2016

Prerequisite : Nil

Course Objectives:

- To introduce students, the fundamental concepts related to the mechanics of fluids.
- To understand the basic principles of fluid machines and devices.
- To apply acquired knowledge on real life problems.
- To analyze existing fluid systems and design new fluid systems.

Syllabus

Fundamental Concepts, fluid statics and dynamics, fluid kinematics, boundary layer theory, hydraulic turbines, positive displacement pumps, rotary motion of liquids**,** centrifugal pump, pumping devices.

Expected Outcome

Up on completion of course the students might be in a position to:

i. Analyze flow problems associated with statics, kinematics and dynamics of fluids.
ii. Design and analyze fluid devices such as water turbines and pumps.
iii. Understand and rectify problems faced in practical cases of engineering applications.

Text Book:

1. Modi P. N. and S. M. Seth, *Hydraulics & Fluid Mechanics*, S.B.H Publishers, New Delhi, 2002.
2. Kumar D. S., *Fluid Mechanics and Fluid Power Engineering*, S. K. Kataria & Sons, New Delhi, 1998.

References:

1. J. F. Douglas, “Fluid Mechanics”, Pearson education.
2. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013
3. Robert W. Fox and Mc Donald, “Introduction to fluid dynamics”, John Wiley and sons
4. K. Subrahmanya, “Theory and applications of fluid mechanics”, (TMH)
5. Shames. I. H, “Mechanics of fluids”.
6. Jagadish Lal, “Fluid mechanics and Hydraulic machines”.
7. R K Bansal, “Hydraulic Machines”

Course Plan

Module	Contents	Hours	Sem. exam marks
I	**Fundamental concepts:** Properties of fluid - density, specific weight, viscosity, surface tension, capillarity, vapour pressure, bulk modulus, compressibility, velocity, rate of shear strain, Newton’s law of viscosity, Newtonian and non-Newtonian fluids, real and ideal fluids, incompressible and compressible fluids.	6	15%

II	**Fluid statics:** Atmospheric pressure, gauge pressure and absolute pressure. Pascal's Law, measurement of pressure - piezo meter, manometers, pressure gauges, energies in flowing fluid, head - pressure, dynamic, static and total head, forces on planar and curved surfaces immersed in fluids, centre of pressure, buoyancy, equilibrium of floating bodies, metacentre and metacentric height.	10	15%
First Internal Exam			
III	**Fluid kinematics and dynamics:** Classification of flow -1D, 2D and 3D flow, steady, unsteady, uniform, non-uniform, rotational, irrotational, laminar and turbulent flow, path line, streak line and stream line. Continuity equation, Euler's equation, Bernoulli's equation. Reynolds experiment, Reynold's number. Hagen- Poiseuille equation, head loss due to friction, friction, Darcy- Weisbach equation, Chezy's formula, compounding pipes, branching of pipes, siphon effect, water hammer transmission of power through pipes (simple problems)	8	15%
IV	**Boundary layer theory:** Basic concepts, laminar and turbulent boundary layer, displacement, momentum, energy thickness, drag and lift, separation of boundary layer. Flow rate measurements- venturi and orifice meters, notches and weirs (description only for notches, weirs and meters), practical applications, velocity measurements- Pitot tube and Pitot –static tube.	10	15%
Second Internal Exam			
V	**Hydraulic turbines :** Impact of jets on vanes - flat, curved, stationary and moving vanes - radial flow over vanes. Impulse and Reaction Turbines – Pelton Wheel constructional features - speed ratio, jet ratio & work done , losses and efficiencies, inward and outward flow reaction turbines- Francis turbine constructional features, work done and efficiencies – axial flow turbine (Kaplan) constructional features, work done and efficiencies, draft tubes, surge tanks, cavitation in turbines.	10	20%
VI	**Positive displacement pumps:** reciprocating pump, indicator diagram, air vessels and their purposes, slip, negative slip and work required and efficiency, effect of acceleration and friction on indicator diagram (no derivations), multi cylinder pumps. **Rotary motion of liquids:** – free, forced and spiral vortex flows, (no derivations), centrifugal pump, working principle, impeller, casings, manometric head, work, efficiency and losses, priming, specific speed, multistage pumps, selection of pumps, pump characteristics.	10	20%
End Semester Exam			

Question Paper Pattern

Max. marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME201	MECHANICS OF SOLIDS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To acquaint with the basic concepts of stress and deformation in solids.
2. To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

Syllabus

Analysis of deformable bodies : stress, strain, material behaviour, deformation in axially loaded bars, biaxial and triaxial deformation. Torsion of elastic circular members, design of shafts. Axial force, shear force and bending moment in beams. Stresses in beams: flexure and shear stress formulae, design of beams. Deflection of beams. Transformation equations for plane state of stress and strain, principal planes and stresses, Mohr's circle. Compound stresses: combined axial, flexural and shear loads – eccentric loading. Buckling: Euler's theory and Rankine's formula for columns.

Expected outcomes: At the end of the course students will be able to

1. Understand basic concepts of stress and strain in solids.
2. Determine the stresses in simple structural members such as shafts, beams, columns etc. and apply these results in simple design problems.
3. Determine principal planes and stresses, and apply the results to combined loading case.

Text Books:

1. Rattan, Strength of Materials, 2e McGraw Hill Education India, 2011
2. S.Jose, Sudhi Mary Kurian, Mechanics of Solids, Pentagon, 2015

References Books:

1. S. H. Crandal, N. C. Dhal, T. J. Lardner, An introduction to the Mechanics of Solids, McGraw Hill, 1999
2. R. C. Hibbeler, Mechanics of Materials, Pearson Education,2008
3. I.H. Shames, J. H. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India, 2006
4. James M.Gere, Stephen Timoshenko, Mechanics of Materials, CBS Publishers & Distributors, New Delhi,2012
5. F. Beer, E. R. Johnston, J. T. DeWolf, Mechanics of Materials, Tata McGraw Hill, 2011
6. A. Pytel, F. L. Singer, Strength of Materials, Harper & Row Publishers, New York,1998
7. E. P. Popov, T. A. Balan, Engineering Mechanics of Solids, Pearson Education, 2012
8. R. K. Bansal, Mechanics of solids, Laxmi Publications, 2004
9. P. N. Singh, P. K. Jha, Elementary Mechanics of Solids, Wiley Eastern Limited, 2012

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction to analysis of deformable bodies – internal forces – method of sections – assumptions and limitations. Stress – stresses due to normal, shear and bearing loads – strength design of simple members. Definition of linear and shear strains.	3	15%
	Material behavior – uniaxial tension test – stress-strain diagrams concepts of orthotropy, anisotropy and inelastic behavior – Hooke's law for linearly elastic isotropic material under axial and shear deformation	3	
	Deformation in axially loaded bars – thermal effects – statically indeterminate problems – principle of superposition - elastic strain energy for uniaxial stress.	4	
II	Definition of stress and strain at a point (introduction to stress and strain tensors and its components only) – Poisson's ratio – biaxial and triaxial deformations – Bulk modulus - Relations between elastic	4	15%
	Torsion: Shafts - torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – economic cross-sections – statically indeterminate problems – shaft design for torsional load.	4	
FIRST INTERNAL EXAM			
III	Beams- classification - diagrammatic conventions for supports and loading - axial force, shear force and bending moment in a beam	2	15%
	Shear force and bending moment diagrams by direct approach	3	
	Differential equations between load, shear force and bending moment. Shear force and bending moment diagrams by summation approach – elastic curve – point of inflection.	5	
IV	Stresses in beams: Pure bending – flexure formula for beams assumptions and limitations – section modulus - flexural rigidity - economic sections – beam of uniform strength.	4	15%
	Shearing stress formula for beams – assumptions and limitations – design for flexure and shear.	4	
SECOND INTERNAL EXAM			
V	Deflection of beams: Moment-curvature relation – assumptions and limitations - double integration method – Macaulay's method - superposition techniques – moment area method and conjugate beam ideas for simple cases.	6	20%
	Transformation of stress and strains: Plane state of stress - equations of transformation - principal planes and stresses.	4	
VI	Mohr's circles of stress – plane state of strain – analogy between stress and strain transformation – strain rosettes	3	20%
	Compound stresses: Combined axial, flexural and shear loads – eccentric loading under tension/compression - combined bending and twisting loads.	4	

	Theory of columns: Buckling theory –Euler's formula for long columns – assumptions and limitations – effect of end conditions - slenderness ratio – Rankin's formula for intermediate columns.	3	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME202	ADVANCED MECHANICS OF SOLIDS	3-1-0-4	2016

Prerequisite: ME201 Mechanics of solids

Course Objectives: The main objectives of the course are

1. To impart concepts of stress and strain analyses in a solid.
2. To study the methodologies in theory of elasticity at a basic level.
3. To acquaint with the solution of advanced bending problems.
4. To get familiar with energy methods for solving structural mechanics problems.

Syllabus

Introduction, concepts of stress, equations of equilibrium, strain components, strain-displacement relations, compatibility conditions, constitutive relations, boundary conditions, 2D problems in elasticity, Airy's stress function method, unsymmetrical bending of straight beams, bending of curved beams, shear center, energy methods in elasticity, torsion of non-circular solid shafts, torsion of thin walled tubes.

Expected outcome: At the end of the course students will be able to

1. Apply concepts of stress and strain analyses in solids.
2. Use the procedures in theory of elasticity at a basic level.
3. Solve general bending problems.
4. Apply energy methods in structural mechanics problems.

Text Books:

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill,2008
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill,2008
3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services,2013
4. L. Govindaraju ,TG Sitharaman, Applied elasticity for Engineers, NPTEL
5. U. Saravanan, Advanced Solid Mechanics, NPTEL
6. S. Anil Lal, Advanced Mechanics of Solids, Siva Publications and Distributions, 2017

References Books:

1. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill,1970
2. R.J. Atkin, and N. Fox, An introduction the theory of elasticity, Longman,1980
3. J. P. Den Hartog, Advanced Strength of Materials, McGraw Hill,1987
4. C. K. Wang, Applied Elasticity, McGraw Hill,1983
5. www.solidmechanics.org/contents.htm - Free web book on Applied Mechanics of Solids by A.F. Bower.

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction to stress analysis in elastic solids - stress at a point – stress tensor – stress components in rectangular and polar coordinate systems - Cauchy's equations – stress transformation – principal stresses and planes - hydrostatic and deviatoric stress components, octahedral shear stress - equations of equilibrium	6	15%
	Displacement field – engineering strain - strain tensor *(basics only)* – analogy between stress and strain tensors - strain-displacement relations *(small-strain only)* – compatibility conditions	4	
II	Constitutive equations – generalized Hooke's law – equations for linear elastic isotropic solids - relation among elastic constants – Boundary conditions – St. Venant's principle for end effects – uniqueness theorem	4	15%
	2-D problems in elasticity - Plane stress and plane strain problems – stress compatibility equation - Airy's stress function and equation – polynomial method of solution – solution for bending of a cantilever with an end load	4	
FIRST INTERNAL EXAM			
III	Equations in polar coordinates (2D) – equilibrium equations, strain-displacement relations, Airy's equation, stress function and stress components *(only short derivations for examination)*	3	15%
	Application of stress function to Lame's problem and stress concentration problem of a small hole in a large plate *(only stress distribution)*	3	
	Axisymmetric problems – governing equations – application to thick cylinders,, rotating discs.	4	
IV	Unsymmetrical bending of straight beams *(problems having c/s with one axis of symmetry only)* – curved beams *(rectangular c/s only)* - shear center of thin walled open sections *(c/s with one axis of symmetry only)*	6	15%
	Strain energy of deformation – special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation – strain energy of a bar subjected to axial force, shear force, bending moment and torque	3	
SECOND INTERNAL EXAM			
V	Maxwell reciprocal theorem – Castigliano's first and second theorems – virtual work principle – minimum potential energy theorem.	5	20%

	Torsion of non-circular bars: Saint Venant's theory - solutions for circular and elliptical cross-sections	4	
VI	Prandtl's method - solutions for circular and elliptical cross-sections - membrane analogy.	4	20%
	Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections	6	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3 X10 marks = 30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3 X10 marks = 30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4 X 10 marks = 40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME203	MECHANICS OF FLUIDS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To study the mechanics of fluid motion.
2. To establish fundamental knowledge of basic fluid mechanics and address specific topics relevant to simple applications involving fluids
3. To familiarize students with the relevance of fluid dynamics to many engineering systems

Syllabus

Fluid Properties, Kinematics of fluid flow, Fluid Statics, Dynamics of fluid flow, Flow through pipes, Concept of Boundary Layer, Dimensional Analysis and Hydraulic similitude

Expected outcome: At the end of the course students will be able to

1. Calculate pressure variations in accelerating fluids using Euler's and Bernoulli's equations
2. Become conversant with the concepts of flow measurements and flow through pipes
3. Apply the momentum and energy equations to fluid flow problems.
4. Evaluate head loss in pipes and conduits.
5. Use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity

Text Books:

1. Balachandran.P, Engineering Fluid Mechanics, PHI,2012
2. A S Saleem, Fluid Mechanics, Fathima Books,2016

References Books:

1. Cengel, Fluid Mechanics, McGraw Hill Education India 2014
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005
3. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002
4. Streeter V. L., E. B. Wylie and K. W. Bedford, Fluid Mechanics, Tata McGraw Hill, Delhi, 2010.
5. Joseph Karz, Introductory Fluid Mechanics, Cambridge University press,2010
6. Fox R. W. and A. T. McDonald, Introduction to Fluid dynamics, 5/e, John Wiley and Sons, 2009.
7. Shames I. H, Mechanics of Fluids, McGraw Hill, 1992.
8. White F.M., Fluid Mechanics, 6/e, Tata McGraw Hill, 2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.	8	15%
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines flow nets, uses and limitations,	8	15%
FIRST INTERNAL EXAM			
III	Dynamics of Fluid flow: Fluid Dynamics: Energies in flowing fluid, head, pressure, dynamic, static and total head, Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in rectangular and cylindrical co-ordinates, Bernoulli's equation and its applications: Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-static tube.	10	15%
IV	Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy- Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	12	15%
SECOND INTERNAL EXAM			
V	Concept of Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	10	20%

VI	Dimensional Analysis and Hydraulic similitude: Dimensional analysis, Buckingham's theorem, important dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynold, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME204	THERMAL ENGINEERING	3-1-0-4	2016

Prerequisite: ME205 Thermodynamics

Course Objectives:

1. To acquire knowledge on the working of steam turbines, IC engines and gas turbines
2. To introduce the combustion process in IC engines
3. To understand air pollution from IC engines and its remedies.

Syllabus

Steam engineering, boilers, steam nozzles, steam turbines, internal combustion engines, performance testing of IC Engines, fuels and fuel combustion, air pollution from IC engines and remedies, combustion in I.C. engines, gas turbines

Expected outcome: At the end of the course the students will be able to

1. Integrate the concepts, laws and methodologies from the course in thermodynamics into analysis of cyclic processes
2. To apply the thermodynamic concepts into various thermal application like IC engines, steam turbines, compressors.

Text Books:

1. Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2003
2. R.K Rajput, Thermal Engineering, Laxmi publications,2010

References Books:

1. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002
2. T.D. Eastop and A McConkey, Applied thermodynamics for engineering technology, Pearson education,1996
3. J.B.Heywood, I.C engine fundamentals. McGraw-Hill,2011
4. Gill, P.W., Smith, JR., J.H., and Ziurys, E.J Fundamentals of internal combustion engines Oxford and IBH,1959
5. Rathore**,** Thermal Engineering, McGraw Hill Education India, 2010

Steam Tables

6. R.S.Khurmi, Steam table with Mollier chart,S.Chand,2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Steam engineering- T- S diagram, Mollier chart, Steam cycles- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapor cycle Steam Boilers: Types of boilers –Cochran boiler, Babcock and Wilcox boiler, Benson boiler, La Mont boiler, Loeffler boiler, Velox boiler, Boiler Mountings and Accessories Steam nozzles:-Types of nozzle- Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow	8	15%
II	Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams, work done, efficiency, condition for maximum efficiency, multistage turbines-condition line, stage efficiency. Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines	8	15%
FIRST INTERNAL EXAM			
III	Internal combustion engines: classification of I.C. Engines- four stroke and two stroke I.C. Engines, Comparison of four stroke and two stroke Engine. Wankel Engine, Air standard cycle-Carnot cycle, Otto cycle; Diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles. Stirling and Ericsson cycles, air standard efficiency, specific work output, work ratio, Actual cycle analysis, deviation of actual engine cycle from ideal cycle. Rotary engines, Stratified charge engine , super charging of SI and CI Engines – turbo charging. Variable specific heats.	10	15%
IV	Performance Testing of I C Engines: Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency- mechanical efficiency, volumetric efficiency, thermal efficiency and relative efficiency, Specific fuel consumption. Testing of I C engines- Morse test, Heat balance test and Retardation test Fuels and fuel combustion: flash point and fire point, calorific value, Fuels for SI and CI engine, Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas. Analysis of fuel combustion-A/F ratio, equivalence ratio, minimum quantity of air, flue gas analysis, excess air.	10	15%
SECOND INTERNAL EXAM			
V	Air pollution from I.C. Engine and its remedies**:** Pollutants from S.I. and C.I. Engines, Methods of emission control, alternative fuels for I.C. Engines; the blending of fuels, Bio fuels. Combustion in I.C. Engines: Combustion phenomena in S.I. engines; Ignition limits, stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; theories of detonation, octane rating of fuels;	10	20%

	pre-ignition; S.I. engine combustion chambers. Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.		
VI	Gas turbines: classification, Thermodynamic analysis of gas turbine cycles-open , closed and semi closed cycle; ideal working cycle- Brayton cycle-P-v and T-s diagram, thermal efficiency. Effect of compressor and turbine efficiencies. Optimum pressure ratio for maximum specific work output with and without considering machine efficiencies. Comparison of gas turbine and IC engines, Analysis of open cycle gas turbine, Improvements of the basic gas turbine cycles-regeneration, intercooling and reheating-cycle efficiency and work output-Condition for minimum compressor work and maximum turbine work. Combustion chambers for gas turbines. pressure loss in combustion process and stability loop.	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME205	THERMODYNAMICS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To understand basic thermodynamic principles and laws
2. To develop the skills to analyze and design thermodynamic systems

Syllabus

Basic concepts, zeroth law of thermodynamics and thermometry, energy, first law of thermodynamics, second law of thermodynamics, entropy, irreversibility and availability, third law of thermodynamics pure substances, equations of state, properties of gas mixtures, Introduction to ideal binary solutions, general thermodynamic relationships, combustion thermodynamics

Expected outcome: At the end of the course the students will be able to

1. Understand the laws of thermodynamics and their significance
2. Apply the principles of thermodynamics for the analysis of thermal systems

Text Books

1. P.K.Nag, Engineering Thermodynamics, McGraw Hill,2013
2. E.Rathakrishnan Fundamentals of Engineering Thermodynamics, PHI,2005

References Books:

1 Y. A. Cengel and M. A.Boles,Thermodynamics an Engineering Approach,McGraw Hill, 2011

2 G.VanWylen, R.Sonntag and C.Borgnakke, Fundamentals of Classical Thermodynamics, John Wiley & Sons,2012

3. Holman J.P, Thermodynamics, McGraw Hill, 2004
4. M.Achuthan, Engineering Thermodynamics, PHI,2004

Steam Tables/Data book

5. R.S.Khurmi, Steam table with Mollier chart, S.Chand,2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Role of Thermodynamics in Engineering and Science -- Applications of Thermodynamics Basic Concepts - Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. (Review only- self study) Zeroth Law of Thermodynamics, Measurement of Temperature- Thermometry, reference Points, Temperature Scales, Ideal gas temperature scale, Comparison of thermometers-Gas Thermometers, Thermocouple, Resistance thermometer Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity.	7	15%
II	Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1, First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Transient flow –Filling and Emptying Process. (Problems), Limitations of the First Law.	8	15%
FIRST INTERNAL EXAM			
III	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump - Performance factors, Kelvin-Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, Corollaries of second law, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale. Clausius Inequality, Entropy- Causes of Entropy Change, Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation in open and closed system, Entropy and Disorder, Reversible adiabatic process- isentropic process	10	15%
IV	Available Energy, Availability and Irreversibility- Useful work, Dead state, Availability function, Availability and irreversibility in open and closed systems - Gouy-Stodola theorem , Third law of thermodynamics. Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables.	10	15%
SECOND INTERNAL EXAM			

V	The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances- Vander Waals Equation of State, Berthelot, Dieterici, and Redlich-Kwong equations of state , Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law -Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy, Introduction to real gas mixtures- Kay's rule. *Introduction to ideal binary solutions, Definition of solution, ideal binary solutions and their characteristics, Deviation from ideality, Raoult's Law, Phase diagram, Lever rule(*in this section numerical problems not)	11	20%
VI	General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations, Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve. #Introduction to thermodynamics of chemically reacting systems, Combustion, Thermochemistry – Theoretical and Actual combustion processes- Definition and significance of equivalence ratio, enthalpy of formation , enthalpy of combustion and heating value (#in this section numerical problems not included)	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
Approved steam tables permitted
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME206	FLUID MACHINERY	2-1-0-3	2016

Prerequisite: ME203 Mechanics of Fluids

Course Objectives:

1. To acquire knowledge on hydraulic machines such as pumps and turbines
2. To understand the working of air compressors and do the analysis

Syllabus

Impact of jets, Hydraulic Turbines, Rotary motion of liquids, Rotodynamic pumps, Positive displacement pumps**,** , Compressors

Expected outcome: At the end of the course the students will be able to

1. Discuss the characteristics of centrifugal pump and reciprocating pumps
2. Calculate forces and work done by a jet on fixed or moving plate and curved plates
3. Know the working of turbines and select the type of turbine for an application.
4. Do the analysis of air compressors and select the suitable one for a specific application

Text Books:

1. Som, Introduction to Fluid Mechanics and Fluid Machines ,McGraw Hill Education India 2011
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications,2005.

Reference Books:

1. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013
2. Yahya S. M, Fans, Blower and Compressor, Tata McGraw Hill, 2005.
3. Shepherd D. G, Principles of Turbo Machinery, Macmillan, 1969.
4. Stepanoff A. J, Centrifugal and Axial Flow Pumps, John Wiley & Sons, 1991.
5. Rajput R. K, Fluid Mechanics and Hydraulic Machines, S. Chand & Co.,2006.
6. Subramanya, Fluid mechanics and hydraulic machines, 1e McGraw Hill Education India,2010

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Impact of jets: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve),– Series of vanes - work done and efficiency Hydraulic Turbines : Impulse and Reaction Turbines – Degree of reaction – Pelton Wheel – Constructional features - Velocity triangles – Euler's equation – Speed ratio, jet ratio and work done , losses and efficiencies, design of Pelton wheel – Inward and outward flow reaction turbines- Francis Turbine – Constructional features – Velocity triangles, work done and efficiencies.	7	15%
II	Axial flow turbine (Kaplan) Constructional features – Velocity triangles- work done and efficiencies – Characteristic curves of turbines – theory of draft tubes – surge tanks – Cavitation in turbines – Governing of turbines – Specific speed of turbine , Type Number– Characteristic curves, scale Laws – Unit speed – Unit discharge and unit power.	7	15%
FIRST INTERNAL EXAM			
III	Rotary motion of liquids – free, forced and spiral vortex flows Rotodynamic pumps- centrifugal pump impeller types,-velocity triangles-manometric head- work, efficiency and losses, H-Q characteristic, typical flow system characteristics, operating point of a pump. Cavitation in centrifugal pumps- NPSH required and available- Type number-Pumps in series and parallel operations. Performance characteristics- Specific speed-Shape numbers – Impeller shapes based on shape numbers.	7	15%
IV	Positive displacement pumps- reciprocating pump – Single acting and double acting- slip, negative slip and work required and efficiency- indicator diagram- acceleration head - effect of acceleration and friction on indicator diagram – speed calculation- Air vessels and their purposes, saving in work done to air vessels multi cylinder pumps. Multistage pumps-selection of pumps-pumping devices-hydraulic ram, Accumulator, Intensifier, Jet pumps, gear pumps, vane pump and lobe pump.	7	15%
SECOND INTERNAL EXAM			
V	Compressors: classification of compressors, reciprocating compressor-single stage compressor, equation for work with and without clearance volume, efficiencies, multistage compressor, intercooler, free air delivered (FAD)	7	20%
VI	Centrifugal compressor-working, velocity diagram, work done, power required, width of blades of impeller and diffuser, isentropic efficiency, slip factor and pressure coefficient, surging and chocking. Axial flow compressors:- working, velocity diagram, degree of reaction, performance. Roots blower, vane compressor, screw compressor.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME207	THERMAL ENGINEERING-I	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

- To impart the basic knowledge of the properties of steam and its application.
- To give knowledge on the analysis of air compressors and gas turbines
- To provide ideas on modes of heat transfer and heat transfer equations

Syllabus

Review of Thermodynamic laws and corollaries- Thermodynamic relations -Steam Engineering- Rankine cycle, steam boilers, steam nozzle, steam turbines-Air compressors- Gas turbines- Heat transfer – rate equations – laws of radiation heat transfer..

Expected outcome .

At the end of the course the students will be able to

i. Integrate the concepts, laws and methodologies of thermodynamics in the analysis of cyclic processes

ii. Apply the thermodynamic concepts in applications like Steam Turbines, Compressors, Gas turbines.

Text Books:

1. Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2003
2. R.K Rajput, Thermal Engineering, Laxmi publications,2013
3. Rathore**,** Thermal Engineering 1e, McGraw Hill Education India, 2010
4. Ballaney P.L, Thermal Engg, Khanna Publishers, 2007

Data Book (Approved for use in the examination): Steam Tables

References:

1. Kearton WJ, Steam turbines theory and practice- A text book for engineering students, Aristophanes press, 2011
2. Cohen, Rogers and Saravanamuttoo, Gas turbine Theory, Longman, 1996.
3. Nag P K, Thermodynamics, Tata McGrawhill, 2011

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Review of thermodynamic laws and corollaries: Transient flow analysis, second law of thermodynamics, Availability and unavailability. Thermodynamic relations.	8	15%
II	Steam engineering- Entropy of steam, temperature-entropy diagram, Rankine cycle, modified Rankine cycle, Improvement in steam cycles, binary vapour cycle, Steam condensers.	8	15%
	FIRST INTERNAL EXAMINATION		
III	Steam boilers- Working of high pressure boilers- Babcock and Wilcox boiler, Benson boiler. Steam turbines – different types,	10	15%

	velocity diagrams, condition for maximum efficiency, Cycles with reheating and regenerative heating. Steam nozzle- Flow through steam nozzles, super saturated flows.		
IV	Compressors- reciprocating air compressors- work done and efficiency, volumetric efficiency, effect of clearance, Rotary compressors, centrifugal and axial compressors.	10	15%
SECOND INTERNAL EXAMINATION			
V	Gas turbines-open and closed cycles. Ideal gas turbine cycle, compressor and turbine efficiencies, simple cycle with regeneration, intercooling and reheating.	10	20%
VI	Heat transfer- Different modes of heat transfer, Derivation of heat transfer equations for all modes of heat transfer (Fourier law, Newtons law of cooling, Planck's law, Kirchoff's law, Wiens displacement law and Stefan Boltzmanns law)- Simple problems.	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Time: 3 hours

The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME209	MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

- To know about different materials, their structure and property relationships
- To study about crystalline and amorphous materials, crystal defects, grain size, strengthening mechanisms, alloying, phase diagrams and heat treatment of metals
- To enable students to understand about the behavior of materials for engineering applications and select the materials for various engineering applications.
- To understand the causes behind fracture and various failure mechanisms

Syllabus:

Crystallography- imperfections- Mechanical properties- plastic deformation- fracture- fatigue- creep- crystallization- diffusion- phase diagrams- heat treatment – strengthening mechanisms- hot and cold working –ferrous and non ferrous alloys.

Expected outcome .

The students will

i. understand crystal structure and various imperfections in materials.
ii. acquire a knowledge about alloying and phase diagrams
iii. know the relationship between structure, properties, processing and performance of metals.
iv. study about various fracture and failure mechanisms in structural components.
v. be able to select materials for specific applications.

Text Books:

- Raghavan V, Material Science and Engineering, Prentice Hall,2004

References:

1. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
2. Callister William. D., Material Science and Engineering, John Wiley,2014
3. Dieter George E, Mechanical Metallurgy, Tata McGraw Hill,1976
4. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998
5. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
6. Van Vlack -Elements of Material Science - Addison Wesley,1989
7. Askland and Phule- The Science and Engineering of Materials, Thompson publishers, 2007
8. Anderson J.C. *et.al*., Material Science for Engineers, Chapman and Hall,1990
9. Clark and Varney,Physical metallurgy for Engineers, Van Nostrand,1964
10. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009
11. http://nptel.ac.in/courses/113106032/1
12. http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2
13. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/
14. http://www.msm.cam.ac.uk/teaching/partIA.php

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	**Introduction**: Material science. Materials ad types of materials: metals, polymers, ceramics, composites, and electronic materials. **Crystal structures and geometry**: Crystal lattices and the unit cell. Principal metallic crystal structures: the body-centered cubic, the face-centered cubic, and the hexagonal close-packed structures. Miller's indices of planes and directions in the cubic system. Atomic packing. Density calculation. Planar and linear atomic densities. Polymorphism. **Crystal imperfections**: Point defects, solid solutions, vacancies and interstitialcies, line defects (dislocations), Burger's vector, edge and screw dislocations. Grain boundaries and grain size.	9	15%
II	**Stresses, strains and Mechanical testing**: Normal and shear stresses. Elastic and plastic deformation. The tensile test and the engineering stress-strain diagrams. Young's modulus, the yield strength, the ultimate tensile strength, the percent elongation and percent reduction in area. True stress and true strain. Compression testing, Hardness and hardness testing. Plastic deformation in single crystals. The slip mechanism and dislocations. Slip systems and the critical resolved shear stress. Schmidt's law. Twinning. Effects of plastic deformation on the microstructure and mechanical properties of metals. Cold work and strain hardening. **Mechanism of crystallization:** Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity. Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems.	9	15%
FIRST INTERNAL EXAMINATION			
III	Strengthening by solid solutions, cold-working. Recovery, recrystallization and grain growth. **Fracture of metals**. Ductile and brittle fracture. Toughness and impact testing. Fracture toughness. Ductile to brittle transition temperature **(DBTT)** in steels and structural changes during DBTT. **Fatigue of metals**. The S/N diagram. Mechanisms of fatigue. Stress raisers and stress concentration. Initiation and growth of fatigue cracks. Factors affecting fatigue behavior of metals. **Creep and stress rupture in metals**. Stages of creep. Effect of stress and temperature on creep behavior. Creep mechanisms, The Larsen-Miller parameter. Stress relaxation.	9	15%

	Diffusion : Atomic diffusion and diffusion mechanisms. Substitutional and interstitial diffusion. Steady state diffusion and Fick's first law. Transient diffusion and Fick's second law. Effect of temperature on diffusion rate. Industrial applications of diffusion.		
IV	**Phase diagrams of pure substances** (Unary systems). Gibb's phase rule of heterogeneous equilibrium. Binary Systems: Systems with unlimited solid solubility (isomorphous). The lever rule. Binary eutectic systems with no solid solubility and eutectic systems with limited solid solubility. Systems with compound and intermediate phases. Systems with peritectics. The invariant reactions, eutectics (and eutectoids) and peritectics (and peritectoids). Applications to typical binary phase diagrams. Copper-Zinc diagram and the Aluminum-Copper diagram. The Iron-iron carbide equilibrium diagram	11	15%
SECOND INTERNAL EXAMINATION			
V	**Heat treatment of eutectoid steel**: The eutectoid reaction in the iron-iron carbide system. The isothermal decomposition of austenite. The T.T.T. diagram. Formation pearlite and bainite. Decomposition of austenite on continuous cooling. Formation of martensite and the martensite lines. The structure of martensite. Annealing, quench hardening, and austempering. The hardness of martensite. Tempering of martensite. Heat treatment of noneutectoid plain carbon steel. T.T.T. diagrams of alloy steels. Hardenability of steel and the end-quench test. The process of precipitation (or Age) hardening and its application to the aluminum-copper alloys. Solution treatment, quenching and aging. Artificial (or forced) aging and over-aging. S**urface hardening methods**:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	11	20%
VI	**Alloy steels**:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties Nickel steels, Chromium steels etc. - Enhancement of **steel properties** by **adding alloying elements:** - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead. **High speed steels:-** Mo and W types, effect of different alloying elements in HSS	7	20%

	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications. **Principal Non ferrous Alloys: -** Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.		
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Time: 3 hours

The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME210	METALLURGY AND MATERIALS ENGINEERING	3-0-0-3	2016

Prerequisite: nil

Course Objectives:

1. To provide fundamental science relevant to materials
2. To provide physical concepts of atomic radius, atomic structure, chemical bonds, crystalline and non-crystalline materials and defects of crystal structures, grain size, strengthening mechanisms, heat treatment of metals with mechanical properties and changes in structure
3. To enable students to be more aware of the behavior of materials in engineering applications and select the materials for various engineering applications.
4. To understand the causes behind metal failure and deformation
5. To determine properties of unknown materials and develop an awareness to apply this knowledge in material design.

Syllabus:-Chemical bonds – crystallography- imperfections- crystallization- diffusion- phase diagrams-heat treatment – strengthening mechanisms- hot and cold working – alloying- ferrous and non ferrous alloys- fatigue-creep- basics, need, properties and applications of modern engineering materials.

Expected outcome: At the end of the course students will be able to

1. Identify the crystal structures of metallic materials.
2. Analyze the binary phase diagrams of alloys Fe-Fe_3C, etc.
3. Correlate the microstructure with properties, processing and performance of metals.
4. Recognize the failure of metals with structural change.
5. Select materials for design and construction.
6. Apply core concepts in materials science to solve engineering problems.

Text Books

1. Raghavan V, Material Science and Engineering, Prentice Hall,2004
2. Jose S and Mathew E V, Metallurgy and Materials Science, Pentagon, 2011

Reference

1 Anderson J.C. *et.al*., Material Science for Engineers,Chapman and Hall,1990
2 Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964
3. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009
4. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
5. Callister William. D., Material Science and Engineering, John Wiley,2014
6. Dieter George E, Mechanical Metallurgy,Tata McGraw Hill,1976
7. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998
8. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
9. Van Vlack -Elements of Material Science - Addison Wesley,1989
10. http://nptel.ac.in/courses/113106032/1
11. http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2
12. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-

solid-state-chemistry-fall-2010/syllabus/
13. http://www.msm.cam.ac.uk/teaching/partIA.php

Course Plan

Module	Contents	Hours	Semester Exam. Marks
I	Earlier and present development of atomic structure; attributes of ionization energy and conductivity, electronegativity and alloying; correlation of atomic radius to strength; electron configurations; electronic repulsion Primary bonds: - characteristics of covalent, ionic and metallic bond: attributes of bond energy, cohesive force, density, directional and non-directional and ductility. properties based on atomic bonding:- attributes of deeper energy well and shallow energy well to melting temperature, coefficient of thermal expansion - attributes of modulus of elasticity in metal cutting process -Secondary bonds:- classification- hydrogen bond and anomalous behavior of ice float on water, application- atomic mass unit and specific heat, application. *(brief review only, no University questions and internal assessment from these portions).*	2	**15%**
	Crystallography:- Crystal, space lattice, unit cell- BCC, FCC, HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties.	1	
	Coordination number and radius ratio; theoretical density; simple problems - Polymorphism and allotropy.	1	
	Miller Indices: - crystal plane and direction *(brief review)* - Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC - Modes of plastic deformation: - Slip and twinning.	1	
	Schmid's law, equation, critical resolved shear stress, correlation of slip system with plastic deformation in metals and applications.	1	
II	Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity.	1	**15%**
	Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems	1	
	Classification of crystal imperfections: - types of dislocation – effect of point defects on mechanical properties - forest of dislocation, role of surface defects on crack initiation.	1	

	Burgers vector –dislocation source, significance of Frank Read source in metals deformation - Correlation of dislocation density with strength and nano concept, applications.	1	
	Significance high and low angle grain boundaries on dislocation – driving force for grain growth and applications during heat treatment.	1	
	Polishing and etching to determine the microstructure and grain size.	1	
	Fundamentals and crystal structure determination by X – ray diffraction, simple problems –SEM and TEM.	1	
	Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	1	
	FIRST INTERNAL EXAMINATION		
III	Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery`s rule - equilibrium diagram of common types of binary systems: five types.	2	**15%**
	Coring - lever rule and Gibb`s phase rule - Reactions: - monotectic, eutectic, eutectoid, peritectic, peritectoid.	1	
	Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite transformation, bainite, spheroidite etc.	1	
	Heat treatment: - Definition and necessity – TTT for a eutectoid iron–carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.	1	
	Tempering:- austermpering, martempering and ausforming - Comparative study on ductility and strength with structure of pearlite, bainite, spherodite, martensite, tempered martensite and ausforming.	1	
	Hardenability, Jominy end quench test, applications- Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	2	

	Types of Strengthening mechanisms: - work hardening, equation - precipitation strengthening and over ageing- dispersion hardening.	1	
	Cold working: Detailed discussion on strain hardening; recovery; re-rystallization, effect of stored energy; re-crystallization temperature - hot working Bauschinger effect and attributes in metal forming.	1	**15%**
	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties	1	
IV	Nickel steels, Chromium steels etc. - Enhancement of steel properties by adding alloying elements: - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead.	1	
	High speed steels:- Mo and W types, effect of different alloying elements in HSS	1	
	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications.	1	**15%**
	Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.	1	
	SECOND INTERNAL EXAMINATION		
	Fatigue: - Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, fatigue tests, S-N curve.	1	
	Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress.	1	
V	Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting	1	**20%**
	Fracture: – Brittle and ductile fracture – Griffith theory of brittle fracture – Stress concentration, stress raiser – Effect of plastic deformation on crack propagation.	1	
	transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging, applications - Mechanism of fatigue failure.	1	

	Structural features of fatigue: - crack initiation, growth, propagation - Fracture toughness (definition only) - Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT, applications.	1	
V1	Creep: - Creep curves – creep tests - Structural change:- deformation by slip, sub-grain formation, grain boundary sliding	1	**20%**
	Mechanism of creep deformation - threshold for creep, prevention against creep - Super plasticity: need and applications	1	
	Composites:- Need of development of composites - geometrical and spatial Characteristics of particles – classification - fiber phase: - characteristics, classifications - matrix phase:- functions – only need and characteristics of PMC, MMC, and CMC – applications of composites: aircraft applications, aerospace equipment and instrument structure, industrial applications of composites, marine applications, composites in the sporting goods industry, composite biomaterials..	2	
	Modern engineering materials: - only fundamentals, need, properties and applications of, intermetallics, maraging steel, super alloys, Titanium – introduction to nuclear materials, smart materials and bio materials.	2	
	Ceramics:-coordination number and radius ratios- AX, A_mX_p, $A_mB_mX_p$ type structures – applications.	1	

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
ME211	MECHANICS OF SOLIDS AND MECHANICS OF MACHINES	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To introduce various behavior of structural components under various loading conditions
- To impart the basics of machines and mechanisms.

Syllabus

Definition of stress, strain and their relations -Mechanisms –Cam -Spur gear –Gear trains- Sliding and Rolling Friction –friction drives - Applied and Constrained Forces - Dynamic force analysis – Balancing - Vibration

Expected outcome.

The student will be able to

i. understand the principles in the formation of mechanisms and their kinematics.
ii. understand the effect of friction in different machine elements.
iii. analyse the forces and toques acting on simple mechanical systems
iv. understand the importance of balancing and vibration.

Text Books:

1. Ambekar A.G., “Mechanism and Machine Theory” Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., “Theory of Machines and Mechanisms”, Oxford University Press, 2003
3. 4. R.S.Khurmi, J.K.Gupta, “Theory of Machines” S.Chand Publications.

References:

1.Martin, J.W., "Engineering Materials, Their properties and Applications", Wykedham Publications (London) Ltd., 1987.
2. Van Vlack.L.H., "Materials Science for Engineers", Addison Wesley, 1985.
3.Thomas Bevan, “Theory of Machines”, CBS Publishers and Distributors, 1984.
4.Ghosh.A, and A.K.Mallick, “Theory and Machine”, Affiliated East-West Pvt. Ltd., New Delhi, 1988.
5.Rao.J.S. and Dukkipatti R.V. “Mechanisms and Machines”, Wiley-Eastern Ltd., New Delhi, 1992.
6.Ramamurthi. V, "Mechanisms of Machine", Narosa Publishing House, 2002
7. Robert L. Norton, "Design of Machinery", McGraw-Hill, 2004.
8. Titterton.G.,”Aircraft Materials and Processes", V Edition, Pitman Publishing Co., 1995.

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	Definition of stress, strain and their relations relations between material constants – axial loading	4	15%
	statically determinate and indeterminate problems in tension & compression -plane truss analysis	4	
	Method of joints – method of sections – 3-D trusses – thermal stresses – impact loading.	4	

II	Mechanisms – Terminology and definitions	2	15%
	kinematics inversions of 4 bar and slider crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons	4	
	Analytical methods– computer approach.	2	
FIRST INTERNAL EXAMINATION			
III	Cams – classifications – displacement diagrams - layout of plate cam profiles– derivatives of follower motion – circular arc and tangent cams.	3	15%
	Spur gear – law of toothed gearing – involute gearing – Interchangeable gears	3	
	Gear tooth action interference and undercutting – nonstandard teeth	2	
IV	Gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.	2	15%
	Sliding and Rolling Friction angle – friction in threads	2	
	Friction Drives – Friction clutches – Belt and rope drives – brakes – Tractive resistance.	3	
SECOND INTERNAL EXAMINATION			
V	Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members - Static Force analysis in simple machine members	4	20%
	Dynamic Force Analysis –Inertia Forces and Inertia Torque	3	
	D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members.	3	
VI	Static and Dynamic balancing – Balancing of revolving and reciprocating masses- Balancing machines	4	20%
	Free vibrations – Equations of motion – natural Frequency	3	
	Damped Vibration – critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation.	4	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100, Exam duration: 3 hrs

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME212	FLUID MECHANICS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

- To establish fundamental knowledge of basic fluid mechanics and address specific topics relevant to simple applications involving fluids
- To familiarize students with the relevance of fluid dynamics to many engineering systems

Syllabus

Fluid Properties, Kinematics of fluid flow, Fluid Statics, Dynamics of fluid flow, Flow through pipes, Concept of Boundary Layer, Dimensional Analysis and Hydraulic similitude

Expected outcome

At the end of the course students will

i. Become conversant with the concepts of flow measurements and flow through pipes
ii. Be able to apply the momentum and energy equations to fluid flow problems.
iii. Be able to evaluate head loss in pipes and conduits.
iv. Be able to use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity

Text Books:

1. Balachandran.P, Engineering Fluid Mechanics, PHI,2012
2. A S Saleem, Fluid Mechanics, Fathima Books,2016

References:

1. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005
2. Cengel, Fluid Mechanics, McGraw Hill Education India 2014
3. Fox R. W. and A. T. McDonald, Introduction to Fluid dynamics, 5/e, John Wiley and Sons, 2009.
4. Joseph Karz, Introductory Fluid Mechanics, Cambridge University press,2010
5. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002 . Streeter V. L., E. B. Wylie and K. W. Bedford, Fluid Mechanics, Tata McGraw Hill, Delhi, 2010.
6. Shames I. H, Mechanics of Fluids, McGraw Hill, 1992.
7. White F.M., Fluid Mechanics, 6/e, Tata McGraw Hill, 2008

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure	8	15%
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational	8	15%

	flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines flow nets, uses and limitations		
FIRST INTERNAL EXAMINATION			
III	Dynamics of Fluid flow: Fluid Dynamics: Energies in flowing fluid, head, pressure, dynamic, static and total head, Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in rectangular and cylindrical co-ordinates, Bernoulli's equation and its applications: Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients,	9	15%
IV	Pipe Flow: Viscous flow: Reynolds experiment, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy- Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	10	15%
SECOND INTERNAL EXAMINATION			
V	Concept of Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von-Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	10	20%
VI	Dimensional Analysis and Hydraulic similitude: Dimensional analysis, Buckingham's theorem, important dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynold, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100, Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
ME213	THEORY OF MACHINES	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To understand the layout of linkages in the assembly of a system/machine.
- To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism.
- To analyse the motion resulting from a specified set of linkages in a mechanism.
- To study the application of friction in different devices.
- To study the power transmission devices.
- To study the use of gyroscopic couples.
- To understand the principles in mechanisms used for governing of machines.

Syllabus

Kinematics – velocity and acceleration- Friction – Brakes – Gear – Cams- Gyroscope - Flywheel Governors- Static and dynamic balancing - Vibration

Expected outcome.

- After this programme, students are expected to have a thorough understanding of different mechanisms and theories which will help in optimising design of machines and equipments and also to solve practical problems in the area of machines and mechanisms.

Text Book:

1. P L Ballaney, Theory of Machines and Mechanisms, Khanna Publishers
2. S S. Rattan-Theory of machines, McGraw Hill

References:

1. Bevan, Theory of Machines, Pearson Education, 1986
2. Rao J S and Dukkipati R V, Mechanism and Machine Theory, Wiley EasternLtd.
3. Malhotra, D.R and Gupta, H C, Theory of Machines, Satya Prakasam Tech. India Publications Ltd.
4. Gosh A and Mallick A K, Theory of Machines and Mechanisms, Affiliated East West Press .
5. Shigley J E. and Uicker J J, Theory of Machines and Mechanisms, McGraw–Hill.

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	Kinematics - links, mechanism, Degrees of freedom, Grashoff's law, four-bar chain, Slider crank chain, inversions and practical applications. Velocity and acceleration diagrams of simple mechanisms. Coriolis acceleration (Theory only). Friction - Pressure and wear theories, pivot and collar friction, Single and multiple disc clutches.	7	15%
II	Brakes - block and band brakes, self energizing and self-locking in braking. Gear – Different types of gears- Nomenclature of spur and helical gears, Law of gearing, Gear trains - Simple, compound gear trains and epicyclic gear	7	15%

	trains.		
FIRST INTERNAL EXAMINATION			
III	Cams - types of cams, cam profiles for knife edged and roller followers with and without offsets for SHM, constant acceleration-deceleration, constant velocity and cycloidal motion	7	15%
IV	Gyroscope –Gyroscopic torque, gyroscopic stabilization of ships and aeroplanes. Flywheel - Turning moment diagrams, fluctuation of energy.	7	15%
SECOND INTERNAL EXAMINATION			
V	Governors - types of governors, simple watt governor - Porter, Proell governors-. Isochronisms, hunting, sensitivity and stability. Hartnell governor(Theory only). Static and dynamic balancing of rotating mass- Single and several masses in different planes, balancing of reciprocating mass, Dynamic analysis of slider crank mechanism(Theory only).	7	20%
VI	Vibration - kinematics of vibrating motion, vibration systems having single degree of freedom, free and force vibration, damped vibration. Torsional vibrations -Transverse vibration. whirling of shaft (Theory only).	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Time: 3 hours

The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME214	Theory of Machines	4-0-0-4	2016

Prerequisite : Nil

Course Objectives

- To impart basic knowledge on kinematics of mechanisms and machines.
- To understand kinematic synthesis of mechanisms.
- To analyse the motion resulting from a specified set of linkages in a mechanism.
- To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism.
- To study the application of friction in different devices.
- To study the power transmission devices

Syllabus

Kinematics – velocity and acceleration- Friction – Brakes – Gear – Cams- Gyroscope - Flywheel Governors- Static and dynamic balancing - Vibration

Expected outcome.

- After the course, students will understand the various aspects of mechanisms and machines and will be able to solve design problems in the area of mechanisms and machines.

Text Books

1. P L Ballaney, Theory of Machines and Mechanisms, Khanna Publishers
2. S S. Rattan-Theory of machines, McGraw Hill

References:

1. J. E. Shigley and J.J Uicker, Theory of Machines and Mechanisms, McGraw–Hill.
2. T. Bevan T., Theory of Machines- A Text Book for Engineering Students, Pearson.
3. Wilson C. E. and J. P. Sadler, Kinematics and Dynamics of Machinery, Pearson.
4. Ambekar A. G., Mechanism and Machine Theory, PHI Learning.
5. Gosh A. and A. K. Mallick, Theory of Machines and Mechanisms, Affiliated East West Press.
6. V.P. Singh, Theory of machines, Dhanpat Rai.

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	Kinematics - links, mechanism, Degrees of freedom, Grashoff's law, four-bar chain, Slider crank chain, inversions and practical applications. Automobile steering mechanisms: Davis and Ackermann steering mechanisms. Velocity and acceleration diagrams of simple mechanisms. Coriolis acceleration (Theory only). Friction - Pressure and wear theories, pivot and collar friction, Single and multiple disc clutches..	10	15%

II	Brakes - block and band brakes, self energizing and self-locking in braking. Gear – Different types of gears- Nomenclature of spur and helical gears, Law of gearing, Gear trains - Simple, compound gear trains and epicyclic gear trains.	9	15%
FIRST INTERNAL EXAMINATION			
III	Cams - types of cams, cam profiles for knife edged and roller followers with and without offsets for SHM, constant acceleration-deceleration, constant velocity and cycloidal motion.	8	15%
IV	Gyroscope –Gyroscopic torque, gyroscopic stabilization of ships and aeroplanes. Flywheel - Turning moment diagrams, fluctuation of energy.	8	15%
SECOND INTERNAL EXAMINATION			
V	Governors - types of governors, simple watt governor - Porter, Proell governors-. Isochronisms, hunting, sensitivity and stability. Hartnell governor. Static and dynamic balancing of rotating mass- Single and several masses in different planes, balancing of reciprocating mass, Dynamic analysis of slider crank mechanism.	10	20%
VI	Vibration - kinematics of vibrating motion, vibration systems having single degree of freedom, free and force vibration, damped vibration. Torsional vibrations -Transverse vibration. whirling of shaft (Description only).	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100, Exam duration: 3 hrs

The question paper shall consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME216	MECHANICAL TECHNOLOGY	4-0-0-4	2016

Prerequisite : Nil

Course Objective

The main objectives of this course are

- To make the students aware of the area of heat transfer and allied fields.
- To give students knowledge of mechanical power generation devices and its applications
- To impart knowledge of low temperature and its applications.
- To analyse the aspects of engineering problems solvable by applying the subject.

Syllabus

Heat transfer - Field of application- Modes of heat transfer- conduction, convection and radiation. Combined conduction and convection. Buckingham's Pi theorem and its application. Heat exchangers- Parallel flow and counter flow heat exchangers - I C Engines- mean effective pressure– Brake power, Indicated power, efficiencies. Performance test- Morse test – Retardation test – Heat balance test. Gas turbine – open and closed cycles – thermodynamics cycles. Compressors - Classifications- reciprocating compressor- Introduction to Rotary compressors, Roots blowers and vane compressors. Principles of refrigeration-unit of refrigeration- Vapour compression system, Vapour Absorption refrigeration. Air conditioning – Psychrometry- Summer and Winter Air conditioning Window type Air conditioning system

Expected Outcome

After successful completion of the course, the student will be able to

(i) identify heat transfer equipment and the theory behind them.

(ii) understand working principles and performances of I C engines, which leads him to know more about automobiles and to search for improved performances.

(iii) understand the working of different type of compressors.

(iv) know the principles and working of refrigerators and air conditioning equipments.

References

1. Rajput R K, Heat and Mass Transfer, S. Chand publishing., 2015. ,
2. Eastop T. D. and A. McConkay, Applied Thermodynamics , Pearson Education, 5th Ed
3. Thermal Engineering, Ballaney P. L., Khanna publishers, 1994. ,
4. Arora C. P., Refrigeration and Air conditioning, Tata McGraw Hill, 2000
5. Sachdeva R. C., Fundamentals of Engineering Heat and Mass Transfer, New Age Science Ltd., 2009.
6. Rajput R. K., Thermal Engineering, Laxmi Publications, 2010.

Course Plan			
Module	Contents	Hours	Sem. exam marks
I	Heat transfer - Field of application- Modes of heat transfer- Conduction- Fourier law of heat conduction, heat flux and thermal conductivity-Factors affecting conductivity- General Heat Conduction Equation in Cartesian Coordinate- thermal diffusivity, One-dimensional steady state conduction through plane walls, hollow cylinders, hollow spheres and their composites with constant conductivity- thermal resistance and equivalent thermal resistance. Transient heat conduction- lumped heat capacity method. Critical radius of insulation and its significance	9	15%
II	Convection - classification-Newton law of cooling, heat transfer coefficient, laminar and turbulent flow. Dimensionless numbers and its significance. Buckingham's Pi theorem and its application to Natural and forced convection heat transfer. Combined conduction and convection-overall heat transfer coefficient, Critical radius of insulation and its significances. Heat exchangers - Classifications- temperatures variation in Parallel flow, counter flow HE- Analysis of Heat Exchangers – Derivation of LMTD and simple problems with NTU method.	6 5	15%
First Internal Exam			
III	Radiation heat transfer - Basic theory of radiation-Spectrum of electromagnetic radiation, Reflection, Absorption and Transmission of radiation - absorptivity, reflectivity and transmissivity-Monochromatic radiation-Laws of radiations- Stefan Boltzman law, Planck's law, Kirchoff's law and Wien's displacement law, Total emissive power-. Black body, Grey body and emissivity Heat exchange between non black bodies- surface and shape resistances- electrical network analogy- heat transfer between parallel surfaces – radiation shields. Simple problems	4 6	15%
IV	I C Engines – Classification - two-stroke and four stroke engines(Working), theoretical and actual working cycles– SI and CI engines – mean effective pressure– Brake power , Indicated power, efficiencies. Performance test- Morse test – Retardation test – Heat balance test. Combustion phenomena in SI and CI engines- detonation, knocking and alternate fuels.	5 4	15%

Second Internal Exam			
V	Gas turbine – open and closed cycles – thermodynamics cycles – regeneration – reheating – intercooling – efficiency and performance of gas turbines . Compressors - Classifications- reciprocating compressor-p-v diagram, work done, effect of Clearance, efficiencies, volumetric efficiency and free air delivered (FAD), two stage compressions, optimum pressure ratio, effect of intercooling. Introduction to rotary compressors, Roots blowers and vane compressors	4 4	20%
VI	Principles of refrigeration-unit of refrigeration - capacity - Coefficient of Performance – reversed Carnot cycle , Bell-Coleman cycle-Vapour compression system-thermodynamic analysis on T-S diagram and p-h diagram-refrigerants - thermodynamic, physical and chemical properties of refrigerants - selection criteria of refrigerants –designation of refrigerants, eco friendly refrigerants Vapour Absorption refrigeration – Layout Ammonia –water system and Electrolux system. Air conditioning – Psychrometry - basic definitions, psychometric chart, psychometric processes - human comfort - comfort chart and limitations (brief discussion only) Summer and Winter Air conditioning Window type Air conditioning system	5 4	20%
End Semester Exam			

Question Paper Pattern

Max. marks: 100, Time: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME218	ELEMENTS OF MACHINE DESIGN	3-1-0-4	2016

Prerequisite : ME213 Theory of machines

Course Objectives:

- To develop an ability to design a system to meet the desired needs by choosing proper machine elements and mechanisms within the realistic constraints

Syllabus:

Introduction to design – design process – material behaviour – stress and strain – stress concentration - theories of failure - Welded joints – Design of keys and cotters-Design of Shaft couplings–Design of Bearing- Design of Gears-Design of Shafts

Expected outcome .

- After completion of this course, students are expected to have an understanding of the design of various machine elements. They will be able to select appropriate mechanisms.

Data Book (Approved for use in the examination):

1. P.S.G., Tech., Machine Design Data Handbook
2. K. Mahadevan , Design data Book -– C.B.S Pub.

References:

1. Shigley J.E., Mechanical Engineering Design, McGraw Hill Book Company
2. Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company
3. Phelan R.M., Fundamentals of Mechanical Design, TMH, Ltd.
4. Doughtie V.L & Vallance A.V., Design of Machine Elements, McGraw Hill Book Company
5. Juvinall R.C. &Marshek K.M., Fundamentals of Machine Component Design, John Wiley
6. Machine Design Robert L Norton , Prentice Hall India
7. Design of machine elements M.F.Spotts, Prentice Hall India
8. Machine Design – Wentzell, Thomson Learning
9. Kulkarni S.G, Machine Design, THM

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to design - steps in design process - design factors - tolerances and fits - principles of standardisation. Materials and their properties - Elastic and plastic behaviour of metals - ductile and brittle behaviour. True stress and true strain - stress - strain curves - Selection of materials - stresses in machine parts - tension, compression, shear, bending and torsional stresses, combined stress. Stress concentration, stress intensity factor - Fracture toughness -factor of safety, margin of safety - variable stress - endurance limit - Theories of failure	9	15%
II	Combined steady and variable stress - Gerber, Goodman, Soderberg method - impact load - fatigue loading	9	15%
FIRST INTERNAL EXAMINATION			

III	Welded joints - types of joints, strength of welds, fillet welds- eccentric loading. Design of keys and cotters. Shaft couplings, - stresses in couplings -design of couplings- Muff and flanged coupling	9	15%
IV	Gears - spur and helical gears - Design for static and dynamic loading and wear - Lewis and Buckingham equations for design.	10	15%
SECOND INTERNAL EXAMINATION			
V	Bearing- Journal bearing -Introduction to lubrication - Hydrodynamic bearings - Sommerfield Number, Petroff's number, L/D ratio, Clearance ratio - minimum film thickness - bearing materials. Rolling contact bearings - bearing types - Ball & roller bearings - Static and dynamic load capacity - Equivalent dynamic load - Bearing life - Selection of bearing.	10	20%
VI	Shaft - stresses in shafts - design for static loads - reversed bending and steady torsion -- design for fatigue loading	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME220	MANUFACTURING TECHNOLOGY	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:-

1. To give an exposure to different techniques of casting and molds required.
2. To provide an exposure to different rolling processes and different rolled products
3. To familiarize with different forging methods, cautions to be adopted in die design.
4. To give an introduction to various work and tool holding devices used in manufacturing.
5. To introduce to the bending, shearing and drawing processes of sheet metal working and allied machines,
6. To give an understanding of welding metallurgy and weldability and to introduce various metal joining techniques.

SYLLABUS

Casting –patterns - Cores – Gating – Risering – Defects in Castings - Rolling –Defects in Rolled parts- forging – Coining – Heading – Piercing –Die Design– Extrusion Process– Extrusion Defects – Drawing Process -Principles of Location –Principles of Clamping – Types of Clamp -Sheet metal characteristics –Deep drawing –Spinning –Definition of Welding – Weldability – Solidification of Weld Metal – Heat Affected Zone – Welding Defects - Gas Welding -Arc Welding - Ultrasonic Welding – Friction Welding – Resistance Welding — Brazing- Soldering.

Expected outcomes: At the end of the course the students will be able to

1. Acquire knowledge in various casting processes and technology related to them.
2. Understand the rolling passes required for getting required shapes of rolled products.
3. Discuss important aspects of forging techniques
4. Discuss sheet metal working processes and their applications to produce various shapes and products.
5. Acquire knowledge in various types of welding processes.

Text books:-

1. Amitabha Ghosh and Ashok Kumar Mallick, Manufacturing Science Affiliated East West Press Ltd, New Delhi, 2002
2. S.Kalpakjian and Steven R Schimid, Manufacturing Engineering and Technology, Pearson,2001

Reference books:-

1. RAO, Manufacturing Technology-Vol 2 3e, McGraw Hill Education India, 2013
2. RAO, Manutacturing Technology-Vol 1 4e, McGraw Hill Education India, 2013
3. Cyril Donaldson and George H LeCain, Tool Design,TMH
4. Handbook of Fixture Design – ASTME
5. Campbell J. S., Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1999
6. P R Beeley, Foundry Technology, Elsevier, 2001
7. Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, Principles of Metal Casting,

Tata McGraw-Hill Education, 2001
8. Paul Degarma E and Ronald A. Kosher ,Materials and Processes in Manufacturing, Wiley,20111
9. P. N. Rao,Manufacturing Technology Foundry, Forming and Welding, Tata McGraw-Hill Education,2011
10. HMT Production Technology, 1e McGraw Hill,2001

Course Plan			
Module	**Contents**	**Hours**	**Semester Examination Marks**
I	Sand Casting – Sand Molds-Types of Molding Sands and Testing	1	15%
	Type of patterns - Pattern Materials	1	
	Cores –Types and applications –Sand Molding Machines	1	
	Gating System – Risering	1	
	Shell Mold Casting – Ceramic Mold Casting	1	
	Investment Casting – Vacuum Casting – Slush Casting	1	
	Pressure Casting – Die Casting – Centrifugal Casting	1	
	Design Considerations based on Various Shapes - Defects in Castings – simple problems in casting	1	
II	Principles of Rolling –Types of rolling mills, Mechanics of Flat Rolling	1	15%
	Roll Force and Power Requirement - Neutral Point	1	
	Hot and Cold Rolling	1	
	Defects in Rolled Plates - Rolling Mills	1	
	Ring Rolling – Thread Rolling	1	
	Applications- Rolling of tubes, wheels, axles and I-beams	1	
FIRST INTERNAL EXAM			
III	Classification of forging – Forging methods – Forging under sticking condition	1	15%
	Precision Forging – Coining – Heading – Piercing	1	
	Die Design:- Preshaping, Design Features, Draft Angles – Die Materials and Lubrication	1	
	Forging Machines – Forging Defects and tests	1	
	Extrusion Process - Hot Extrusion – Cold Extrusion	1	
	Impact Extrusion – Extrusion Defects – Drawing Process, wire drawing process	1	

IV	Principles Location - Degrees of Freedom, 3-2-1 principle of locating	1	15%
	Locating from Planes - Locating from Circular Surfaces	1	
	Concentric Locating - Principles of Clamping	1	
	Types of Clamps - Strap Clamps Slide Clamps - Swing Clamps - Hinge Clamps	1	
	Vacuum Clamping - Magnetic Clamping	1	
SECOND INTERNAL EXAM			
V	Sheet metal characteristics – Typical shearing	1	20%
	Bending Sheet and Plate – Spingback - Bending Force	1	
	Press Brake Forming - Tube Bending	1	
	Stretch Forming - Deep Drawing	1	
	Rubber forming - Spinning Shear Spinning - Tube Spinning	1	
	Definition of Welding - Weldability – Solidification of the Weld Metal	1	
	Heat Affected Zone – correlation of strength of welded joint with structure - Welding Defects	1	
VI	Gas Welding: – Flame Characteristics	1	20%
	Equipment, fluxes and filler rods	1	
	Arc Welding – Applications and Equipment	1	
	Electrodes	1	
	Shielded Metal Arc Welding – Submerged Arc Welding	1	
	GTAW – Plasma Arc Welding	1	
	Ultrasonic Welding – Friction Welding	1	
	Resistance Spot Welding	1	
	Resistance Seam Welding – Stud Welding – Percussion Welding - simple problems in welding	1	
	Brazing:- Filler Metals, Methods - Soldering:- Techniques, Types of Solders and Fluxes	1	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME222	THERMAL ENGINEERING II	4-0-0-4	2016

Prerequisite : ME207 Thermal engineering - I

Course Objectives:

- To acquire knowledge on the working of IC engines, Refrigerators, Air conditioners and heat exchangers.
- To introduce the combustion process in IC engines
- To understand air pollution from IC engines and its remedies.

Syllabus:

Fuels and combustion- Normal and abnormal combustion in IC engines- Alternate fuels in IC engines- Performance testing of IC engines -IC engine pollution- Heat exchangers- Refrigeration and Air conditioning.

Expected outcome:

At the end of the course the students will be able to

i. Integrate the concepts, laws and methodologies from the course in thermodynamics into analysis of cyclic processes

ii. To apply the thermodynamic concepts into various thermal application like IC engines, Refrigeration and air conditioning, Heat exchangers.

Text Books:

1. Rudramoorthy , Thermal Engineering, Tata McGraw Hill Education India, 2003
2. R.K Rajput, Thermal Engineering, Laxmi publications,2010
3. Rathore**,** Thermal Engineering 1e, Tata McGraw Hill Education India, 2010

References Books:

1. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002
2. T.D. Eastop and A McConkay, Applied thermodynamics for engineering technology, Pearson education,1996
3. J.B.Heywood, I.C engine fundamentals. McGraw-Hill,2011
4. Gill, P.W., Smith, JR., J.H., and Ziurys, E.J Fundamentals of internal combustion engines Oxford and IBH,1959

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Fuels and combustion- Stochiometry, calculation of A/F ratio and equivalence ratios, volumetric and gravimetric analysis, fuel properties.	9	15%
II	Combustion in IC engines- Normal and abnormal combustion in SI and CI engines, auto ignition- pre ignition and detonation- factors affecting detonation, knocking in engine.	9	15%
FIRST INTERNAL EXAMINATION			

III	Performance testing of IC Engines, Alternate fuels in IC engines- biodiesel, hydrogen, natural gas, LPG, Alcohol- IC engine pollution and control, Emission norms	9	15%
IV	Heat Exchangers- Different types- LMTD and effectiveness. Problems	9	15%
SECOND INTERNAL EXAMINATION			
V	Refrigeration- Vapor compression refrigeration system, Vapor absorption refrigeration system, simple cycle- TS and PH diagrams- COP- Refrigerants and their properties- Eco friendly refrigerants. Application of refrigeration- Domestic refrigerators, Water coolers, ice plants	9	20%
VI	Air conditioning- Psychrometry-Comfort and industrial air conditioning, Working of room air conditioners- Use of psychrometric charts- Split and packaged system- Automobile airconditioning.	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100 Time: 3 hours

The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME230	FLUID MECHANICS AND MACHINES LABORATORY	0-0-3-1	2016

Prerequisite: ME203 Mechanics of fluids

Course Objectives: The main objectives of this course is to demonstrate the applications of theories of basic fluid mechanics and hydraulic machines and to provide a more intuitive and physical understanding of the theory.

Syllabus

Study:

1. Study of flow measuring equipments - water meters, venturi meter, orifice meter, current meter, rotameter
2. Study of gauges - pressure gauge, vacuum gauge, manometers.
3. Study of valves - stop valve, gate valve and foot valve.
4. Study of pumps – Centrifugal, Reciprocating, Rotary, Jet.
5. Study of Turbines - Impulse and reaction types.
6. Study of Hydraulic ram, accumulator etc.

List of Experiments:

1. Determination of coefficient of discharge and calibration of Notches
2. Determination of coefficient of discharge and calibration of Orifice meter
3. Determination of coefficient of discharge and calibration of Venturimeter.
4. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus
5. Determination of hydraulic coefficients of orifices
6. Determination of metacentric height and radius of gyration of floating bodies.
7. Experiments on hydraulic ram
8. Reynolds experiment
9. Bernoulli's experiment
10. Experiment on Torque converter
11. Performance test on positive displacement pumps
12. Performance test on centrifugal pumps, determination of operating point and efficiency
13. Performance test on gear pump
14. Performance test on Impulse turbines
15. Performance test on reaction turbines (Francis and Kaplan Turbines)
16. Speed variation test on Impulse turbine
17. Determination of best guide vane opening for Reaction turbine
18. Impact of jet

Note: 12 experiments are mandatory

Expected outcome: At the end of the course the students will be able to

1. Discuss physical basis of Bernoulli's equation, and apply it in flow measurement (orifice, Nozzle and Venturi meter), and to a variety of problems
2. Determine the efficiency and plot the characteristic curves of different types of pumps and turbines.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME231	COMPUTER AIDED MACHINE DRAWING LAB	0-0-3-1	2016

Course Objectives:

1. To introduce students to the basics and standards of engineering drawing related to machines and components.
2. To teach students technical skills regarding assembly, production and part drawings.
3. To familiarize students with various limits, fits and tolerances.
4. To help students gain knowledge about standard CAD packages on modeling and drafting.

Syllabus

Introduction to Machine Drawing, Drawing Standards, Fits, Tolerances, Production drawings. Introduction to CAD, assembly drawings, etc.

Expected outcome

At the end of the course students will be able to

1. Acquire the knowledge of various standards and specifications about standard machine components.
2. Make drawings of assemblies with the help of part drawings given.
3. Ability to select, configure and synthesize mechanical components into assemblies.
4. Apply the knowledge of fits and tolerances for various applications.
5. Able to model components of their choice using CAD software.
6. Get exposure to advanced CAD packages.

Text Books:

1. N. D. Bhatt and V.M. Panchal, Machine Drawing, Charotar Publishing House,2014
2. K C John, Machine Drawing, PHI,2009
3. P I Vargheese and K C John, Machine Drawing, VIP Publishers ,2011
4. K.L.Narayana, P.Kannaiah & K. Venkata Reddy,Machine Drawing, New Age Publishers,2009
5. Ajeet Singh, Machine Drawing Includes AutoCAD, Tata McGraw-hill,2012
6. P S Gill, Machine Drawing, Kataria & Sons,2009

Course Plan		
Module	**Contents**	**Hours**
0	Introduction Principles of drawing, free hand sketching, manual drawing, CAD drawing etc.	01
I	Drawing standards**:** 2 exercises Code of practice for Engineering Drawing, BIS specifications – lines, types of lines, dimensioning, sectional views, Welding symbols, riveted joints, keys, fasteners –bolts, nuts, screws, keys etc.	05
II	Fits ,Tolerances and Surface Roughness**:** 2 exercises Limits, Fits – Tolerances of individual dimensions – Specification of Fits – basic principles of geometric & dimensional tolerances. Preparation of production drawings and reading of part and assembly drawings, surface roughness, indication of surface roughness, etc.	06
FIRST INTERNAL EXAM		
III	Introduction to drafting package: Introduction, input, output devices, introduction to drafting software like Auto CAD, basic commands and development of simple 2D and 3D drawings. Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.	06
IV	Assembly drawings(2D)**:** 10 exercises Preparation of assembled views. (Manually): Shaft couplings – Connecting rod - Machine Vice – Stuffing box – Plummer block. (Using software package, 2D Drawing) :– Universal joint - Screw jack – Lathe Tailstock – Rams Bottom Safety Valve – Steam stop valve. Preparation of Bill of materials and tolerance data sheet.	24
SECOND INTERNAL EXAM		
Note: 50% of assembly drawings (Module IV) must be done manually and remaining 50% of assembly drawings must be done using any 2D drafting package.		
FINAL INTERNAL EXAM		

Examination scheme

(1) End semester examination shall be for 30 marks and of 2 hours duration.

(2) End semester exam shall be based on Module IV. It shall be conducted as a CAD examination

(3) 50 marks are allotted for internal evaluation: first internal exam 25 marks, second internal exam 25 marks and class exercises 20 marks.

(4) The first internal exam will be based on modules I and II and the second internal exam will be a based on Module IV alone. (Both will be conducted as manual drawing examinations)

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME232	THERMAL ENGINEERING LABORATORY	0-0-3-1	2016

Prerequisite : Should have registered for ME204 Thermal Engineering

Course Objectives:

1. To study the various types IC engines and their parts
2. To conduct the performance test on IC engines, compressors and blowers
3. To familiarize equipment used for measuring viscosity, flash and fire point and Calorific value of petroleum products

Syllabus

List of experiments:

Study of I.C engines :-

a) Diesel engines - all systems and parts

b) Petrol engines - all systems and parts

Experiments

1. Determination of flash and fire points of petroleum products -flash and fire point apparatus
2. Determination of viscosity of lubricating oil- viscometer
3. Determination of calorific value of solid and liquid fuels- calorimeter
4. Determination of calorific value of and gaseous fuels - calorimeter
5. Performance test on petrol engines with various types of loading systems
6. Performance test on Diesel engines with various types of loading systems
7. Heat Balance test on petrol/Diesel engines
8. Cooling curve of IC engines
9. Valve timing diagram of IC engines
10. Economic speed test on IC engines
11. Retardation test on IC engines
12. Determination volumetric efficiency and Air-fuel ratio of IC engines
13. Morse test on petrol engine
14. Performance test on reciprocating compressor
15. Performance test on rotary compressor/blower
16. Draw velocity profile in a pipe flow using Prandtl -Pitot tube
17. Analysis of automobile exhaust gas and flue gas using exhaust gas analyser

Note: 12 experiments are mandatory

Expected outcome: At the end of the course the students will be able to

1. Determine the efficiency and plot the characteristic curves of different types of Internal Combustion engines, compressors and blowers
2. Conduct experiments for the determination of viscosity, calorific value etc of petroleum products

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME233	Mechanical Engineering Lab	0-0-3-1	2016

Prerequisite : Nil

Course Objective

- To develop engineering related skills of fluid mechanics and prime movers
- To provide necessary practical knowledge related to the theory of fluid mechanics and energy conversion systems.
- To familiarize with various apparatus and machines in fluid mechanics and IC engines and conduct experiments.

List of Experiments

1. Determination of coefficient of discharge and calibration of rectangular notch
2. Determination of coefficient of discharge and calibration of triangular notch.
3. Determination of coefficient of discharge and calibration of venturI meter
4. Determination of coefficient of discharge and calibration of orifice meter.
5. Determination of hydraulics coefficient using orifice apparatus.
6. Determination of meta-centric height and radius of gyration of floating body.
7. Pipe friction apparatus to find Darcy's frictional coefficient and Chezy's constant.
8. Performance test on positive displacement pump
9. Performance test on centrifugal pump
10. Performance test on impulse turbine.
11. Performance test on reaction turbine.
12. Performance test on hydraulic ram
13. Performance test on two stroke diesel engine.
14. Performance test on four stroke diesel engine.
15. Performance test on four stroke petrol engines
16. Performance test on two stroke petrol engines
17. Calibration of pressure gauge

Note: It is mandatory to conduct at least 12 experiments.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME235	MACHINE DYNAMICS AND MATERIAL TESTING LAB	0-0-3-1	2016

Prerequisite: ME209 & ME213

Course Objectives:

- To make the students understand the theory of machines through practical exercises.
- To acquire knowledge on material testing principles and use of destructive testing equipment.

Syllabus

List of experiments:

1. Tensile Test on Mild Steel, High carbon Steel and Cast Iron specimens
2. Shear test on MS Rod
3. Torsion test on MS, Aluminium and Brass wire
4. Izod and Charpy Impact tests
5. Hardness test (Rockwell and Brinnell)
6. Compression test on helical springs
7. Microscopic Examination of Steels, Cast Iron, Al, Cu, Zn
8. Thermal Expansion Coefficient using Dial Gauge Dilatometer.
9. Strain Measurement using Rosette strain gauge
10. Test to study the effect of hardening- Improvement in hardness and impact resistance of steels.
11. Tempering - Improvement Mechanical properties Comparison (i) Unhardened specimen (ii) Quenched Specimen and (iii) Quenched and tempered specimen.
12. To study magnetic hysteresis of ferromagnetic material.
13. Universal Governor Apparatus
    a) Determination of speed and sensitivity of Watt governor
    b) Determination of speed and sensitivity of Proel governor
    c) Determination of speed and sensitivity of Porter governor
14. Determination of whirling speed of shaft
15. Cam Study Analysis (Circular cam with roller, knife edge and flat follower)
16. Pendulum Experiment
    a) Simple pendulum Experiment
    b) Bifilar suspension Pendulum Experiment
    c) Compound pendulum Experiment
17. Torsional vibration
    a) Single rotor Torsional vibration experiment
    b) Single rotor Torsional vibration experiment
18. Journal bearing experiment

Expected outcome:

- After completion of this programme, students are expected to have knowledge on material testing principles, destructive testing and practical background of machines theory.

Course code.	Course Name	L-T-P - Credits	Year of Introduction
ME236	Machine shop	0-0-3-1	2016

Prerequisite: ME220 Manufacturing Technology

Course Objectives

- To acquaint with the basic operations of lathe, shaping, slotting, grinding and milling machines.
- To conduct the exercise involving plane turning, groove cutting, taper turning, facing, thread cutting, gear cutting and grinding operations.

List of exercises

1. Demonstration of construction and operations of general purpose machines :– lathe, drilling machine, milling machine, shaper, planning machine, slotting machine, cylindrical grinder, surface grinder, and tool and cutter grinder.
2. Plane turning and Step turning on lathe.
3. Groove turning (cup and ball) and taper turning on lathe.
4. Thread cutting and knurling operations on lathe.
5. Exercise on machining flat surfaces, grooving keyways using shaping machines.
6. Machining of V –block using shaper machines.
7. Machining grooves and key slots using slotting machine.
8. Experiment on drilling machines –drilling and boring operations.
9. Reaming, counter sinking and tapping operations using drilling machines.
10. Experiment on milling machine – Plane milling, keyway cutting, and cutting of splines.
11. Experiment on vertical milling.
12. Cutting of spur gear on milling machine.
13. Grinding of plane surface using surface grinding machine.
14. Cylindrical grinding using cylindrical grinding machine.

Expected outcome.

The students will be able to

i. operate different machine tools using proper work holders
ii. produce different part features to the desired quality.

Text Books:

1. R.K. Jain, Production Technology, Khanna Publishers.
2. HMT, Production Technology, Tata McGraw Hill.
3. Chapman, Workshop Technology Vol II, ELBS.
4. S.K. Hajra Choudhury, Workshop Technology Vol II, Media Promoters & Publishers.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
ME237	WELDING AND MACHINE TOOLS LAB	0-0-3-1	2016

Prerequisite: Nil

Course Objectives:

- Provide practical experience on various machining operations using Lathe.
- Familiarization with basics of welding.
- Provide practical experience in carrying out welding.

List of Exercises/ Experiments (Minimum 10 are mandatory)

(a). Machine Tools:

1. Study of Precision Tools and Measuring Instruments.
   Equipment: Vernier Calliper, Micrometer, Surface Plate, Surface Gauge, Slip Gauge, Screw Pitch Gauge, Feeler Gauge, Dial Gauge, Sine Gauge, Plug Gauge, Straight edge Gauge.

2. Study of Nomenclature of Single Point Cutting Tool.
   Equipment: HSS Single point cutting tool.

3. Study of Centre Lathe.
   Equipment: Centre Lathe.

To perform following lathe operations on a work piece for given dimensions :

4. Plane Turning.
   Equipment: HSS Single point cutting tool (V-tool), Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper.

5. Step Turning.
   Equipment: HSS Single point cutting tool (V-tool), Parting tool, Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper.

6. Grooving.
   Equipment: HSS Single point cutting tool (V-tool), Parting tool, Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, and Vernier calliper.

7. Taper Turning.
   Equipment: HSS Single point cutting tool (V-tool), Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, Vernier calliper and double end spanner.

8. Thread Cutting.
   Equipment: HSS Single point cutting tool (V-tool), Tool holder, Surface gauge, steel rule, outside calliper, Jenny calliper, Vernier calliper Centre gauge and thread pitch gauge.

(b) Welding:

9. Study of Welding Equipment and Procedures.
   Equipment: MMAW, MIG, TIG, SAW.

10. To study various types of welding joints and practice edge preparation.
    Equipment: Butt joint, Lap joint, T-Joint, Corner joint, Workpiece, File/Grinder, Wirebrush.

11. To Prepare a Single V-Butt Joint using Arc Welding Process.
    Equipment: Arc welding machine, Mild steel work pieces, Mild steel Electrodes, Electrode holder, Ground clamp, Flat nose tong, Face shield, Apron, Hand gloves, work table, Bench vice, Rough flat file, steel rule, wire brush, Try square, Bell peen hammer, chipping hammer, chisel, grinding machine.

12. To Prepare a Lap Joint using Arc Welding Process.
    Equipment: Arc Welding Machine, Mild Steel Work Pieces, Mild Steel Electrodes, Electrode Holder, Ground Clamp, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

13. To Prepare a T Joint using Arc Welding Process
    Equipment: Arc Welding Machine, Mild Steel Work Pieces, Mild Steel Electrodes, Electrode Holder, Ground Clamp, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

14. To prepare a Butt Joint Using TIG Welding Process.
    Equipment: TIG Welding Machine, Welding Cable With Earth Clamps, Gas Cooled TIG Welding Torch, Inert Argon Gas Hose Pipe, Tungsten Rod, Flow Meter, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Ball Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

15. To prepare a Lap Joint Using TIG Welding Process.
    Equipment: TIG Welding Machine, Welding Cable With Earth Clamps, Gas Cooled TIG Welding Torch, Inert Argon Gas Hose Pipe, Tungsten Rod, Flow Meter, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

16. To Prepare a Butt Joint using MIG Welding Process.
    Equipment: MIG Welding Machine, Welding Cable With Earth Clamps, MIG Welding Torch, CO_2 Gas Flow Meter with Preheater, Contact Tips, Input Gas Hose Pipes, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

17. To Prepare a Lap Joint using MIG Welding Process.
    Equipment: MIG Welding Machine, Welding Cable With Earth Clamps, MIG Welding Torch,

CO_2 Gas Flow Meter With Preheater, Contact Tips, Input Gas Hose Pipes, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

18. To Prepare a T Joint using MIG Welding Process.
    Equipment: MIG Welding Machine, Welding Cable With Earth Clamps, MIG Welding Torch, CO_2 Gas Flow Meter With Preheater, Contact Tips, Input Gas Hose Pipes, Mild Steel Work Pieces, Face Shield, Apron, Hand Gloves, Work Table, Bench Vice, Rough Flat File, Try Square, Bell Peen Hammer, Chipping Hammer, Chisel, Grinding Machine.

19. Demonstration of Submerged Arc Welding Process.
    Equipment: Power Source, Welding Head Trolley, Welding Clamp With Earth Clamp, Welding Cable With Earth Lug, Control Cable, Track, Contact Tip, Contact Pole, Flux Hose, Flux Hopper .

Expected Outcome:

After successful completion of the course, the student will be able to:

i. Machine the given specimen to required dimension using Lathe.
ii. Demonstrate the principle of operation of MMAW, TIG, MIG & SAW.
iii. Prepare specified type of joint using various welding processes.

Text Book(s):

1. O.P Khanna; Welding Technology; Dhanpat Rai Publications.
2. Acharkan. N.; Machine Tool Design Vol. 1 to 4, MIR Publication.
3. Chapman; Workshop Technology, Vol II, ELBS.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
ME238	ADVANCED MACHINE TOOLS LAB	0-0-3-1	2016

Prerequisite: Nil

Course Objectives:

- Introduction to various Machining process.
- To familiarization with the fundamentals of CNC Machine.
- To introduce the student to CNC operations.

List of Exercises/ Experiments (Minimum 10 are mandatory)

1. Bolt Making on Lathe Machine
   Equipment: Cutting Saw, Center Lathe, Pedestal Grinder, HSS Tool Bit And Straight Or Right Hand Tool Holder, Center Drill, Live Center, Stock and Die, Metal Work Vice.

2. Study of Drilling Machines.
   Equipment: Radial Drilling Machine.

3. Study of Nomenclature of Drill Bit.
   Equipment: Drill Bit.

4. To Drill the Given Work Piece as Required.
   Equipment: Mild Steel Work Piece, Drill Bit, Lot Drill Bit, Drill Chuck.

5. Study of Shaping Machines.
   Equipment: Shaper Machine.

6. To Perform V- Machining on the Given Work Piece.
   Equipment: Shaper Machine, Punching Machine, Steel Rule, Hammer, Shaper Tool, Try Square.

7. To Perform U-Cut on the Given Work Piece.
   Equipment: Shaper machine, Steel rule, Hammer, Shaper tool, Try Square.

8. Study of Slotting Machines
   Equipment: Slotter.

9. To make a Slot on the Given Work Piece.
   Equipment: Slotting Machine, Steel rule, Hammer, Shaper tool, Try Square.

10. To Cut External Key Way Using Slotter.
    Equipment: Slotting Machine, Steel Rule, Hammer, Shaper Tool, Try Square.

11. Study of Milling Machines.
    Equipment: Milling Machine.

12. To Perform Plane Milling Operation on the Given Specimen.
    Equipment: Milling Machine, Work Piece, Steel Ruler.

13. To Make Spur Gear on a Given Work Piece.
    Equipment: Steel Rule, Milling Cutter, Spanner, Mandrel, Dog Carrier.

14. To make Bevel Gear on a Work Piece.
    Equipment: Steel Rule, Milling Cutter, Spanner, Mandrel, Dog Carrier.

15. Study and Demonstration of CNC Machine.
    Equipment: CNC Machine.

16. To Program and Run Milling Operation Using CNC Machine.
    Equipment: CNC Machine, Computer.

17. To Program and Execute Turning Operation Using CNC Lathe.
    Equipment: CNC Machine, Computer.

18. Study of Cutting Process.
    Equipment: Variety of Cutting Equipment.

19. Study of CNC Plasma Arc Cutting (working principle and procedure only).

Course Outcome:

Upon successful completion of the course, the student will be able to :

i. Machine the given work piece to specified dimensions.
ii. Understand the fundamentals of CNC machining.

Text Book(s):

- Chapman; Workshop Technology, Vol II; ELBS.
- HMT; Production Technology; Tata McGraw Hill.
- Yoram Koren; Numerical Control of Machine Tools; McGraw-Hill.
- Acharkan. N.; Machine Tool Design Vol. 1 to 4; MIR Publication.