M.D. UNIVERSITY, ROHTAK

SCHEME OF STUDIES AND EXAMINATION

(Under NEP-2020)

BACHELOR of TECHNOLOGY

(MECHANICAL ENGINEERING)

SEMESTER 3rd & 4th

Scheme effective from academic session 2026-27

'H' Scheme (Under NEP-2020)

1. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits
2 Hours Practical (Lab) per week	1 credit

2. Structure of the Undergraduate Engineering program:

Sr. No.	Category
1	Humanities and Social Sciences including Management courses
2	Basic Science Courses
3	Engineering Science courses
4	Program Core Courses (Branch specific)
5	Professional Elective courses relevant to chosen specialization/branch
6	Open Elective Courses (from Humanities, Technical Emerging or other Subjects)
7	Project work, Seminar and Internship in Industry or elsewhere
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition] etc. (non-credit)

3. Course code and definition:

Course Code	**Definition**
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional Core Courses
LC	Laboratory Courses
MC	Mandatory Courses
PT	Practical Training
PEC	Professional Elective courses
OEC	Open Elective courses
S	Seminar

PROGRAM OUTCOMES (PO)

Engineering Graduates will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Semester-3

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-ME-201-H	Fluid Mechanics	3	0	0	3	**3**	25	50		75	3
2	26PCC-ME-203-H	Thermal Engineering	3	0	0	3	**3**	25	50		75	3
3	26PCC-ME-205-H	Strength of Materials	3	0	0	3	**3**	25	50		75	3
4	26PCC-ME-207-H	Industrial Engineering	3	0	0	3	**3**	25	50		75	3
5	26ESC-ME-209-H	Engineering Mechanics	2	0	0	2	**2**	15	35		50	3
6	26BSC-MATHME-203-H	Mathematics III (PDE, Probability & Hypothesis Testing)	3	0	0	3	**3**	25	50		75	3
7	26LC-ME-213-H	Fluid Mechanics Lab	0	0	2	2	**1**	5		20	25	3
8	26LC-ME-215-H	Thermal Engineering Lab	0	0	2	2	**1**	5		20	25	3
9	26LC-ME-217-H	Strength of Materials Lab	0	0	2	2	**1**	5		20	25	3
10	26LC-ME-219-H	Engineering Mechanics Lab	0	0	2	2	**1**	5		20	25	3
11	26LC-ME-221-H	Industrial& Production Lab	0	0	2	2	**1**	5		20	25	3
12	*26AU-ENV-202-H	Environmental Science	2	0	1	3		Refer Note 1				
Total						30	22				550	

FOR HONORS COURSE

1	26PCC-ME-223-H	Advanced Thermodynamics	3	0	0	3	**3**	25	50		75	3
2	26LC-ME-225-H	Advanced Thermodynamics Lab	0	0	2	2	**1**	5		20	25	3
Total						**5**	4				100	

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Note-1:26AU-ENV-202-H is a mandatory non–credit course in which students must obtain passing marks in theory. The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of a degree. However, these marks will appear on the student detailed marks certificate.

Marks Distribution:

- Internal Assessment: 30 marks
- Theory Examination: 70 marks

The institute will conduct the theory examination at its own level

Semester-4

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-ME-202-H	Fluid Machines	3	0	0	3	**3**	25	50		75	3
2	26PCC-ME-204-H	Engineering Materials & Applications	3	0	0	3	**3**	25	50		75	3
3	26PCC-ME-206-H	Manufacturing Technology-I	3	0	0	3	**3**	25	50		75	3
4	26PCC-ME-208-H	Measurement and Metrology	3	0	0	3	**3**	25	50		75	3
5	26PCC-ME-210-H	Solid Mechanics	3	1	0	4	**4**	30	70		100	3
6	26PCC-ME-212-H	Computer Aided Design & Manufacturing	3	0	0	3	**3**	25	50		75	3
7	26LC-ME-214-H	Fluid Machines Lab	0	0	2	2	**1**	5		20	25	3
8	26LC-ME-216-H	Materials & Metallurgical Engineering Lab	0	0	2	2	**1**	5		20	25	3
9	26LC-ME-218-H	Measurement and Metrology Lab	0	0	2	2	**1**	5		20	25	3
10	26LC-ME-220-H	Manufacturing Technology Lab-I	0	0	2	2	**1**	5		20	25	3
11	26LC-ME-222-H	Computer Aided Design & Manufacturing Lab	0	0	2	2	**1**	5		20	25	3
Total						29	24				600	

FOR HONORS COURSE

1	26PCC-ME-224-H	Product Design and Development	3	0	0	3	**3**	25	50		75	3
2	26LC-ME-226-H	Product Design and Development Lab	0	0	2	2	**1**	5		20	25	3
Total						**5**	4				100	

NOTE: At the end of 4th semester each Student has to undergo for industrial training/project related to engineering sectors for the duration of 4 to 6 weeks after the end of semester exam. Students must submit training report along with certificate from the organization, which will be evaluated in 5th sem.

The students of **B. Tech (Working Professionals)** courses have to submit training/ project report of their work in their respective company/ organization for the period of Sumer training/ industrial training for the evaluation purpose.

Course code	**26PCC-ME-201-H**				
Category	Professional Core Courses				
Course title	**Fluid Mechanics**				
Scheme and Credits	L	T	P	**Credits**	Semester-III
	3	0	0	3	
Objectives:	• To learn about the application of mass and momentum conservation laws for fluid flows • To understand the importance of dimensional analysis • To obtain the velocity and pressure variations in various types of simple flows				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Fluid Properties and Fluid Statics: Concept of fluid and flow, ideal and real fluids, continuum concept, and properties of fluids, Newtonian and non-Newtonian fluids. Pascal's law, hydrostatic equation, hydrostatic forces on plane and curved surfaces, stability of floating and submerged bodies, relative equilibrium, Problems. Fluid Kinematics: Eulerian and Lagrangian description of fluid flow; stream, streak and path lines; types of flows, flow rate and continuity equation, differential equation of continuity in cylindrical and polar coordinates, rotation, vorticity and circulation, stream and potential functions, flow net, Problems.

UNIT-II

Fluid Dynamics: Concept of system and control volume, Euler's equation, Bernoulli's equation, venturimeter, orifices, orificemeter, mouthpieces, kinetic and momentum correction factors, Impulse momentum relationship and its applications, Problems. Compressible Fluid Flow: Introduction, continuity momentum and energy equation, sonic velocity, propagation of elastic waves due to compression of fluid, propagation of elastic waves due to disturbance in fluid, stagnation properties, isentropic flow, effect of area variation on flow properties, isentropic flow through nozzles, diffusers, injectors, Problems.

UNIT-III

Viscous Flow: Flow regimes and Reynolds's number, Relationship between shear stress and pressure gradient, uni-directional flow between stationary and moving parallel plates, movement of piston in a dashpot, power absorbed in bearings. Problems. Flow Through Pipes: Major and minor losses in pipes,

Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes, Problems.

UNIT-IV

Boundary Layer Flow: Boundary layer concept, displacement, momentum and energy thickness, von-karman momentum integral equation, laminar and turbulent boundary layer flows, drag on a flat plate, boundary layer separation and control. Streamlined and bluff bodies lift and drag on a cylinder and an airfoil, Problems. Turbulent Flow: Shear stress in turbulent flow, Prandtl mixing length hypothesis, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes, Problems.

Course Outcomes: At the end of the course, the student shall be able to:

1. Expedite the properties of fluid along with pressure measurement techniques and concept of stability.
2. Understand the characteristics of fluid and application of continuity and Bernoulli's equation.
3. Conceptualisation of boundary layer, laminar and turbulent flow.
4. Analyse flows through pipes and open channels.

TEXT BOOKS:

1. Fluid Mechanics – Streeter V L and Wylie E B, Mc Graw Hill
2. Mahesh Kumar - Fluid Mechanics and Hydraulic Machines-Pearson Education.
3. Mechanics of Fluids – I H Shames, Mc Graw Hill

REFERENCES BOOKS:

1. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, TMH
2. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
3. Fluid Mechanics and Machinery – S.K. Agarwal, TMH, New Delhi

Course code	**26PCC-ME-203-H**				
Category	Professional Core Courses				
Course title	**Thermal Engineering**				
Scheme and Credits	L	T	P	**Credits**	Semester-III
	3	0	0	3	
Objectives:	• To learn about work and heat interactions, and balance of energy between system and its surroundings • To learn about application of I law to various energy conversion devices • To evaluate the changes in properties of substances in various processes • To understand the difference between high grade and low grade energies and II law limitations on energy conversion • To learn about gas and vapor cycles and their first law and second law efficiencies • To learn about gas dynamics of air flow and steam through nozzles • To analyze the performance of steam turbines				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit. Use of steam tables with mollier chart is permissible in the examination hall.

UNIT-I

Fundamentals - System & Control volume; Property, State & Process; Work-Thermodynamic definition of work; Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems.

First Law for Cyclic & Non-cyclic processes: Concept of total energy E; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

UNIT-II

Second law: Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Carnot cycle; Absolute temperature scale.

Clausius inequality: Definition of entropy S; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles-Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Exergy balance equation and Exergy analysis.

UNIT-III

Definition of Pure substance: Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface;

Vapor power cycles :Basic Rankine cycle Rankine cycle with superheat, reheat and regeneration, exergy analysis. Supercritical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.

UNIT-IV

TdS relations: Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron and Clapeyron-Clausius equations.

Basics of compressible flow: Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation compressible flow in diffusers, efficiency of nozzle and diffuser.

Course Outcomes:

1. After completing this course, the students will be able to apply energy balance to systems andcontrol volumes, in situations involving heat and work interactions
2. Students can evaluate changes in thermodynamic properties of substances
3. The students will be able to evaluate the performance of energy conversion devices
4. The students will be able to differentiate between high grade and low grade energies.
5. The students will get a good understanding of various practical powercycles and heat pump cycles.
6. They will be able to analyze energy conversion in various thermal devices such as combustors, aircoolers, nozzles, diffusers, steam turbines and reciprocating compressors
7. They will be able to understand phenomena occurring in high speed compressible flows

Text Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Course code	**26PCC-ME-205-H**				
Category	Professional Core Courses				
Course title	**Strength of Materials**				
Scheme and Credits	L	T	P	**Credits**	Semester-III
	3	0	0	3	
Objectives:	• To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads • To calculate the elastic deformation occurring in various simple geometries for different types of loading				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Stress & Strain: Concept & types of Stresses and Strains, Poisson's ratio, Hooks law, Stress Strain diagrams, stresses and strains in simple and compound bars under axial loading, elastic constants & their relationships, temperature stresses and strains in simple and compound bars under axial loading, Problems.

Principle Stresses& Strains: Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stresses, Problems.

UNIT-II

Shear Force & Bending Moment: Definitions, Beams and types transverse loading on beams, types of beam support, SF& BM diagram for cantilevers, simply supported and over-hanging beams, calculation of maximum BM & SF and Point of contra flexure, Problems.

Bending & Shear Stresses in Beams: Bending stresses in Beam, Theory of bending of beams, bending stress distribution and neutral axis, shear stresses in beam, shear stress distribution Problems.

UNIT-III

Torsion of Circular Members: Torsion, stresses and deformation in circular solid and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, Problems.

Columns & Struts: Introduction, Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formulae for the elastic buckling load, Euler's, Rankine,

Gordon's formulae Johnson's empirical formula for axial loading columns and their applications, eccentric compression of a short strut of rectangular & circular sections, Problems.

UNIT-IV

Slope & Deflection: Relationship between bending moment, slope & deflection, Mohr's theorem, moment area method, method of integration, Macaulay's method, calculations for slope and deflection of (i) cantilevers and (ii) simply supported beams with or without overhang under concentrated load, Uniformly distributed loads or combination of concentrated & uniformly distributed loads and Maxwell's reciprocal theorem, Problems.

Course Outcomes:

1. After completing this course, the students should be able to recognise various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components
2. The students will be able to evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading

Text Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, TataMcGrawHill Publishing Co. Ltd., New Delhi 2005.

Course code	**26PCC-ME-207-H**				
Category	Professional Core Courses				
Course title	**Industrial Engineering**				
Scheme and Credits	L	T	P	**Credits**	Semester-III
	3	0	0	3	
Objectives:	Students will be able - To understand about the concepts of work study and productivity management. To learn about different time study methods and calculating standard time for any given job. To evaluation of job and design of incentives schemes. To understand about ergonomics.				
Class Work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Industrial Engineering:Definition and Scope of Industrial Engineering Role of an Industrial Engineer in Industry, Functions of Industrial Engineering Department and Its Organization, Qualities of an Industrial Engineer.

Productivity Concept, Objectives, Factors Affecting Productivity, Productivity Measurement, Causes of Low Productivity, Tools and Techniques to Improve Productivity, Work Study and Productivity.

UNIT-II

Method Study : Objectives and scope, recording techniques: operation process charts, flow process charts, two hand process chart, activity chart, other charts, , flow diagram, string diagram, critical examination techniques, development, installation and maintenance of improved methods,Principles of motion economy, Micro Motion study, Therbligs, SIMO charts, memo-motion study.

UNIT-III

Work Measurement: Purpose of Work Measurement, The Basic Procedure, The Techniques of Work Measurements.

Time Study: Introduction, Basic Concept and Procedure,: Scope and objectives, concepts of measurement of work in units of time, Techniques of work measurement, stop watch time study, allowances and calculation of standard time, standard time and its applications, Work sampling.

UNIT-IV

Product Design and Development: Principles of product design, tolerance design; Quality and cost considerations; Product life cycle; Standardization, simplification, diversification; Value engineering and analysis; Concurrent engineering; Design for "X".

Facility Design: Facility location factors and evaluation of alternate locations; Types of plant layout and their evaluation; Computer aided layout design techniques; Assembly line balancing; Materials handling systems.

Course Outcomes:

1 Apply selected industrial engineering techniques for enhancing productivity in an organization

2 Apply the methods engineering and operational analysis in re-designing of work systems.

3 Apply engineering work measurement principles in analysing and measurement of work.

4 Create skills among the students with respect to workplace design, working postures and lifting tasks.

5 Understand projects and improve the performance of routine activities by application of appropriate industrial engineering tools.

Books:

1"Motion & Time study: Design and Measurement of Work", Barnes Ralph M., Wiley Text Books. 2001

2 Bridger, R.S., "Introduction to Ergonomics", CRC Press. 2008

3 "William J Stevenson, Operations Management", McGrawHill, 12th Edition, India 2017

4 "Work Systems – The Methods, Measurement & Management of Work", Mikell P Groover, , Pearson India Education, ISBN: 978-93- 325-8124-1.

Course code	**26ESC-ME-209-H**				
Category	Professional Core Courses				
Course title	**Engineering Mechanics**				
Scheme and Credits	L	T	P	**Credits**	Semester-III
	3	0	0	3	
Objectives:	1. To understand the basic force system. 2. To learn about Applying principles of particle kinematics. 3. To understand the concepts of particle dynamics. 4. To Learn energy methods & momentum methods.				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Engineering Mechanics:Force system, dimensions and units in mechanics, laws of mechanics, vector algebra, addition and subtraction of forces, cross and dot products of vectors, moment of a force about a point and axis, couple and couple moment, transfer of a force to a parallel position, resultant of a force system using vector method, Problems involving vector application

Equilibrium: Static and dynamic equilibrium, static in determinacy, general equations of equilibrium, Varingnon's theorem, Lami's theorem, equilibrium of bodies under a force system, Problems.

UNIT-II

Principles of Lifting Machines: Introduction : Simple Machine , Compound Machine ,Lifting , Mechanical Advantage, Input of a Machine , Output of a Machine , Efficiency of a Machine, Ideal Machine, Velocity Ratio, Relation Between Efficiency, Mechanical Advantage and Velocity Ratio of a Lifting Machine, Reversibility of a Machine, . Condition for the Reversibility of a Machine, Self-locking Machine, Friction in a Machine, Law of a Machine, Maximum Mechanical Advantage of a Lifting Machine, Maximum Efficiency of a Lifting Machine.

Simple Lifting Machines: Introduction :Types of Lifting Machines, Simple Wheel and Axle, Differential Wheel and Axle, Weston's Differential Pulley Block, Geared Pulley Block, Worm and Worm Wheel, Worm Geared Pulley Block, Single Purchase Crab Winch, Double Purchase Crab Winch, Simple Pulley, First System of Pulleys, Second System of Pulleys, Third System of Pulleys, Simple Screw Jack, Differential Screw Jack , Worm Geared Screw Jack.

UNIT-III

Centroid , Centre of mass and Centre of gravity, Determination of centroid, centre of mass and centre of gravity by integration method of regular and composite figures and solid objects, Problems.

Moment of Inertia: Area moment of inertia, mass moment of inertia, parallel axis and perpendicular axis theorems, radius of gyration, polar moment of inertia, product of inertia, principle axis, problem based on composite figures and solid objects.

UNIT-IV

Truss and Frame: Truss, classification of truss, assumptions in truss analysis, perfect truss.

Applications of Friction: Introduction: Ladder Friction,Wedge Friction, Screw Friction, Relation Between Effort and Weight Lifted by a Screw Jack, Relation Between Effort and Weight Lowered by a Screw Jack, Efficiency of a Screw Jack.

Particle Dynamics: Energy methods and momentum methods, Newton's second law of motion; dynamic equilibrium and D'Alembert's principle.

Course Outcomes (COs): At the end of the course, the student shall be able to:

1. Understand the basic force system.
2. Apply principles of particle kinematics.
3. Grasp the concepts of particle dynamics.
4. Learn energy methods & momentum methods.

Recommended Books:-

Engineering Mechanics – Irving H. Shames, PHI Publication
Engineering Mechanics – U.C.Jindal, Galgotia Publication
Engineering Mechanics – A.K.Tayal, Umesh Publication

Course code	26BSC-MATHME-203-H				
Category	Basic Science course				
Course title	**Mathematics III (PDE, Probability & Hypothesis Testing)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-III
	3	0	**0**	**3**	
Branch	Mechanical Engineering				
Classwork	25 Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

1. Formulation, Classification and solution methodologies for first (linear and non-linear, both) and second order PDE with applications inengineering.
2. Understand the concept of probability, random variable and some specific Probability distribution like binomial, Poison, Exponential and normal distributions and their applications in different engineering, science
3. Understand the concept of bivariate random variable and bivariate distribution. Also analyze the correlation and regression problems.
4. Understanding the concept of curve fitting and sampling, hypothesis, and hypothesis testing using various statistical technique like z, t-test and chi square distribution etc.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: **To define** the concepts and terminology of Partial differential equation (PDE) including formulation, classification and solution methodologies for first (linear and non-linear, both) and second order PDE with applications in engineering.

CO2: Understand the concept of Methods of Separation of variables with applications in real world problems.

CO3: **Understand** the concepts and related terminology of probability and statistics including conditional probability, Baye's rule, random variables, expectation, probability distributions, Bivariate distribution and conditional probability density, correlation, regression, tests etc.

CO4: **Apply** the knowledge & ideas ofmethod of least square and standard probability distributions (Binomial, Poisson, Normal, Exponential) in modelling and analysis of real-world problems.

CO5: **Analyze** and**classify various** statistical tests, and justify their selection for solving given engineering and real-world problems.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**1**			**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**1**			**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**2**			**-**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**								

Note: Examiner will set nine (09) questions in all with two questions from each unit and Q.1 is compulsory and covering all Units. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinee have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Formulation of PDE, Lagrange's linear PDEs; First order non-linear PDEs, Charpit's Method. Second-order linear PDE equations and their classification, Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method.

UNIT-II

Initial and boundary conditions, D'Alembert's solution of the wave equation,Separation of variables method to simple problems in Cartesian coordinates. Methods of Separation of variable's applications to one dimensional Heat and Wave Equations, Two-dimensional Heat flow and Laplace equation.

UNIT-III

Probability spaces, conditional probability, Bayes' rule, Discrete random variables, Bernoulli, Binomial, Poisson Probability Distribution. Expectation of Discrete Random Variables, Moments, Correlation coefficient, Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, conditional densities,

UNIT-IV

Co-efficient of Correlation and Rank Correlation, Lines of Regression, Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, Small samples: Tests for single mean, difference of means, Chi-square test for goodness of fit and independence of attributes.

Textbooks/References:

1. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
2. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
3. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
5. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
6. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi Reprint 2013.

Course code	**26LC-ME-213-H**				
Category	Professional Core courses				
Course title	**Fluid Mechanics Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	1. Understand the techniques and concept of stability. 2. Learning continuity and Bernoulli's equation. 3. Learn discharge measuring devices and hydraulic coefficients. 4. Knowledge of different types of pipe losses and determine the velocity profile in a pipe.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To determine the coefficient of impact for vanes.
2. To determine coefficient of discharge of an orificemeter.
3. To determine the coefficient of discharge of Notch (V and Rectangular types).
4. To determine the friction factor for the pipes.
5. To determine the coefficient of discharge of venturimeter.
6. To determine the coefficient of discharge, contraction & velocity of an orifice.
7. To verify the Bernoullis Theorem.
8. To find critical Reynolds number for a pipe flow.
9. To determine the meta-centric height of a floating body.
10. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
11. To show the velocity and pressure variation with radius in a forced vertex flow.
12. To verify the momentum equation.

Course Outcomes (COs): At the end of the course, the student shall be able to:

1. Understand the techniques and concept of stability.
2. Learning continuity and Bernoulli's equation.
3. Analyse discharge measuring devices and hydraulic coefficients.
4. Knowledge of different types of pipe losses and determine the velocity profile in a pipe.

Note: 1. At least eight experiments are to be performed in the semester.

Course code	26**LC-ME-215-H**				
Category	Professional Core Courses				
Course title	**Thermal Engineering Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	1. To understand Vapour power cycles. 2. To understand steam boilers, their types and components. 3. To learn fundamentals of flow of steam through a nozzle. 4. To understand Steam turbines,condensers and compressors.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1.To study low pressure boilers and their accessories and mountings.
2. To study high pressure boilers and their accessories and mountings.
3. To prepare heat balance sheet for given boiler.
4. To study the working of impulse and reaction steam turbines.
5. To find dryness fraction of steam by separating and throttling calorimeter.
6. To find power out put& efficiency of a steam turbine.
7. To find the condenser efficiencies.
8. To study and find volumetric efficiency of a reciprocating air compressor.
9. To study cooling tower and find its efficiency.
10. To find calorific value of a sample of fuel using Bomb calorimeter.
11. Calibration of Thermometers and pressure gauges.

Course Outcome (COs): At the end of the course, the student shall have practical exposure of:

1. Vapour power cycles and find and compare different cycles based on their performance parameters and efficiencies.
2. Steam boilers, their types and components.
3. Fundamentals of flow of steam through a nozzle.
4. Steam turbines and can calculate their work done and efficiencies.
5. Types and working of condensers and compressors and define their different types of efficiencies

Note:

1. At least eight experiments should be performed from the above list.

Course code	**26LC-ME-217-H**				
Category	Professional Core courses				
Course title	**Strength of Materials Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	1. To learn the principles of mechanics of solid and various properties of materials. 2.Able to understand the concepts of stress, strain of materials and ability to interpret the data from the experiments.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To study the Brinell hardness testing machine & perform the Brinell hardnesstest.
2. To study the Rockwell hardness testing machine & perform the Rockwellhardness test.
3. To study the Vickers hardness testing machine & perform the Vickers hardnesstest.
4. To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test.
5. To study the Impact testing machine and perform the Impact tests (Izod &Charpy).
6. To study the Universal testing machine and perform the tensile test.
7. To perform compression & bending tests on UTM.
8. To perform the shear test on UTM.
9. To study the torsion testing machine and perform the torsion test.

Course Outcomes (COs): At the end of the course, the student shall be able to:

1. Learn the principles of mechanics of solid and engineering.
2. Preparation of formal laboratory reports describing the results of experiments.
3. Acquire to operate basic instruments in mechanics of materials lab.
4. Able to understand the concepts of stress, strain of materials and ability to interpret the data from the experiments.

Note:

1. At least Seven experiments are to be performed in the semester.

Course code	**26LC-ME-219-H**				
Category	Engineering Science courses				
Course title	**Engineering Mechanics Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	To understand various basic issues of Mechanical Engineering like IC engines, machines and mechanics of machines.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To calculate the Mechanical Advantage, Velocity Ratio and Efficiency of single start and Double start and Triple start worm & Worm Wheel.
2. To find the Mechanical Advantage, velocity Ratio and Efficiency of a Differential Wheel and Axle.
3. To find Moment of Inertia of a Fly Wheel.
4. To study reciprocal theorem of deflection using a simply supported beam.
5. To study moment area theorem for slopes and deflections of the beam.
6. Experimental and analytical study of 3 hinged arch and influence line for horizontal thrust.
7. Experimental and analytical study of behavior of struts with various end conditions.
8. To study theory of friction.
9. Experiment on a two-hinged arch for horizontal thrust & influence line for Horizontal thrust.
10. Experimental and analytical study of a 3 bar pin jointed Truss.
11. Experimental and analytical study of deflections for unsymmetrical bending of a Cantilever beam.

Course Outcomes: The students who have undergone the course will be able to understand working of IC engines, types of boilers and accessories and understand the basic mechanics.

Note:

1. At least eight experiments are to be performed in the Semester.

Course code	**26LC-ME-221-H**				
Category	Engineering Science courses				
Course title	**Industrial& Production Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	1. To understand and apply flow process charting techniques for men, material, and machine types. 2. To analyze and improve existing processes using flow process charts and diagrams. 3. To apply principles of motion economy and hand motion fundamentals. 4. To perform micro-motion study and multiple activity charting. 5. To calculate standard time and perform stopwatch time study.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To prepare the men type flow process charts & diagrams for a selected Problem.
2. To prepare the material type flow process chart & diagrams for the selected problem according to existing method an Improved.
3. To prepare the m/c type flow process chart & diagrams for a selected problem according to existing method and an improved.
4. To prepare the multiple activity chart & diagrams for a selected problem according to existing method and an involved.
5. Study of principle of fundamental of hand motion.
6. To study and principle of motion economy
7. To study Performance of micro motion study of job.
8. To study man-machines chart of assignment.
9. To study Standard time calculation.
10. To study Stop watch time study of a job.

Course Outcomes:

1. Students will be able to create flow process charts and diagrams for men, material, and machine types.
2. Students will be able to analyze and improve existing processes using flow process charts and diagrams.
3. Students will understand and apply principles of motion economy and hand motion fundamentals.
4. Students will be able to perform micro-motion study and multiple activity charting.
5. Students will be able to calculate standard time and perform stopwatch time study.

Note:

1. At least eight experiments are to be performed in the Semester.

26-AU-ENV-202-H: (ENVIRONMENT SCIENCE)

Theory 70 Marks 30 Marks (Internal Marks)

Unit-1 The Multidisciplinary nature of environment studies. Definition,scope and importance. (2 Lecture)

Unit-2 Natural Resources:

Renewable and non-renewable resources:

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation: deforestation, case studies. Timber extraction, mining dams and their effects on forests and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes, caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Water logging, salinity, case studies.

e) Energy resources: Growing energy needs; renewable and non-renewable energy sources, use of alternate energy sources, case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

g) Role of an individual in conservation of natural resources.

h) Equitable use of resources for sustainable lifestyles. (5 Lecture)

Unit-3 Ecosystems:

* Producers, consumers and decomposers.
* Energy flow in the ecosystem.
* Ecological succession.
* Food chains, food webs and ecological pyramids.
* Introduction, types, characteristic features, structure and function of the following eco-system:

a. Forest ecosystem.

b. Grassland ecosystem.

c. Desert ecosystem.

d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) (5 Lecture)

Unit-4 Biodiversity and its conservation

a) Introduction - Definition: Genetic, Species and ecosystem diversity.

b) Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.

c) Biodiversity at global, National and local levels.

d) India as a mega-diversity nation.

e) Hot-spots of biodiversity.

f) Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.

g) Endangered and endemic species of India.

h) Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. (3 Lecture)

Unit-5 Environmental pollution:

Definition, causes, effects and control measures of:

a) Air pollution.
b) Water pollution
c) Soil pollution
d) Marine pollution
e) Noise pollution
f) Thermal pollution
g) Nuclear hazards

* Solids waste management: causes, effects and control measures of urban and industrial wastes.
* Role of an individual in prevention of pollution.
* Pollution case studies.
* Disaster management: floods, earthquake, cyclone and landslides. (5 Lecture)

Unit-6 Social issues and the Environment:

* From unsustainable to sustainable development.
* Urban problems related to energy.
* Water conservation, rain water harvesting, watershed management.
* Resettlement and rehabilitation of people: its problems and concerns case studies.
* Environmental ethics: Issues and possible solutions.
* Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
* Wasteland reclamation.
* Consumerism and waste products.
* Environment Protection Act.
* Air (Prevention and Control of pollution) Act.
* Water (Prevention and Control of pollution) Act.
* Wildlife Protection Act.
* Forest Conservation Act.
* Issues involved in enforcement of environmental legislation.
* Public awareness. (5 Lecture)

Unit-7 Human population and the Environment.

Population growth, variation among nations.

Population explosion- Family Welfare Programme.

Environment and human health.

Human Rights.

Value Education.

HIV/AIDS.

Woman and Child Welfare

Role of Information Technology in Environment and human health.

Case Studies. (5 Lecture)

Unit-8 Field Work :

* Visit to a local area to document environmental assets - river/forest/grassland/hill/mountain.
* Visit to a local polluted site-urban/Rural/ Industrial/ Agricultural.
    * Study of common plants, insects, birds.
* Study of simple ecosystems- pond, river, hill slopes, etc.. (15 Lecture)

References

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Pub. Ltd. Bikaner.
2. Bharucha, Frach, The Biodiversity of India, MApin Publishing Pvt. Ltd. Ahmedabad-380013, India, E-mail : mapin@icenet.net(R).
3. Brunner R.C. 1989, Hazardous Waste Incineration, Mc. Graw Hill Inc. 480p.
4. Clark R.S., Marine pollution, Slanderson Press Oxford (TB).
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Pub. House, Mumbai 1196 p.
6. De A.K., Environmental Chemistry, WileyEastern Ltd.
7. Down to Earth, Centre for Science and Environment (R).
8. Gleick, H.P., 1993. Water in crisis, Pacific Institute for Studies in Dev. Environment & Security Stockholm Env. Institute, Oxford Univ. Press, 473p.
9. Hawkins R.E. Encyclopedia of Indian Natural History, Bombay Natural HistorySociety, Bombay(R).
10. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment, Cambridge Uni. Press 1140p.
11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284p.
12. Mackinney, M.L. & Schoch, RM 1996, Environmental Science systems & solutions, Web enhanced edition. 639p.
13. Mhaskar A.K., Mayyer Hazardous, Tekchno-Science Publications (TB).
14. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB).
15. Odum, E.P. 1971, Fundamentals of Ecology. W.B. Saunders Co. USA, 574p.
16. Rao M.N. & Datta, A.K. 1987 Waste Water Treatment. Oxford & TBH Publ. Co. Pvt. Ltd. 345p.
17. Sharma, B.K. 2001, Environmental Chemistry, Goal Publ. House, Meerut.
18. Survey of the Environment, The Hindu (M).
19. Townsend C., Harper J. and Michael Begon. Essentials of Ecology, Blackwell Science (TB).
20. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Comliances and Standards, Vol. I and II Enviro Media (R).
21. Tridevi R.K. and P.K. Goal, Introduction to air pollution, Techno Science Publications (TR).
22. Wagner K.D., 1998, Environmental Management, W.B. Saunders co. Philadelphia, USA 499p.
23. Atext book environmental education G.V.S. Publishers byDr. J.P. Yadav.

(M)Magazine, (R)Reference, (TB) Textbook

The scheme of the paper will be under:

The subject of Environmental Studies will be included as a qualifying paper in all UG Courses and the students will be required to qualify the same otherwise the final result will not be declared and degree will not be awarded.

The examination willbe conducted along with the semester examinations.

Exam. Pattern: In case of awarding the marks, the paper will carry

100 marks. Theory: 70 marks, Internal Marks: 30 marks.

The structure of the question paper will be:

Part- A: Short Answer Pattern	:	10	marks
Part- B:EssayType with inbuilt choice	:	60	marks

Instructions for Examiners:

Part-A: Question No. 1 is compulsory and will contain five short- answer type question of 2 mark each covering the entire syllabus.

Part-B: Eight essay type questions (with inbuilt choice) will be set from the entire syllabus and the candidate will be required to answer any four of them. Each essay type question will be of 15 marks.

The examination of the regular students will be conducted by the concerned college/Institute. Each student will be required toscore minimum 40% marks separately in theory and practical/Fieldvisit. The marks in this qualifying paper will not be included indetermining the percentage of marks obtained for the award of degree.

However, these marks will be shown in the detailed marks certificate

Course code	**26PCC-ME-223-H**				
Category	Professional Core Courses				
Course title	**Advanced Thermodynamics**				
Scheme and Credits	L	T	P	**Credits**	Semester-III
	3	0	0	3	
Objectives:	• To impart knowledge on the fundamentals of theory of energy, its quality and significance for the applications of thermal systems. To impart knowledge on the analysis of simple compressible and multicomponent systems. • To impart knowledge on the different thermodynamic property relations, applications, power,refrigeration cycles and use of thermodynamics in daily life.				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit. Use of steam tables with mollier chart is permissible in the examination hall.

UNIT-I

Basic concepts, work, heat, and first law of thermodynamics: Macroscopic and microscopic views, state, property, interaction by contact, work, the first law, heat, energy, and characteristics of an object. The second law of thermodynamics: Reversible process, Caratheodory's formulation, entropy, entropy change in an irreversible process, corollaries of second law, and applications.

UNIT-II

Analysis of simple compressible systems and other simple systems: Basic governing equations, thermodynamic relations, equation of state, cubic equations, generalized compressibility chart, and applications. Analysis of open systems, exergy and irreversibility: Conservation of mass and energy, steady and transient states, maximum work potential of open and closed systems, exergy analysis of simple processes, and heat engines producing maximum power.

UNIT-III

Multicomponent systems: Fundamental property relationships, partial molar properties, equation of state for mixtures, chemical potential, and fugacity. Phase equilibrium in multicomponent and reactive mixtures: Conditions for equilibrium, analysis phase equilibrium, stability, mass balance, first law analysis, second law analysis, work potential of a chemical reaction, chemical exergy.

UNIT-IV

Power and refrigeration cycles: Periodic heat engines, vapor power cycles, and gas power cycles, modified vapor compression cycles, actual vapor compression cycles, gas refrigeration and absorption

Course code	**26LC-ME-225-H**

refrigeration cycles. Non equilibrium thermodynamics and thermodynamics in daily life: Basic postulates, thermoelectric phenomenon, thermal diffusion, the first and second law in daily life.

Course Outcomes:

1. Students will be able to understand theoretical principles of energy and exergy analysis, behavior of real and ideal gases, thermodynamic property relations and reactive systems. analyze thermodynamic processes in daily routine life and in various industries.

Text Books:

1. Dhar, P.L, "Engineering Thermodynamics- a generalized approach", Elsevier Ltd., 1st ed. 2008.
2. A. Bejan, "Advanced Engineering thermodynamics", John Wiley and Sons, 3rd ed. 2006.
3. G. Rogers and Y. Mayhow, "Engineering thermodynamics", Prentice Hall, 4th ed. 1996.
4. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
5. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
6. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics,JohnWiley and Sons.
7. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Category	Professional Core Courses				
Course title	**Advanced Thermodynamics Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	• To understand Vapour power cycles. • To understand steam boilers, their types and components. • To learn fundamentals of flow of steam through a nozzle. • To understand Steam turbines,condensers and compressors.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. Performance Test on IC Engines: Conducting load tests on 4-stroke petrol or diesel engines to determine efficiency, air-fuel ratio, and heat balance sheets.
2. Bomb Calorimeter: Determining the calorific value (heating value) of solid or liquid fuels.
3. Reciprocating Air Compressor: Measuring the volumetric efficiency and isothermal efficiency of single or two-stage air compressors.
4. Steam Generator/Boiler Study: Studying low/high-pressure boilers, their mountings, and accessories.
5. Refrigeration and Air Conditioning: Studying the vapor compression refrigeration cycle and determining the coefficient of performance (COP).
6. Calibration of Instruments: Calibrating pressure gauges and thermometers.
7. Dryness Fraction of Steam: Determining the dryness fraction of steam using calorimeters.

Course Outcome (COs): At the end of the course, the student shall have practical exposure of analyzing energy conversion, heat transfer, and engine performance. Common experiments include studying 4-stroke petrol/diesel engines, calculating fuel calorific values via bomb calorimeter, assessing steam generator efficiency, and studying refrigeration/air conditioning cycles.

Note:

1. At least five experiments should be performed from the above list.

SEMESTER-IV

SYLLABUS

Course code	**26PCC-ME -202-H**				
Category	Professional Core Courses				
Course title	**Fluid Machines**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Objectives:	The students completing this course are expected to understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Impact of free jets: Impulse – momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships, Problems.

Impulse Turbines: Classification – impulse and reaction turbines, water wheels, component parts, construction, operation and governing mechanism of a Pelton wheel, work done, effective head, available head and efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio, number of jets, number of buckets and working proportions, Performance Characteristics, governing of impulse turbines, Problems.

UNIT-II

Francis Turbines: Component parts, construction and operation of a Francis turbine, governing mechanism, work done by the turbine runner, working proportions and design parameters, slow, medium and fast runners, degree of reaction, inward/outward flow reaction turbines, Performance Characteristics, Problems.

Propeller and Kaplan turbines: Component parts, construction and operation of a Propeller, Kaplan turbine, differences between the Francis and Kaplan turbines, draft tube - its function and different forms, Performance Characteristics, Governing of reaction turbine, Introduction to new types of turbine, Deriaz(Diagonal), Bulb, Tubular turbines, Problems.

UNIT-III

Dimensional Analysis and Model Similitude: Dimensional homogeneity, Rayleigh's method and Buckingham's πtheorem, model studies and similitude, dimensionless numbers and their significance. Unit quantities, specific speed and model relationships for turbines, scale effect, cavitations – its causes, harmful effects and prevention, Thomas cavitation factor, permissible installation height, Problems.

Centrifugal Pumps: Classification, velocity vector diagrams and work done, manometric efficiency, vane shape, head capacity relationship and pump losses, pressure rise in impeller, minimum starting speed, design considerations, multi-stage pumps. Similarity relations and specific speed, net positive suction head, cavitation and maximum suction lift, performance characteristics. Brief introduction to axial flow, mixed flow and submersible pumps, Problems.

UNIT-IV

Reciprocating Pumps: Construction and operational details, discharge coefficient, volumetric efficiency and slip, work and power input, effect of acceleration and friction on indicator diagram (pressure – stroke length plot), separation, air vessels and their utility, rate of flow into or from the air vessel, maximum speed of the rotating crank, characteristic curves, centrifugal vs reciprocating pumps, brief introduction to screw, gear, vane and radial piston pumps, Problems.

Hydraulic systems: Function, construction and operation of Hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift and hydraulic press, Fluid coupling and torque converter, Hydraulic ram, Problems.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Application of momentum equation and its application.
CO 2- Understand the construction, working principle and design analysis of hydraulic turbines.
CO 3- Expedite construction, working principle and design analysis of pumps.
CO 4- Knowledge of the design of a prototype on the basis of dimensional analysis.

Text Books:

1. Fluid Mechanics and Hydraulic Machines – Mahesh Kumar, Pearson Indian Education Service Pvt. Ltd. India.
2. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi
3. Hydraulic Machines – Jagdish Lal, Metropolitan

References:

1. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers
2. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill
3. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons.

Course code	**26PCC-ME-204-H**				
Category	Professional Core Courses				
Course title	**Engineering Materials & Applications**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Objectives:	1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria. 2. To provide a detailed interpretation of equilibrium phase diagrams 3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Crystal Structure: Unit cells, Space Lattice, Coordination Number, Metallic crystal structures, Imperfection in solids: Point, Line, Interfacial and Volume defects; Sources of Dislocations - their effects and remedies, Critically resolved shear stress.

Mechanical Properties of metals,Hooke's law, Stress-Strain Diagram, Yield Point Phenomenon, Strain Aging, Recovery - Recrystallization and Grain Growth, Strain Hardening, Mechanism of Strain Hardening, Bauschinger Effect.

UNIT-II

Static failure theories: Ductile and brittle failure mechanisms, Fracture mechanics: Types of Fracture in metals, Griffith theory of Brittle fracture, Ductile Fracture, Fatigue failure: Factors to cause Fatigue Failure, Fatigue Test, Effect of Stress concentration on Fatigue, Effect of Temperature on Fatigue,Effect of Metallurgical variables on fatigue properties SN curve, Creep: Creep Limit, Creep Test, Creep Curve, Creep Curve at Constant Temperature,Effect of Metallurgical variables on Creep,

UNIT-III

Cooling Curve of Pure Metal, Dendritic Solidification of Pure Metal, Effect of Grain Size on Mechanical Properties, Alloys, Importance of Alloys, Classification of Alloys, Cooling Curves for Binary Alloys, Interpretation of simple eutectic diagram, Eutectic Structure, Solid Solution

Equilibrium Diagram, Combination type Equilibrium Diagram, Peritectic reaction diagram, Allotropic form of Iron, Constituents of Iron and Steel, Iron-Carbon Equilibrium Diagram, TTT Diagram, Austempering or Isothermal Quenching, Martempering or stepped quenching, Tempering.

UNIT-IV

Heat treatment of Steel: Objectives of Heat Treatment, Heat treatment Processes: Annealing, Normalising, Spheroidising, Hardening, Quenching Technique, Case Hardening: Carburising, Nitriding, Cyaniding, Induction Hardening, Flame Hardening.

Properties of Cast Iron, Types of Cast Iron, Effects of Impurities and Alloying elements on Cast Iron, Effects of Alloying Elements on Steel, Silicon Steel, Heat Resisting Steel, Aluminium Alloys, Functions of Alloying Elements in Aluminium.

Course Outcomes:

1. Student will be able to identify crystal structures for various materials and understand the defects in such structures
2. Understand how to tailor material properties of ferrous and non-ferrous alloys
3.How to quantify mechanical integrity and failure in materials

Text Books:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Course code	**26PCC-ME-206-H**				
Category	Professional Core Courses				
Course title	**Manufacturing Technology-I**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Objectives:	To impart knowledge on: - Metal casting processes - Plastic deformation of metals (rolling, extrusion, forging, sheet metal working) - Basic welding processes and selection - Metal cutting, tool life, jigs, and fixtures - Machine tools and metrology fundamentals.				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Metal Cutting & Tool Life: Introduction, basic tool geometry, single point tool nomenclature, single point tool signature, Chips types and their characteristics, mechanics of chips formation, orthogonal and oblique metal cutting, Cutting Parameters: Cutting Speed, Feed, Depth of Cut, Tool life relationship, Tailor equation of tool life, Tool Wear and types of tool wear, Mechanics of Tool Wear
Surface Cleaning: Purpose of Cleaning, Surface Cleaning Methods and Selection of Cleaning Processes, Mechanical Methods, Ultrasonic Cleaning, Flame Cleaning, Chemical Cleaning Processes.

UNIT-II

Jigs and Fixtures: Introduction, Purpose and Advantages of Jigs and Fixtures, Important Considerations while Designing Jigs and Fixtures, Meaning of Location, Principles of Locations, Different Methods Used for Locations, Clamping, Different Types of Clamps, Different types of Jigs and Fixtures

Metrology: Measurement, Line Standard Angular Measuring Devices: Protractors, Universal Bevel Protractors, Face Standard Angular Measuring Devices: Sine Bar, Measurement of Inclines: Spirit Level, Clinometer, Auto-collimator, Comparator- mechanical, electrical, optical, Basic Characteristics of Surface finish, Surface Integrity,SurfaceMetallurgy,Factors on which surface finishing of machined component depends.

UNIT-III

Machine Tools: Introduction, Lathe machine: Constructional features and operations, Specification of Lathe machine, Difference between Shaper and Planner, Drilling machining and its types, Working principles and difference between capstan and turret lathes.

Metal Casting Process: Introduction, Foundry: Introduction to Casting Processes, Basic Steps inCasting Processes. Pattern: Types of Pattern and Allowances. Sand Casting: Sand Characteristics, Constituents and Preparation. Core making and its Types, Cupola Furnace, Fettling. Inspection of Castings, Sand Casting Defects & Remedies.

UNIT-IV

Welding: Introduction to Welding, Classification of Welding Processes, Gas Welding: Oxy-AcetyleneWelding, Resistance Welding: Resistance welding principle, Spot and Seam Welding, Arc Welding: Metal Arc, TIG & MIG Welding, Submerged arc welding (SAW), Thermit welding, Laser beam welding, Welding Defects and remedies, Brazing & Soldering.

Forming Processes: Basic Principle of Hot & Cold Working, Hot & Cold Working Processes, Hot working Processes: Rolling, Extrusion, Forging, Wire Drawing, Sheet Metal Operations: Measuring, Layout marking, Shearing, Punching, Blanking, Piercing, Forming, Bending and Joining.

Course Outcome (COs): At the end of the course, the student shall be able to:

CO 1- Demonstrate the knowledge about different metal casting processes.

CO 2- Understand the plastic deformation of metals under rolling, extrusion, forging and sheet metal working.

CO 3- Acquire knowledge about basic welding processes and their selection for fabrication of different components.

CO 4 - Learn about different Metal Cutting & Tool Life, Jigs and Fixtures.

CO 5- Acquire the basics of Machine Tools and Metrology.

References Books: 1. Manufacturing Engineering Technology, K. Jain, Pearson Education

2. Manufacturing Technology: Foundry, Forming and Welding by P.N.Rao, TMH.

3. Principles of Manufacturing Materials and Processes, James S.Campbell, TMH.

4. Welding Metallurgy by G.E.Linnert, AWS.

5. Production Engineering Sciences by P.C.Pandey and C.K.Singh, Standard Publishers Ltd.

6. Manufacturing Science by A.Ghosh and A.K.Mallick, Wiley Eastern

Course code	**26PCC-ME-208-H**				
Category	Professional Core Courses				
Course title	**Measurement and Metrology**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Objectives:	1. To provide a basic knowledge about measurement systems and their components 2. To learn about various sensors used for measurement of mechanical quantities 3. To learn about system stability and control 4. To integrate the measurement systems with the process for process monitoring and control				
Class Work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Measurement systems and performance – accuracy, range, resolution, error sources; Instrumentation system elements – sensors for common engineering measurements; Signal processing and conditioning;

Instruments and Their representation: Introduction, Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Classification of Instruments, Standards and Calibration.

UNIT-II

Transducer Elements : Introduction, Analog and Digital Transducers, Electromechanical; Potentiometric,Inductive Self Generating and Non-Self Generating Types, Electromagnetic, Electrodynamic, Eddy Current,Magnetostrictive, Variable Inductance.

Linearly Variable Differential Transformer, Variable Capacitance, PiezoElectric Transducer and Associated Circuits, Unbonded and Bonded Resistance Strain Gages. Strain Gage Bridge circuits,Ionisation Transducers, Mechano Electronic Transducers, Opto-Electrical Transducers, Photo Conductive Transducers, Photo Volatic Transducers.

UNIT-III

Motion, Force and Torque Measurement: Introduction, Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moire-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass & Force Balance Type, Hydraulic Load Cell, Pneumatic Load Cell, Elastic Force Devices, Strain Gage, Torque Transducer, Toque Meter. Amplifiers: Mechanical, Hydraulic, Pneumatic, Optical, Electrical, Amplifying elements.

Temperature Measurement: Introduction, Measurement of Temperature, Non-Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Liquid-in-Glass thermometer, Pressure Thermometer, Electrical Methods – Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, Thermocouple Materials, Radiation Methods (Pyrometry), Total Radiation Pyrometer, Selective Radiation Pyrometer.

UNIT-IV

Control systems – basic elements, open/closed loop, design of block diagram; control method – P, PI, PID, when to choose what, tuning of controllers; System models, transfer function and system response, frequency response; Nyquist diagrams and their use.

Pressure and Flow Measurement: Moderate Pressure Measurement, Monometers, High Pressure Transducer, Low Pressure Measurement, Quantity Meters, Positive Displacement Meters, Flow Rate Meters, Variable Head Meters, Variable Area Meters, Rotameters, Pitot-Static Tube Meter, Drag Force Flow Meter, Turbine Flow Meter, Electronic Flow Meter, Electro Magnetic Flow meter, Hot-Wire Anemometer.

Course Outcomes:

Upon completion of this course, the students will be able to understand the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices automatically.

Text Books:

1.Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 200
2.Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6th Edition) 6th Edition, Pearson Education India, 2007
3.Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York,1999.

Course code	**26PCC-ME-210-H**				
Category	Professional Core Courses				
Course title	**Solid Mechanics**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Objectives:	The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.Apply and use energy methods to find force, stress and displacement in simple structures and springs.Understand and determine the stresses and strains in pressure vessels. Knowledge of stress functions, and calculate stresses in rotating rings, discs, and curved beams.				
Class Work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's & Maxwell's theorems, Numericals.

UNIT-II

Various theories of elastic failure with derivations and graphical representations:Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, Maximum strain energy theory, Distortion energy (von Mises) theory. Applications of failure theories to problems involving **two-dimensional stress systems**, including:(i) combined direct loading and bending (ii) combined torsional and direct loading.

Direct and Bending Stresses: Stresses under the combined action of **direct loading and bending moment**. Conditions for stability. Stresses due to direct loading and bending moment about both principal axes

UNIT-III

Thin Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in dia, and volume of thin cylinders.

Thick Cylinders: Introduction - Lame's theory for thick cylinders – Derivation of Lame's formulae – distribution of hoop and radial stresses across thickness – design of thick cylinders – compound cylinders – Necessary difference of radii for shrinkage – Thick spherical shells.

UNIT-IV

Springs: Stresses in open-coiled helical springs subjected to axial loads and twisting moments. Analysis of leaf springs, flat spiral springs, and concentric springs. Numerical problems related to combined stresses, failure theories and springs.

Unsymmetrical Bending: Properties of beam cross section, product of inertia, ellipse of inertia, slope of the neutral axis, stresses & deflections, shear center and the flexural axis, Winkler Bach formula,Numericals.

Course Outcomes (COs): After studying this course, students will be able:

CO 1- Apply and use energy methods to find force, stress and displacement in simple structures and springs.

CO 2- Understand and determine the stresses and strains in pressure vessels.

CO 3- Knowledge of stress functions, and calculate stresses in rotating rings, discs, and curved beams.

CO 4- Evaluate the behaviour and strength of structural elements subjected to three dimensional stress system.

Text Books: 1. Strength of Materials – G.H.Ryder, Third Edition in SI Units 1969 Macmillan, India.

2. Strength of Materials – Sadhu Singh, Khanna Publishers
3. Strength of Materials by R. K. Bansal, Lakshmi Publications, 16th Edition, 2022.

References: 1. Book of Solid Mechanics – Kazmi, Tata Mc Graw Hill

2. Strength of Materials – D.S. Bedi - S. Chand & Co. Ltd. 3. Strength of Materials – U.C Jindal - Pearson India Ltd.
3. A Textbook of Strength of Materials, by R. K. Rajput, 7e (Mechanics of Solids) SI Units S. Chand & Co, NewDelhi 7th edition 2022.
4. Strength of Materials by S.S.Ratan Tata McGrill Publications 3rd Edition, 2016.

Course code	**26PCC-ME-212-H**				
Category	Professional Core Courses				
Course title	**Computer Aided Design & Manufacturing**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Objectives:	• Understand the fundamentals of various Computer Aided Design, basics of geometric modeling, curves surfaces, solids and Additive Manufacturing Technologies for application to various industrial needs. • Learn what Additive manufacturing (AM) is and understand why it has become one of the most important technology trends in decades for product development and innovation. • Differentiate between subtractive and Additive manufacturing.				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Introduction to CAD/CAM/CAE and Digital Design Environment

Introduction to Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM) and Computer-Aided Engineering (CAE). Product design cycle and design process. Role, importance and necessity of CAD/CAM in modern manufacturing. Applications of CAD/CAM in mechanical, aerospace, automotive and biomedical industries. CAD system architecture: hardware components, input/output devices, graphics display systems and software requirements.

Comparison between **subtractive manufacturing (machining)** and **additive manufacturing (AM)**.

Fundamentals of Additive Manufacturing: Principle of AM, workflow of AM processes, basic steps in AM (CAD model generation, STL conversion, slicing, toolpath generation, fabrication and post-processing). Classification of AM technologies. Applications of AM in various sectors including aerospace, automotive, biomedical, bio-printing, tissue and organ engineering, architectural engineering, surgical simulation, art, healthcare and customized manufacturing.

UNIT-II

Geometric Modeling and Transformations

Basics of geometric and solid modeling, coordinate systems. Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations. Curves: Algebraic and geometric forms, reparametrization, Analytical and Synthetic curves, cubic splines, Bezier curves and B-spline curves.

Surfaces and Solids: Plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-spline surface, Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition.

UNIT-III

Additive Manufacturing and Design for AM

Introduction to Design for Additive Manufacturing (DfAM). Software tools and data formats used in AM. Direct Digital Manufacturing (DDM) and digital workflow. Classification and working principles of major additive manufacturing technologies: Vat Photopolymerization, Material Extrusion, Material Jetting, Binder Jetting, Powder Bed Fusion, Directed Energy Deposition, Sheet Lamination. Materials used in additive manufacturing: polymers, metals, ceramics and composites. Effect of significant process parameters on build quality, mechanical properties and surface finish. Applications of AM in rapid prototyping, rapid tooling and functional part manufacturing.

UNIT-IV

Computer Aided Engineering and Advanced Manufacturing Systems

Introduction to Finite Element Method (FEM). Steps in Finite Element Analysis (FEA): discretization, element formulation, assembly and solution. Finite element modeling and boundary conditions. Analysis of one-dimensional and two-dimensional structural problems.

Flexible Manufacturing Systems (FMS): Introduction, components of FMS, types of FMS, FMS layouts, planning and implementation of FMS, advantages and industrial applications.

Computer Aided Process Planning (CAPP): Introduction to process planning, conventional process planning methods, types of CAPP (variant and generative), steps involved in variant process planning and implementation of CAPP in manufacturing systems.

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

1. Demonstrate the knowledge of Computer Aided design and Additive Manufacturing.
2. Able to understand the concept of wireframe modeling, surface modeling and solid modeling.
3. Able to understand the method of manufacturing of liquid based, powder based and solid based techniques

References:

1. CAD/ CAM by Groover and Zimmer, Prantice Hall.
2. CAD/ CAM Theory and Practice by Zeid, McGraw Hill
3. Numerical Control and Computer Aided Manufacturing by Kundra, Rao & Tiwari, TMH.
4. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014.

S. No	NEPTEL course name	Instructor	Host Institute
1.	Computer Aided Design and Manufacturing. https://nptel.ac.in/courses/112102101	Prof. Anoop Chawla, Prof. P.V. Madhusudan Rao	IIT Delhi

Course code	**26LC-ME-214-H**				
Category	Professional Core Courses				
Course title	**Fluid Machines Lab**				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	0	0	2	1	
Objectives:	(i) To understand the principles and performance characteristics of flow and thermal devices. (ii) To know about the measurement of the fluid properties. (iii)To understand the theory, working and performance characteristics of various hydraulic machines like pumps and turbines.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To study the constructional details of a Pelton turbine and draw its fluid flow circuit.
2. To draw the following performance characteristics of Pelton turbine-constant head, constant-speed and constant efficiency curves.
3. To study the constructional details of a Francis turbine and draw its fluid flow circuit.
4. To draw the constant head, constant speed and constant efficiency performance characteristics of Francis turbine.
5. To study the construction details of a Kaplan turbine and drawits fluid flow circuit.
6. To drawthe constant head, speed and efficiency curves for a Kaplan turbine.
7. To study the constructional details of a Centrifugal Pump and draw its characteristic curves.
8. To study the constructional details of a Reciprocating Pump and draw its characteristics curves.
9. To study the construction details of a Gear oil pump and its performance curves.
10. To study the constructional details of a Hydraulic Ram and determine its various efficiencies..
11. To study the constructional details of a Centrifugal compressor.
12. To study the model of Hydro power plant and draw its layout.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Understand the concept of momentum equation.

CO 2- Knowledge of construction, working principle and performance of hydraulic turbines.

CO 3- Learn construction, working principle and performance of pumps.

CO4- Explore construction, working principle and performance of hydraulic ram.

NOTE:

1. At least ten experiments are to be performed in the Semester.
2. At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

Course code	**26LC-ME-216-H**				
Category	Professional Core Courses				
Course title	**Materials & Metallurgical Engineering Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	1. Learn the principles of materials science and engineering though lab investigation. 2. Understand the basics structure of materials and ability to interpret the data from the experiments.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To study the different Mechanical Properties of metals.
2. To study crystal structures of a given specimen.
3. To study crystal imperfections in a given specimen.
4. To study different constituents of Iron and Steel
5. To study Allotropic form of Iron
6. To study heat treatment processes (Annealing, Hardening and Normalizing) of steel specimen.
7. To study Iron-Carbon Equilibrium Diagram.
8. To study the heat treatment processes- Austempering, Martempering and Tempering.
9. To study the Fatigue failure with Fatigue test on a specimen
10. To study the creep failure with creep curve of a given specimen.
11. To study the different Case Hardening Processes.
12. To study the Continuous cooling curves (TTT Diagram).

Course Outcomes:

1- Learn the principles of materials science and engineering though lab investigation.

2- Prepare formal laboratory reports describing the results of experiments.

3- Operate basic instruments in materials science and engineering.

4- Understand the basics structure of materials and ability to interpret the data from the experiments.

Note:-

1. **At least eight experiments are to be performed in the semester.**

Course code	**26LC-ME-218-H**				
Category	Professional Core Courses				
Course title	**Measurement and Metrology Lab**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	1 - To understand about the applications of measurement systems. 2 - To understand about the basics and working principle of pressure, temperature and flow measurement. 3 - Identify the different variation of measurement parameter with various input conditions. 4 - To analyze the primary, secondary and tertiary measurements. 5 - To learn about the various control devices and parts of measurement systems.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To Study various Temperature Measuring Instruments
   (a) Mercury – in glass thermometer
   (b) Thermocouple
2. To study the working of Bourdon Pressure Gauge and to check the calibration of the gauge in a dead-weight pressure gauge calibration set up.
3. To study a Linear Variable Differential Transformer (LVDT) and use it in a simple experimental set up to measure a small displacement.
4. To measure load (tensile/compressive) using load cell on a tutor.
5. To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer.
6. To measure the speed of a motor shaft with the help of non-contact type pick-ups (magnetic or photoelectric).
7. To measure the stress & strain using strain gauges mounted on simply supported beam/cantilever beam.
8. To measure static/dynamic pressure of fluid in pipe/tube using pressure transducer/pressure cell.
9. Vibration measurement.
10. To study various types of measurement Error.

Course Outcomes:

1 - To understand about the applications of measurement systems.

2 - To understand about the basics and working principle of pressure, temperature and flow measurement.

3 - Identify the different variation of measurement parameter with various input conditions.

4 - To analyze the primary, secondary and tertiary measurements.

5 - To learn about the various control devices and parts of measurement systems

Note: 1. At least eight experiments are to be performed in the Semester.

Course code	**26LC-ME-220-H**				
Category	Professional Core Courses				
Course title	**Manufacturing Technology Lab-I**				
Scheme and Credits	L	T	P	**Credits**	
	0	0	2	1	
Objectives:	1. To understand different types of Machine tool and operations performed 2. To know about the different Welding processes and their applications 3. To understand the mechanics of different types of Chips formation during metal cutting processes. 4. To understand about the various types of Sheet metal processes.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

1. To Prepare a Job involving Facing, Turning and Step Turning on Lathe Machine.
2. To Prepare a Dovetail Lap Joint and Cross Half Lap Joint in Carpentry Shop.
3. To Prepare the Lap Joint and Butt Joint using Arc Welding Process.
4. To Prepare M.S Plate into required model by V- fitting and make a V- fitting from the given two M.S pieces in Fitting Shop.
5. To Study the different Sheet metal operations: Shearing, Punching, Blanking, Piercing, Forming, Bending and Joining.
6. To Study the Gas Welding: Oxy-Acetylene Welding and Resistance Welding processes in detail.
7. To Study the different Types of Patterns and their Allowances in detail.
8. To Study the Orthogonal and Oblique metal cutting operations in detail.
9. To Study the types of Chips and Mechanics of Chips formation in metal cutting operation.
10. To Study the different types of Jigs and Fixtures with their Industrial advantages.
11. To Study the different operations performed on Lathe machine with specification of Lathe machine.
12. To study Shaper machine, parts of shaper machine and its Quick Return Mechanism.

Course Outcomes: At the end of the course, the student shall have practical exposure of:

CO 1- Prepare different jobs in Machine, Fitting, Welding and Carpentry Shops
CO 2- Various types of Chips formation and Mechanics of Chip Formation
CO 3- Understand about the Orthogonal and Oblique metal cutting operations
CO 4- Understand about the Lathe and Shaper Machine operations
CO 5- Understand about the Arc welding, Gas and Resistance Welding processes.

Note:-

1. **At least ten experiments are to be performed in the semester.**

Course code	**26LC-ME-222-H**				
Category	Engineering Science courses				
Course title	**COMPUTER AIDED DESIGN & MANUFACTURING LAB**				
Scheme and Credits	L	T	P	**Credits**	Semester-V
	0	0	2	1	
Objectives:	At the end of the course, the student shall be able to: Display of the basic fundamentals of modeling package. Explore the surface and solid modeling features. Learning the techniques of 3D modeling of various mechanical parts.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

List of Experiments:

The students will be required to carry out the following exercises using software packages (e.g. Solid works / Pro Engineer/AutoCAD/ I-Deas/ Solid Edge/CURA etc.)

1. CAD Modeling Assignments
   (i) Use and learn import/export techniques and customization of software.
   (ii) Construction of simple machine parts and components like Coupling, Crankshaft, Pulley, Piston , Connecting rod, nuts, bolts, gears and helical springs
   (iii) Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies: Lathe Tail stock, Machine vice, Pedestal bearing, Drill jigs and Milling fixture.
   (iv) Make the part family/family table of a bolt.
2. CAM Assignments Tool path generation, Part programming, G & M codes development for machining operations, Physical interpretation of machining features and tool geometries.
3. To perform reverse engineering of a product using 3D scanner.
4. To print coupling, crankshaft, pulley, piston, connecting rod, nuts, bolts with FDM 3D printer with suitable filament like Nylon, ABS etc.
5. To print a product with FDM 3D printer which is developed with reverse engineering.
6. To Draw Orthographic projection Drawings (Front, Top and side) of boiler safety valve giving name the various components of the valve.
7. Make an Isometric dimensioned drawing of a connecting Rod using isometric grid and snap.
8. Draw 3D models by extruding simple 2D objects, dimension and name the objects.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO 1- Display of the basic fundamentals of modeling package.
CO 2- Explore the surface and solid modeling features.
CO 3- Learning the techniques of 3D modeling of various mechanical parts.
CO 4- To expedite the procedure and benefits of FEA and CAE.

Note:-

1. At least Five experiments are to be performed in the semester.
2. At least five experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.
3. The students will be required to carry out the following exercises using educational software (AutoCAD, I-DEAS, Pro-Engineer etc).

Course code	**26PCC-ME-224-H**				
Category	Professional Core Courses				
Course title	Product Design and Development				
Scheme and Credits	L	T	P	**Credits**	Semester-IV
	3	0	0	3	
Objectives:	To Design products creatively while applying engineering design principles. • To Apply principles of human factors, ethics and environmental factors in product design. • To Work in groups or individually in their pursuit of innovative product design. • To implement value design for optimum product cost.				
Class work	25 Marks				
Exam	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

Note: Examiner will set 9 questions in all. Q1 is compulsory and of short answer type covering all the four units. Remaining eight questions are to be set by taking two questions from each unit. Each question carries equal marks (10 marks). Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Product Development Process: General problem-solving process - Flow of Work during the process of designing - Activity Planning Timing and scheduling, Planning Project and Product Costs - Effective Organization Structures - Interdisciplinary Cooperation, Leadership and Team behaviour.

Task Clarification: Importance of Task Clarification - Setting up a requirements list - Contents, Format, Identifying the requirements, refining and extending the requirements, Compiling the requirements list, Examples. Using requirements lists - Updating, Partial requirements lists, Further uses - Practical applications of requirements lists.

UNIT-II

Conceptual Design: Steps in Conceptual Design. Abstracting to identify the essential problems - Aim of Abstraction, Broadening the problem. Formulation, Identifying the essential problems from the requirements list, establishing functions structures, Overall function, Breaking a function down into sub-functions. Developing working structures - Searching for working principles, Combining Working Principles, Selecting Working Structures, Practical Application of working structures. Developing Concepts - Firming up into principle solution variants, Evaluating principle solution variants, Practical Applications of working structures. Examples of Conceptual Design - One Handed Household Water Mixing Tap, Impulse - Loading Test Rig.

UNIT-III

Embodiment Design: Steps of Embodiment Design, Checklist for Embodiment Design Basic rules of Embodiment Design Principles of Embodiment Design - Principles of Force Transformations, Principles of Division of Tasks, Principles of Self Help, Principles of Stability and Bi-Stability, Principles of Fault-Free Design Guide for Embodiment Design - General Considerations, Design to allow for expansion, Design to allow for creep and relaxation, Design against Corrosion, Design to minimize wear, Design to Ergonomics, Design for Aesthetics, Design for Production, Design for

Assembly, Design forMaintenance, Design for Recycling, Design for Minimum risk, Design to standards. Evaluation of Embodiment Designs.

UNIT-IV

Mechanical Connections, Mechatronics and Adaptronics: Mechanical Connections - General functions and General Behaviour, Material connections, From Connections, Force connections, Applications. Mechatronics - General Architecture and Terminology, Goals and Limitations, Development of Mechatronic Solution, Examples. Adaptronics - Fundamentals and Terminology, Goals and Limitations, Development of Adaptronics Solutions, Examples.

Course Outcomes: After successful completion of the course, the student will be able to • Apply knowledge of basic science and engineering fundamentals • Undertake problem identification, formulation and solution • Understanding of the principles of sustainable design and development • Understanding of professional and ethical responsibilities and commitment to them.

Textbooks:

1. G.Paul; W. Beitzetal, Engineering Design, Springer International Education, 2010.
2. Kevin Otto: K. Wood, Product Design And Development, Pearson Education, 2013.
3. Kenith B. Kahu, Product Planning Essentials, Yes dee Publishing, 2011.
4. K.T. Ulrich, Product Design and Development, TMH Publishers, 2011.

Online Learning Resources:

• https://nptel.ac.in/courses/112107217 • https://nptel.ac.in/courses/112104230
• https://www.youtube.com/watch?v=mvaqZAFdL6U
• https://nptel.ac.in/courses/107103082 •https://quizxp.com/nptel-product-design-and-manufacturing assignment-5/

Course code	**26LC-ME-226-H**				
Category	Professional Core Courses				
Course title	**Product Design and Development Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	1	
Objectives:	To understand the process of product dissection, analyze the working principles, and apply design concepts to develop a product architecture.				
Class work mark	5 Marks				
Practical mark	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

Following are the details of the lab experiments performed by the students.

Product Design experiments:

1. Product Dissection: Understanding the process of disassembling a product to analyze its design and functionality
2. Working Principle: Analyzing the underlying principles and mechanisms of a product
3. Application:Understanding the product's purpose, benefits, and user needs
4. Disassembly:Plan Creating a systematic plan to disassemble a product
5. Parts and Function:Identifying and explaining the functions of individual parts and modules
6. Design Concept: Applying design principles to develop a product concept
7. Product Architecture: Defining the overall structure and organization of a product
8. Design Synthesis:Combining design elements to create a cohesive product design
9. Design Embodiment:Translating design concepts into a physical product

Course Outcomes:

1. Understand the importance of product dissection in design and development
2. Analyze the working principles and applications of a product
3. Develop a disassembly plan for a product
4. Identify and explain the functions of product parts and modules
5. Apply design concepts to synthesize and embody a product design

Note:

1. **At least seven experiments are to be performed in the Semester.**