



Second Year (Lateral Entry) Curriculum

Admission Year 2026-27

**Bachelor of Technology (Lateral Entry)
Mechanical Engineering**

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

Semester - 3

- a. **Course Name:** Material Engineering
- b. **Course Code:** 03010903PC01
- c. **Prerequisite:** Workshop and Manufacturing Technology
- d. **Rationale:** To provide an insight into materials classification, structural study by analyzing the atomic arrangement and properties modification through heat treatment and alloying. Also to check the quality of the material through various Non-Destructive methods to ensure safe application of materials.
- e. **Course Learning Objective:**

CLOBJ 1	To provide fundamental knowledge of engineering materials and their properties for engineering applications.
CLOBJ 2	To develop understanding of crystal structures, grain size, and their influence on the properties of metals.
CLOBJ 3	To enable students to analyze and interpret equilibrium phase diagrams of engineering materials.
CLOBJ 4	To familiarize students with the characteristics and applications of ferrous, nonferrous metals, and alloys.
CLOBJ 5	To impart knowledge of heat treatment processes and strengthening mechanisms used for steels and engineering materials.
CLOBJ 6	To introduce the principles, processing steps, and applications of powder metallurgy techniques.

f. Course Learning Outcomes:

CLO 1	Understand the properties and characteristic of engineering materials.
CLO 2	Identify the properties of metals with respect to crystal structure and grain size.
CLO 3	Interpret the phase diagrams of materials.
CLO 4	Describe about the ferrous, nonferrous metals and alloys.
CLO 5	Describe the concept of heat treatment of steels & strengthening mechanisms
CLO 6	Explain the powder metallurgy processes.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	-	0	2	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	Engineering Materials: Classification of Engineering Materials, Engineering requirements of materials, Criterion for selection of materials for engineering applications through Structure-Properties, Performance correlation ship	5%	1
2	Crystal Structure and Crystal Imperfections : Unit Cell, Crystal structure, Bravais lattice, atomic packing factor, coordination number, crystal directions and planes, Miller indices, Imperfections in crystals and their effect on properties, Recovery, Recrystallization and Grain Growth.	15%	5
3	Phase Diagrams and Theory of Alloys: Unary and Binary equilibrium phase diagrams, Lever rule, Gibb's phase rule, strengthening mechanisms types, strain hardening, solid solutions and compounds, Solid Solution Strengthening Mechanisms, Hume-Rothery rules; cooling curves, Different reactions like eutectic, eutectoid etc. Allotropy of Iron, Iron-Iron-Carbide equilibrium diagram. Plain carbon steels, its classification and properties, Alloy Steel, its classification and properties, Stainless steel, Tool Steel, designation of Steels, Effect of alloying elements like Cr, Mo, Ni, W, V, Nb, B, Al, etc on the Properties of Steel, Cast Iron, its classification and properties, White Cast iron, Grey Cast iron, Nodular Cast iron, Malleable Cast iron, Chilled Cast Iron etc	25%	12
4	Non-Ferrous Alloys, Non Metallic Materials and Nanomaterials: Copper alloys, Aluminum alloys: Classification, Composition, Properties and applications. Plastics, Composites, Ceramics: Classification, Composition, Properties and applications. Introduction to Nanomaterials and its applications for communication, filtering, feedback control systems.	15%	6
5	Heat Treatment of Steels and Alloys: Heat Treatment Cycle, Time-Temperature-Transformation (TTT) Diagram, CCR, Different types of heat Treatments like Annealing, Normalizing, Hardening, Tempering, Austempering, Martempering, Ausforming, Surface hardening and Case hardening treatments, Jominy Hardenability Test.	15%	6
6	Powder Metallurgy: Production of Powder, blending, Compacting, Sintering; Application, advantages and limitations.	10%	
7	Non Destructive Testing: Principle, Advantages, limitations and Applications of Dye Penetration Testing, Magnetic Particle Testing, Eddy current testing Radiography Testing, Ultrasonic Testing.	10%	
8	Metallography: Structure of Metals, Macro-examination: Macro-etching; Microscopic examinations: Specimen	5%	

	Preparation, etching, grain size measurement; Concept of chemical analysis of steel and Iron for Carbon, Sulphur & Phosphorous.		
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i. Text Book and Reference Book:

1. "Introduction to Physical Metallurgy" by Sydney H. Avner.
2. "Callister's Material Science and Engineering" by R. Balasubramaniam.
3. "Practical Non-Destructive Testing" by Baldev Raj, T. Jayakumar and M. Thavasimuthu.
4. "Mechanical Metallurgy" by George E. Dieter.
5. "Materials Science and Engineering" by Raghavan V.

- a. **Course Name:** Material Engineering Laboratory
- b. **Course Code:** 03010903PC02
- c. **Prerequisite:** Workshop and Manufacturing Technology
- d. **Rationale:** To provide an insight into materials classification, structural study by analyzing the atomic arrangement and properties modification through heat treatment and alloying. Also to check the quality of the material through various No-Destructive methods to ensure safe application of materials.

e. Course Learning Objective:

CLOBJ 1	To provide fundamental knowledge of engineering materials and their properties for engineering applications.
CLOBJ 2	To develop understanding of crystal structures, grain size, and their influence on the properties of metals.
CLOBJ 3	To enable students to analyze and interpret equilibrium phase diagrams of engineering materials.
CLOBJ 4	To familiarize students with the characteristics and applications of ferrous, nonferrous metals, and alloys.
CLOBJ 5	To impart knowledge of heat treatment processes and strengthening mechanisms used for steels and engineering materials.
CLOBJ 6	To introduce the principles, processing steps, and applications of powder metallurgy techniques.

f. Course Learning Outcomes:

CLO 1	Understand the properties and characteristic of engineering materials.
CLO 2	Identify the properties of metals with respect to crystal structure and grain size.
CLO 3	Interpret the phase diagrams of materials.
CLO 4	Describe about the ferrous, nonferrous metals and alloys.
CLO 5	Describe the concept of heat treatment of steels & strengthening mechanisms
CLO 6	Explain the powder metallurgy processes.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	2	1	-	-	20	-	30	50

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. "Introduction to Physical Metallurgy" by Sydney H. Avner.
2. "Callister's Material Science and Engineering" by R. Balasubramaniam.
3. "Practical Non-Destructive Testing" by Baldev Raj, T. Jayakumar and M. Thavasimuthu.
4. "Mechanical Metallurgy" by George E. Dieter.
5. "Materials Science and Engineering" by Raghavan V.

- a. **Course Name:** Manufacturing Processes
- b. **Course Code:** 03010903PC03
- c. **Prerequisite:** Workshop and Manufacturing Practices
- d. **Rationale:** To provide students with fundamental knowledge and practical understanding of manufacturing processes, machining principles, tooling, and process selection required for efficient production of engineering components.

e. Course Learning Objective:

CLOBJ 1	Introduce students to the classification, selection, and industrial applications of various manufacturing processes.
CLOBJ 2	Develop fundamental understanding of conventional machining processes, machine tools, and machining time estimation.
CLOBJ 3	Enable students to analyze metal cutting mechanics, machining forces, power requirements, and machining economics.
CLOBJ 4	Impart knowledge of finishing and surface treatment processes for improving dimensional accuracy and surface quality of engineering components.
CLOBJ 5	Familiarize students with the principles, design, and applications of jigs and fixtures for efficient and accurate manufacturing.
CLOBJ 6	Provide understanding of non-conventional manufacturing processes, their working principles, capabilities, and industrial applications.

f. Course Learning Outcomes:

CLO 1	Understand the role, classification, and selection of manufacturing processes in industrial applications.
CLO 2	Acquire fundamental knowledge of conventional machining processes, machine tools, and machining time calculations.
CLO 3	Analyze the mechanics of metal cutting to evaluate forces, energy, and machining economics.
CLO 4	Understand finishing processes and select appropriate surface finishing techniques for engineering components.
CLO 5	Apply principles of jigs and fixtures for accurate, economical, and repeatable manufacturing.
CLO 6	Understand the principles, capabilities, and applications of non-conventional manufacturing processes

g. Teaching & Examination Scheme:

Teaching Scheme	Evaluation Scheme
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L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	-	0	2	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Fundamentals of Manufacturing Processes: importance of manufacturing, economic and technological definition of manufacturing, Classification of manufacturing processes, Selection of Manufacturing process	5%	1
2	Conventional Machining Processes & Machine Tools: Characteristics of material removal processes, need and purpose of conventional material removal processes. Lathe – Constructional features, classification, operations, facing, plain turning, drilling, knurling etc., threading cutting process (single start multiple start) and gear train, taper turning methods and calculations. Types of tools for various operations, accessories and attachments, Calculation of Machining time. Milling – Constructional features, classification, face and peripheral milling, up milling and down milling processes, Types of tools for various operations, dividing head attachment, operations on milling machine, gear milling, Machining time. Numerical based on indexing methods and machining time. Drilling – Constructional features, classification, Types of tools and work holding devices, tool holding devices - tapping, quick change chuck, floating holder. Operations on drilling machine, machining time. Numerical based on machining time. Planers, Shapers and Slotters: Classification of planers, Shapers and Slotters, Attachments extending the processing capacities of planers, Shapers and Slotters, machine and tooling requirements	30%	12
3	Mechanics of Metal Cutting: Introduction to basic elements of machining. Merchant circle diagram. Force and velocity relationship, shear plane angle. Energy consideration in Machining, Earnst-Merchant theory. Economics of metal machining.	20%	6
4	Finishing Processes: Introduction to grinding, types of machines and operations, dressing and trueing, glazing, designating system, selection of grinding wheel, lapping, honing.	15%	4
5	jigs and Fixture: Essential requirements of jigs & fixtures, economics of jigs and fixtures, principles of location and clamping, location and clamping devices, types of drill bushes, types of jigs and fixtures- such as fixtures for milling, welding, heat treatment, grinding, assembly and inspection processes; standardization in jigs and fixtures, principle of work holders, common work holders for production like vises, chucks, arbors, mandrels & collets.	15%	4

6	Non-conventional Manufacturing Processes: EDM, EBM, PAM, IBM, ECM, ECG, CM, AJM, WJM, AWJM, wire cut EDM, USM, LBM process principles, process parameters, process selection and their applications.	15%	3
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i. Text Book and Reference Book:

1. "Production Technology" by R.K. Jain.
2. "Elements of Workshop Technology (Vol I & Vol II)" by Hajra Choudhary.
3. "Workshop Technology (Vol I & Vol II)" by B.S. Raghuwanshi.

- a. **Course Name:** Manufacturing Processes Lab
- b. **Course Code:** 03010903PC04
- c. **Prerequisite:** Workshop and Manufacturing Practices
- d. **Rationale:** To provide students with fundamental knowledge and practical understanding of manufacturing processes, machining principles, tooling, and process selection required for efficient production of engineering components.

e. Course Learning Objective:

CLOBJ 1	Introduce students to the classification, selection, and industrial applications of various manufacturing processes.
CLOBJ 2	Develop fundamental understanding of conventional machining processes, machine tools, and machining time estimation.
CLOBJ 3	Enable students to analyze metal cutting mechanics, machining forces, power requirements, and machining economics.
CLOBJ 4	Impart knowledge of finishing and surface treatment processes for improving dimensional accuracy and surface quality of engineering components.
CLOBJ 5	Familiarize students with the principles, design, and applications of jigs and fixtures for efficient and accurate manufacturing.
CLOBJ 6	Provide understanding of non-conventional manufacturing processes, their working principles, capabilities, and industrial applications.

f. Course Learning Outcomes:

CLO 1	Understand the role, classification, and selection of manufacturing processes in industrial applications.
CLO 2	Acquire fundamental knowledge of conventional machining processes, machine tools, and machining time calculations.
CLO 3	Analyze the mechanics of metal cutting to evaluate forces, energy, and machining economics.
CLO 4	Understand finishing processes and select appropriate surface finishing techniques for engineering components.
CLO 5	Apply principles of jigs and fixtures for accurate, economical, and repeatable manufacturing.
CLO 6	Understand the principles, capabilities, and applications of non-conventional manufacturing processes

g. Teaching & Examination Scheme:

Teaching Scheme	Evaluation Scheme
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L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	2	1	-	-	20	-	30	50

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. "Production Technology" by R.K. Jain.
2. "Elements of Workshop Technology (Vol I & Vol II)" by Hajra Choudhary.
3. "Workshop Technology (Vol I & Vol II)" by B.S. Raghuwanshi.

- a. **Course Name:** Strength of Materials
- b. **Course Code:** 303106201
- c. **Prerequisite:** Fundamental Knowledge of Mechanics of Solids
- d. **Rationale:** This course provides an analytical foundation in the mechanics of deformable bodies, emphasizing stress analysis, material behavior under complex loading, structural stability, and failure prediction. The subject cultivates the theoretical and computational competencies essential for safe and efficient structural and mechanical design.
- e. **Course Learning Objective:**

CLOBJ 1	Understand and apply torsion principles to analyze shear stress distribution, angle of twist, and power transmission in circular shafts.
CLOBJ 2	Evaluate strain energy concepts for different loading conditions such as gradual, sudden, and impact loads, including distortion and volumetric energy calculations.
CLOBJ 3	Apply classical failure theories to predict the safe performance of materials subjected to combined or multi-axial stresses.
CLOBJ 4	Analyze column stability and buckling behavior using Euler's theory and empirical column formulas for different end conditions.
CLOBJ 5	Determine beam slopes and deflections using differential equation methods and energy-based approaches for various loading cases.
CLOBJ 6	Analyze fatigue behavior of materials and design machine components considering endurance limits, fluctuating stresses, and mean stress criteria.

f. Course Learning Outcomes:

CLO 1	Apply torsion theory to determine shear stress, angle of twist, and power transmission in circular shafts.
CLO 2	Evaluate strain energy under gradual, sudden, and impact loading, including distortion and dilation energy.
CLO 3	Predict failure under multi-axial stresses using classical failure theories.
CLO 4	Determine critical buckling loads of columns using theoretical and empirical approaches.
CLO 5	Compute beam slopes and deflections using differential equation and energy methods.
CLO 6	Analyze fatigue behavior and design components using endurance limits and mean stress criteria

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Torsion Of Circular Members: Theoretical formulation and derivation of the torsion equation under the classical assumptions of pure torsional behavior, analysis of shear stress distribution in solid and hollow circular shafts, evaluation of polar moment of inertia and polar modulus, determination of angular deformation and rigidity under applied torque, assessment of power transmission capacity of rotating shafts.	15%	6
2	Strain Energy: Strain energy in elastic systems, strain energy under gradual, sudden and impact loading, derivation of stress and formation expressions using energy principles, total strain energy formulation, distortion (shear) energy and dilation (volumetric) energy, analytical evaluation and derivations of energy components.	20%	10
3	Theories Of Elastic Failure: Rationale for theories of failures under multi-axial stress states, Maximum Principal Stress Theory (Rankine criterion), Maximum Shear Stress Theory (Tresca criterion), Maximum Distortion Energy Theory (Von Mises criterion), and analytical application of these theories in design, failure statements of Maximum Principal Strain Theory, Total Strain energy Theory, comparative assessment and graphical representation of failure criteria for ductile and brittle materials.	25%	12
4	Columns And Structural Stability: Euler's column theory with assumptions, derivation of Euler's critical (crippling) load, buckling load for columns under different end conditions including hinged-hinged, fixed-fixed, fixed-free and fixed-hinged cases, concept of effective length, slenderness ratio, limitations of Euler's theory, Johnson's parabolic formula for intermediate columns, Rankine formula for practical column design, comparison of Euler, Johnson and Rankine approaches.	15%	6
5	Deflections Of Beams: Differential equation of the elastic curve, determination of slope and deflection using double integration method, Castigliano's strain energy method for deflections of beams under standard loading conditions.	10	5
6	Fatigue And Fluctuating Stress: Variable and fluctuating stresses, completely reversed cyclic stress, fatigue behavior of materials under repeated loading, fatigue strength and endurance limit, S-N curve representation, factors influencing fatigue performance, stress concentration and stress concentration factor, notch sensitivity and its significance, design considerations for finite life and infinite life, mean stress theories including Soderberg criterion, Goodman relation and Gerber parabola for fatigue design.	15	6

i. Text Book and Reference Book:

1. "Strength of Materials "by R.K.Bansal.
2. "Mechanics of Materials "by R. C. Hibbeler.
3. "Mechanics of Materials: by Timoshenko and Gere.
4. "Engineering Solid Mechanics "by L.S Srinath.
5. "Strength of Materials", by R.K. Rajput

- a. **Course Name:** Kinematics and Theory of Machines
- b. **Course Code:** 03010903PC07
- c. **Prerequisite:** Basic knowledge of Mechanics of Solids, Engineering Graphics and Design.
- d. **Rationale:** To provide students with a strong foundation in the kinematics of machinery for analyzing, designing, and applying mechanical mechanisms through theory, experimentation, case studies, and exposure to recent technological advancements.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts of kinematic chains, mechanisms, and mobility analysis used in machine design and motion transmission systems.
CLOBJ 2	To develop the ability to analyze velocity and acceleration of various machine elements using graphical and analytical approaches.
CLOBJ 3	To gain knowledge of the design and working principles of cams, followers, and gear trains for achieving desired motion characteristics..
CLOBJ 4	To study the functioning and modern applications of governors, gyroscopes, and friction mechanisms in advanced mechanical systems and emerging technologies.
CLOBJ 5	To apply kinematic and dynamic principles in solving real-life mechanical engineering problems through practical case studies and industrial applications.

f. Course Learning Outcomes:

CLO 1	Analyze kinematic chains and mechanisms using degrees of freedom and inversion concepts.
CLO 2	Determine the velocity and acceleration of machine elements using graphical and analytical methods.
CLO 3	Design cams, followers, and gear trains for specified motion requirements.
CLO 4	Apply kinematic principles to real-life mechanical systems through case studies.
CLO 5	Evaluate the role of governors, gyroscopes, and friction devices in research trends and technological advancements.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	Mechanisms and Machines: Kinematic links, pairs, chains, mechanisms and machines; constrained motion; degrees of freedom (Kutzbach & Gruebler); Grashof's law; inversions of four-bar and slider-crank chains; transmission angle; straight-line mechanisms; applications in industrial mechanisms.	15%	7
2	Velocity and Acceleration Analysis: Velocity and angular velocity; instantaneous center method; relative velocity method; acceleration analysis (radial, transverse and Coriolis components); Klein's construction; application to IC engine slider-crank mechanism.	25%	10
3	Cam and Followers: Classification; terminology; follower motions; displacement diagrams; pressure angle and undercutting; cam sizing; graphical and analytical cam profile generation; applications in automated and packaging machinery.	20%	8
4	Gears and Gear Trains: Gear terminology; involute and cycloidal profiles; law of gearing; path of contact; interference and undercutting; spur, helical, bevel, worm, rack & pinion gears; simple, compound and epicyclic gear trains; automotive and EV gear train case studies.	15%	8
5	Governors, Gyroscope and Friction Devices: Types and characteristics of governors; working principles and applications; gyroscopic effects; clutches, brakes, bearings; uniform wear and uniform pressure theories; belt and rope drives; industry-oriented examples.	15%	8
6	Recent Research and Technological Advancements: Smart and compliant mechanisms; robotic and mechatronic linkages; MEMS-based mechanisms; use of computational tools in mechanism analysis.	10%	4

i. Text Book and Reference Book:

1. "Theory of Machines" by S.S. Rattan.
 2. "Theory of Machines" by Dr. Sadhu Singh.
 3. "Kinematics and Dynamics of Machinery: by R L Norton.
 4. "Mechanics of Machines" by Nikolai Dechev and William L. Cleghorn.
 5. "Theory of Mechanisms and Machines", by A. Ghosh, A. K. Mallik.
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- a. **Course Name:** Kinematics and Theory of Machines Lab
- b. **Course Code:** 03010903PC08
- c. **Prerequisite:** Basic knowledge of Mechanics of Solids, Engineering Graphics and Design.
- d. **Rationale:** To provide students with a strong foundation in the kinematics of machinery for analyzing, designing, and applying mechanical mechanisms through theory, experimentation, case studies, and exposure to recent technological advancements.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts of kinematic chains, mechanisms, and mobility analysis used in machine design and motion transmission systems.
CLOBJ 2	To develop the ability to analyze velocity and acceleration of various machine elements using graphical and analytical approaches.
CLOBJ 3	To gain knowledge of the design and working principles of cams, followers, and gear trains for achieving desired motion characteristics..
CLOBJ 4	To study the functioning and modern applications of governors, gyroscopes, and friction mechanisms in advanced mechanical systems and emerging technologies.
CLOBJ 5	To apply kinematic and dynamic principles in solving real-life mechanical engineering problems through practical case studies and industrial applications.

f. Course Learning Outcomes:

CLO 1	Analyse kinematic chains and mechanisms using degrees of freedom and inversion concepts.
CLO 2	Determine the velocity and acceleration of machine elements using graphical and analytical methods.
CLO 3	Design cams, followers, and gear trains for specified motion requirements.
CLO 4	Apply kinematic principles to real-life mechanical systems through case studies.
CLO 5	Evaluate the role of governors, gyroscopes, and friction devices in research trends and technological advancements.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				T	CE	P	T	P	
-	-	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Text Book and Reference Book:

1. "Theory of Machines "by S.S. Rattan..
2. "Theory of Machines "by Dr. Sadhu Singh.
3. "Kinematics and Dynamics of Machinery: by R L Norton
4. " Mechanics of Machines "by Nikolai Dechev and William L. Cleghorn
5. "Theory of Mechanisms and Machines", by A. Ghosh, A. K. Mallik.

- a. **Course Name:** Partial Differential Equations and Statistics
- b. **Course Code:** 03019103BS05
- c. **Prerequisite:** Basic Concepts of Differential Equations, Data Analysis and basic probability and statistics.
- d. **Rationale:** The subject of Partial Differential Equations and Statistics provides mathematical and analytical tools for solving engineering and real-life problems. PDEs help in modeling physical phenomena such as heat transfer, fluid flow, and vibrations, while Statistics enables data analysis, interpretation, forecasting, and decision-making.
- e. **Course Learning Objective:**

CLOBJ 1	Solve first-order linear and nonlinear partial differential equations using methods like Charpit's Method.
CLOBJ 2	Analyze second-order PDEs including the modelling and solution of Heat, Wave, and Laplace equations.
CLOBJ 3	Apply statistical techniques including moments, correlation, regression, and curve fitting.
CLOBJ 4	Conduct hypothesis testing using various statistical tests like z-test, t-test, and Chi-square test.
CLOBJ 5	Understand probability theory, random variables, and specific probability distributions such as Binomial and Normal.

f. Course Learning Outcomes:

CLO 1	Formulate and solve first-order PDEs to model foundational transport phenomena relevant to engineering flows and thermodynamics..
CLO 2	Solve the heat, wave, and Laplace equations using analytical methods to analyze conduction, vibration, and potential flow problems in mechanical systems.
CLO 3	Apply statistical inference to estimate parameters in mathematical models and Interpret results from stochastic differential equations.
CLO 4	Employ probability distributions and stochastic concepts to model system reliability, fatigue life, and uncertainties iautomotive and mechanical design.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	First Order Partial Differential: Equations First order partial differential equations, solutions of first order linear and nonlinear PDEs, Charpit's Method (cases).	20%	12
2	Second Order Partial Differential Equations: Classifications of PDE, Separation of Variables Method, Modelling and solution of the Heat, Wave and Laplace Equation, Integral Transform Methods, Green's Function Approach.	30%	18
3	Statistics: Moments, skewness and Kurtosis Correlation and regression: Rank correlation. Curve fitting by the method of least squares. Hypothesis testing: z-test, t-test, chi-square test	30%	18
4	Probability and Probability distribution: Probability spaces, Random variables (discrete & continuous) conditional probability, independence, Bayes' Theorem and applications. Probability mass functions, Expectation, variance, and moments, Binomial and Poisson distributions, Chebyshev's Inequality. Probability density functions, Expectation and variance for continuous variables, Exponential, Gamma and Normal distributions.	20%	12

i. Text Book and Reference Book:

1. "Fundamentals of Mathematical Statistics" by S.C. Gupta and V. K. Kapoor.
2. "A First Course in Probability" by S. Ross.
3. "Introduction to Partial Differential Equations" by Rao.K. S.
4. "Elementary Applied Partial Differential Equations with Fourier Series and Boundary Value Problems", by Richard Haberman.
5. "Advanced Engineering Mathematics" by K. A. Stroud and Dexter Booth.
6. "Advanced Engineering Mathematics" by Erwin Kreyszig.

- a. **Course Name:** Thermodynamics
- b. **Course Code:** 03010903ES01
- c. **Prerequisite:** Basic knowledge of Mechanical Engineering
- d. **Rationale:** Knowledge of Thermodynamics is required to design any device involving the interchange between heat and work or the conversion of material to produce heat.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts of heat, work, and laws of thermodynamics used in engineering applications.
CLOBJ 2	Apply the first and second laws of thermodynamics for analyzing flow and non-flow energy processes.
CLOBJ 3	Analyze entropy, exergy, and irreversibility concepts in thermodynamic systems using the second law of thermodynamics.
CLOBJ 4	Understand and evaluate thermodynamic properties and relations of pure substances, ideal gases, and real gases.
CLOBJ 5	To analyze the working principles and performance of basic thermodynamic cycles used in engineering systems.

f. Course Learning Outcomes:

CLO 1	Explain the concept of heat and work transfer applicable to various engineering applications using thermodynamics law.
CLO 2	Apply 2nd law of thermodynamics for different flow and non-flow processes.
CLO 3	Analyze the concepts of entropy and exergy by applying 2nd law of thermodynamics.
CLO 4	Describe the relations between various thermodynamics properties for pure substance.
CLO 5	Analyze the working principles of basic thermodynamic cycles.
CLO 6	Apply thermodynamic laws and relations for ideal and real gases.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				T	CE	P	Theory	P	
3	-	1	4	20	20	50	60		150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Thermodynamics Fundamentals: Fundamentals of Thermodynamics, Macroscopic vs microscopic view point, Reversible, Irreversible & Quasi-static Process, concept of continuum. Exact & Inexact differentials. Types of Work, free expansion, Equation of state of a gas, properties of Ideal gas, specific heat, work done in various quasi-static processes. Heat transfer -sensible heat, latent heat, heat and work as a path function, Thermodynamic Laws.	20%	8
2	First Law of thermodynamic: Joule's experiment, Internal energy as property of system, first law applied to various quasi static processes, PMMI , Limitations of the First Law, control volume, Steady flow energy equation, Applications of SFEE. Second law of thermodynamics Thermal Reservoir, Heat Engine, cyclic Heat engine, Kelvin-Planck statement and Clausius Statements and their Equivalence, Refrigerator and Heat pump, COP, PMM II, ,reversibility and irreversibility, causes of irreversibility, Carnot cycle, reversible cycle.	25%	10
3	Entropy and Exergy Entropy: Clausius theorem, the property of entropy, the inequality of Clausius, Entropy principle and its applications, Entropy change during different thermodynamic processes, entropy generation in closed systems and open systems. Exergy Available energy, availability and availability function of a closed system, availability and availability function of an open system , dead state, Helmholtz function, Gibbs functions, Irreversibility and Gouy-Stodola Theorem, Second law efficiency	20%	10
4	Properties of Pure Substance: Thermodynamic properties of pure substances in solid, liquid and vapour phases, Phase Transformations, dryness fraction, Gibbs phase rule, Triple point, critical state, p-v, p-T, T-s, h-s, p-h diagrams, Properties and processes in ideal vapour, use of steam tables and Molliers diagram in determination of steam properties, psychometric ⁺ processes, energy interaction and entropy calculations for various thermodynamic processes	15%	7
5	Thermodynamics Cycles and Relations: (a) Thermodynamic cycles - Basic Rankine cycle, Basic Brayton cycle, Basic vapor compression cycle and comparison with Carnot cycle, Methods to improve the	15%	7

	efficiency and performance. (b) Thermodynamic relations - Maxwell relation, first and second law combined (T-ds relation). Joule-Kelvin effect (real gas), basics of Fuel cell.		
6	Fuels and Combustion: First law analysis of combustion reactions-Heat calculations using enthalpy tables-Adiabatic energy. Flame temperature-Chemical equilibrium and equilibrium composition calculations using free	5%	3

i. Text Book and Reference Book:

1. Thermodynamics - An Engineering Approach, By Cengel & Boles
2. Fundamentals of Engineering Thermodynamics, By Moran & Shapiro
3. Engineering Thermodynamics, By P. K. Nag, Tata McGraw-Hill Education
4. Thermal Science & Engineering, By D.S. Kumar.
5. Thermodynamics, By C.P. Arora

- a. **Course Name:** Functional Communication Skills
- b. **Course Code:** 03010003HM01
- c. **Prerequisite:** Knowledge of Advanced Communication and Interpersonal Skills
- d. **Rationale:** This course develops workplace-oriented communication skills by bridging academic language competence with professional communication requirements.
- e. **Course Learning Objective:**

CLOBJ 1	Develop grammatical accuracy and logical reasoning skills through sentence correction, para jumble, and statement–assumption analysis.
CLOBJ 2	Strengthen advanced reading and analytical skills to interpret complex texts, infer meaning, and evaluate authorial intent.
CLOBJ 3	Apply professional writing skills in creating resumes, cover letters, emails, and reports suitable for workplace communication.
CLOBJ 4	Enhance digital and verbal communication skills through LinkedIn profile building, JAM activities, and telephone/video call etiquette.
CLOBJ 5	Improve clarity, coherence, and professionalism in oral and written communication through structured practice and workplace-oriented tasks.

f. Course Learning Outcomes:

CLO 1	Identify grammatical, usage, and style errors; logically reorder sentences; and differentiate facts from assumptions in workplace problem scenarios.
CLO 2	Understand the usage of grammatical rules, cohesion markers, professional writing formats, and communication etiquette to produce accurate workplace communication.
CLO 3	Apply principles of professional communication to ensure clarity, coherence, time management, and etiquette in both written and spoken workplace contexts.
CLO 4	Analyze effective verbal, digital, and virtual communication skills through JAM participation, LinkedIn profile optimization, and telephone/video call interactions. substance.
CLO 5	Create ATS-friendly resumes, customized cover letters, professional emails, structured reports, optimized LinkedIn profiles.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				T	CE	P	Theory	P	
1	-	2	2	40	-	20	60	30	150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Sentence Correction: Error identification (grammar, usage, style) Common workplace errors Contextual grammar usage	10%	2
2	Para Jumbles & Sentence: Reordering Logical sequencing Cohesion markers Theme identification	8%	1
3	Statement and Assumptions: Fact vs assumption Logical reasoning basics Workplace problem scenarios	10%	1
4	Reading Comprehension: (Level of Difficulty - Advanced Inferential questions Author's tone & intent Vocabulary in context	12%	2
5	Resume and Cover Letter Writing: Resume formats Achievement-based bullet points Customizing cover letters	14%	2
6	Building a Professional LinkedIn Profile: Professional headline Summary writing Digital networking ethics	8%	1
7	Just a Minute (JAM) Idea organization: Fluency techniques Time management in speech	8%	1
8	Telephone and Video Call Etiquette Opening & closing calls: Voice modulation Virtual meeting etiquette	8%	1
9	Email Writing Format: Professional tone Subject lines Email etiquette	10%	2
10	Report Writing Report Writing Types of reports: Structure & formatting Use of visuals & data	12%	2

i. Text Book and Reference Book:

1. Business Communication Today, By Bovee, Courtland L., and John V. Thill
2. Essentials of Business Communication, By Guffey, Mary Ellen, and Dana Loewy.
3. Advanced Grammar in Use, By Hewings, Martin.
4. English Vocabulary in Use: Advanced, By McCarthy, Michael, and Felicity O'Dell.
5. Personality Development and Soft Skills., By Mitra, Barun K
6. Technical Communication: Principles and Practice, By Raman, Meenakshi, and Sangeeta Sharma

Semester - 4

- a. **Course Name:** Metrology and Quality Control
- b. **Course Code:** 03010904PC01
- c. **Prerequisite:** Zeal to Learn the subject
- d. **Rationale:** To comprehensively develop the student's ability to understand, select, operate, calibrate, and critically analyse advanced metrological instruments and quality control techniques, integrating statistical process control, inspection methodologies, and modern measurement technologies for accurate evaluation, improvement, and assurance of product and process quality in systems.

e. Course Learning Objective:

CLOBJ 1	To develop an understanding of the fundamental principles of metrology, calibration techniques, and the operational characteristics of measuring instruments used in engineering applications.
CLOBJ 2	To enable students to apply linear, angular, and advanced measurement techniques for precise and reliable engineering measurements in industrial and laboratory environments.
CLOBJ 3	To develop the ability to analyze limits, fits, and tolerances and to design suitable gauges for ensuring dimensional accuracy and quality control in engineering applications.
CLOBJ 4	To provide knowledge of quality control concepts, statistical analysis methods, process capability evaluation, and inspection systems for effective monitoring and improvement of manufacturing processes.
CLOBJ 5	To apply Total Quality Management principles, Statistical Quality Control (SQC) tools, Six Sigma methodologies, ISO standards, and acceptance sampling techniques to analyze, control, and improve quality performance in manufacturing and service systems.
CLOBJ 6	To evaluate recent research developments and technological advancements in metrology and smart quality control systems for improving measurement accuracy, automation, process monitoring, and industrial quality management practices.

f. Course Learning Outcomes:

CLO 1	Explain the fundamentals of metrology, calibration concepts, and characteristics of measuring instruments.
CLO 2	Apply linear, angular, and advanced measurement techniques for accurate engineering measurements.
CLO 3	Analyze limits, fits, tolerances, and design appropriate gauges for engineering applications.
CLO 4	Interpret quality concepts, statistical measures, process capability, and inspection systems.
CLO 5	Implement Total Quality Management tools, SQC, Six Sigma, ISO standards, and acceptance sampling methods.
CLO 6	Evaluate recent research and technological advancements in metrology and smart quality control systems.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	-	0	2	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Fundamentals of Metrology Principles and applications of metrology; classification of measurements and measuring systems; concepts and procedures of calibration; static and dynamic characteristics of measuring instruments including accuracy, precision, sensitivity, hysteresis, range- span, resolution, repeatability, and reliability etc.	15%	3
2	Linear and Angular Measurements Standards of measurement including line standards and end standards; sources and types of errors ; linear and angular measuring instruments ; Mechanical comparators, Measurement of Force, Torque, Strain, Temperature, Pressure, Speed, Acceleration, Humidity & Surface Finish.	20%	06
3	Limit Fit Tolerances Tolerances, limits, fits and allowances, basis of system, hole basis and shaft basis system, types of fits and their interpretation types of gauges and gauge design & Numerical.	10%	04
4	Fundamentals of Quality Control Quality concept and definition, importance and evolution of quality, product and service quality dimensions, quality characteristics of products and services, basic statistical measures and quality terminology, sources of process variation, chance and assignable causes, process capability analysis, quality control tools and techniques, quality of design, reliability concept, quality-related costs including prevention appraisal rework and repair costs, quality assurance concepts, role of quality and inspection, stages of inspection in manufacturing.	20%	06
5	Total Quality Management: TQM principles and concepts, customer focus and continuous improvement, employee involvement, quality planning and assurance, quality audits and certification, Six Sigma philosophy and DMAIC methodology, ISO 9000 and international quality standards, quality documentation and compliance, Statistical	15%	05

	Quality Control, variable and attribute measurement, acceptance sampling, OC curves, sampling plans, control charts for variables and attributes.		
6	Recent Research and Technological Advancements: Advanced metrology techniques, coordinate measuring machines (CMMs), laser-based and optical measurement systems, nano-scale metrology, smart quality control using IoT, digital twin integration, computed tomography (CT) applications, advanced calibration methods, modern quality control practices for precision manufacturing.	20%	06

i. Text Book and Reference Book:

1. A Textbook of Metrology(Textbook) by M. Mahajan, DhanpatRai & Company"
2. Metrology and Measurement By Annand Bewoor & Vinay Kulkarni | McGraw-Hill
3. Engineering Metrology By G. Thomas and G. Butter | Worth PUB
4. Engineering Metrology by R.K Jain | Khanna Publishers.
5. Engineering Metrology and Measurement By N V Raghavendra and Krishnamurthy | Oxford University Press

- a. **Course Name:** Metrology and Quality Control
- b. **Course Code:** 03010904PC02
- c. **Prerequisite:** Zeal to Learn the subject
- d. **Rationale:** To comprehensively develop the student's ability to understand, select, operate, calibrate, and critically analyse advanced metrological instruments and quality control techniques, integrating statistical process control, inspection methodologies, and modern measurement technologies for accurate evaluation, improvement, and assurance of product and process quality in systems.
- e. **Course Learning Objective:**

CLOBJ 1	Develop practical knowledge of linear, angular, and surface measurement techniques used in engineering metrology and inspection.
CLOBJ 2	Apply various precision measuring instruments, gauges, comparators, and calibration methods for dimensional accuracy evaluation.
CLOBJ 3	Perform inspection and quality control experiments using statistical quality control techniques and process monitoring tools.
CLOBJ 4	Analyze measurement data and evaluate manufacturing quality using control charts, inspection methods, and statistical tools.
CLOBJ 5	Understand the principles of calibration, error analysis, and industrial quality assurance practices used in manufacturing industries.

f. Course Learning Outcomes:

CLO 1	Identify and explain the working principles of precision measuring instruments, gauges, comparators, and inspection devices used in metrology laboratories.
CLO 2	Perform linear, angular, thread, gear, and surface roughness measurements using appropriate metrological instruments and techniques.
CLO 3	Calibrate measuring instruments such as micrometers, dial gauges, and temperature measuring devices using standard procedures.
CLO 4	Analyze dimensional deviations, measurement errors, and process variations using inspection data and statistical quality control methods.
CLO 5	Evaluate manufacturing quality using control charts, acceptance criteria, and statistical process control techniques for variable and attribute data
CLO 6	Demonstrate professional laboratory practices, interpretation of inspection results, and effective use of quality control tools in industrial applications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	2	1	-	-	20	-	30	50

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. **A Textbook of Metrology(Textbook)** by M. Mahajan, DhanpatRai & Company"
2. **Metrology and Measurement** By Annand Bewoor & Vinay Kulkarni | McGraw-Hill
3. **Engineering Metrology** By G. Thomas and G. Butter | Worth PUB
4. **Engineering Metrology** by R.K Jain | Khanna Publishers.
5. **Engineering Metrology and Measurement** By N V Raghavendra and Krishnamurthy | Oxford University Press

- a. **Course Name:** Fluid Mechanics and Machines
- b. **Course Code:** 03010904PC03
- c. **Prerequisite:** Zeal to Learn the subject
- d. **Rationale:** To provide fundamental understanding of fluid mechanics and develop analytical skills to apply fluid flow principles in evaluating turbines, pumps, and modern fluid machinery systems.

e. Course Learning Objective:

CLOBJ 1	Understand the fundamental properties of fluids, principles of fluid statics, and pressure measurement techniques used in engineering applications.
CLOBJ 2	Apply concepts of fluid kinematics and buoyancy to analyze fluid flow behavior and stability of floating and submerged bodies.
CLOBJ 3	Analyze inviscid fluid flow using continuity, momentum, Euler's, and Bernoulli's equations for solving practical fluid flow and flow measurement problems.
CLOBJ 4	Evaluate viscous flow behavior in pipes by determining velocity distribution, energy losses, and flow characteristics in pipe systems and networks.
CLOBJ 5	Analyze boundary layer phenomena and turbomachinery performance, including turbines and pumps, for efficient energy conversion and fluid transport applications.
CLOBJ 6	Evaluate recent research developments and technological advancements in fluid machinery, smart turbine systems, flow control devices, and modern fluid engineering technologies.

f. Course Learning Outcomes:

CLO 1	Understand basic fluid properties, fluid statics, and pressure measurement methods.
CLO 2	Apply fluid kinematics and buoyancy principles to fluid flow problems.
CLO 3	Analyse inviscid fluid flow using continuity, momentum, and Bernoulli's equation.
CLO 4	Apply viscous flow concepts in pipes and pipe networks.
CLO 5	Describe boundary layer flow characteristics and separation effects.
CLO 6	Determine the performance of turbines, pumps, and modern fluid machinery technologies.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	0	2	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE-

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	<p>FUNDAMENTAL OF FLUID AND FLUID STATICS</p> <p>Properties of fluid, Newton’s law of viscosity, surface tension, Capillary Action, Pressure and its types. Pascal’s law, hydrostatic law, pressure measurements through Piezometer and U-Tube manometer.</p>	15%	05
2	<p>FUNDAMENTALS OF FLUID KINEMATICS AND FLOATING BODIES</p> <p>Types of Fluid Flow, Discharge, Continuity Equation in 2 Dimensions and 3 Dimensions, Velocity and Acceleration, Velocity Potential Function and Stream Function, Flow Net</p> <p>Buoyancy and Floatation Buoyancy: Centre of Buoyancy, Meta Centre, Meta Centric Height, Condition of equilibrium for floating and submerged bodies.</p> <p>Fluid Dynamics (Inviscid flow)</p> <p>Control volume- application of continuity equation and momentum equation, Incompressible flow, Euler’s equation, Bernoulli’s equation and its application. Flow measurements using Venturimeter, Orifice meter and Pitot tube.</p>	15%	08
3	<p>Fluid Dynamics (Viscous flow)</p> <p>Flow of viscous fluids in a circular pipe, shear stress and pressure gradient relationship, Velocity distribution, Major and Minor energy losses in pipes, Darcy-Weisbach equation, pipes in series and parallel connection, Equivalent Pipe. Flow Through Branched Pipes, Hydraulic Gradient and Total Energy Line.</p>	20%	10
4	<p>BOUNDARY LAYER FLOW:</p> <p>Basic Terminology: Laminar Boundary Layer. Turbulent Boundary Layer, Laminar Sub Layer, Boundary layer Thickness, Displacement Thickness, Energy Thickness. Drag Force on a Flat Plate due to Boundary Layer, Turbulent Boundary layer over flat Plate, Separation of boundary layer and methods of preventing Separation.</p>	10%	05
5	<p>TURBOMACHINERY</p> <p>Effect of Impact of Jet on vertical stationary and moving plane, Classification of a turbine, Difference Between Impulse and Reaction Turbine, Impulse Turbine:, Pelton wheel: Construction working, work done, Head & efficiencies and design aspects.</p> <p>Reaction Turbine: Radial flow reaction turbine, Francis turbine: construction & working, work done, efficiency and design aspect, Working of Propeller and Kaplan turbine.</p> <p>Concept of Draft tube, Specific speed, Unit quantities, Cavitation, Degree of reaction</p> <p>Pumps: Classification of Pumps, Construction and working of Centrifugal Pump and Reciprocating Pump, work done, Heads, Efficiencies, Characteristic curves,</p>	25%	12

	Concept of Net positive suction head, minimum starting speed of the pump, Cavitation phenomena.		
6	RECENT RESEARCH AND TECHNOLOGICAL ADVANCEMENTS API Turbines for Drives and Power Generation, SMART Turbines for Pressure Reducer De-Superheater (PRDS), Bellows pulsators, Hollow fiber diaphragm technology, Flow Distribution Systems and several Injection Rate Control Devices (IRCDs)	15%	05

i. Text Book and Reference Book:

1. Fluid Mechanics & Hydraulics Machines (Textbook) By R. K. Bansal | Laxmi Publications"
2. Fluid Mechanics By Yunus A. Cengel, John M. Cimbala | Tata McGraw
3. Introduction to Fluid Mechanics and Fluid Machines By S. K. Som and G. Biswas | Tata McGraw Hill
4. Engineering Fluid Mechanics By K.L. Kumar | Eurasia Publication HouseEngineering
5. Fluid Mechanics and Hydraulic Machines By R.K. Rajput | S.Chand & Co.

a. Course Name: Fluid Mechanics and Machines

b. Course Code: 03010904PC04

c. Prerequisite: Zeal to Learn the subject

d. Rationale: To provide fundamental understanding of fluid mechanics and develop analytical skills to apply fluid flow principles in evaluating turbines, pumps, and modern fluid machinery systems.

e. Course Learning Objective:

CLOBJ 1	Understand the fundamental principles of fluid flow, fluid measurement, dimensional analysis, and hydraulic machines through experimental investigations.
CLOBJ 2	Apply fluid mechanics concepts to determine flow characteristics, discharge coefficients, hydraulic parameters, and turbine performance.
CLOBJ 3	Conduct experiments on flow measurement devices, notches, orifices, and hydraulic turbines using standard laboratory procedures and instrumentation.
CLOBJ 4	Analyze fluid flow behavior under laminar and turbulent conditions and interpret experimental and computational results.
CLOBJ 5	Utilize computational techniques such as CFD and dimensional analysis for solving practical fluid flow engineering problems.
CLOBJ 6	Evaluate the performance of hydraulic systems and interpret efficiency characteristics for engineering applications.

f. Course Learning Outcomes:

CLO 1	Explain the principles of fluid flow, flow measurement devices, dimensional analysis, and hydraulic machines used in fluid mechanics laboratories.
CLO 2	Perform experiments to measure discharge, flow characteristics, hydraulic coefficients, and efficiency of hydraulic machines using standard laboratory equipment.
CLO 3	Apply Bernoulli's theorem, Reynolds experiment principles, Buckingham π

	theorem, and hydraulic performance equations to solve fluid flow problems.
CLO 4	Analyze laminar and turbulent flow behavior, notch characteristics, orifice parameters, and turbine performance using experimental observations and engineering calculations.
CLO 5	Evaluate the performance and efficiency of hydraulic turbines, hydraulic ram pumps, and flow systems based on experimental and computational data.
CLO 6	Develop computational and problem-solving skills using CFD analysis and dimensional analysis techniques for practical fluid engineering applications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	2	1	-	-	20	-	30	50

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. **Fluid Mechanics & Hydraulic Machines (Textbook)** By R. K. Bansal | Laxmi Publications"
2. **Fluid Mechanics** By Yunus A. Cengel, John M. Cimbala | Tata McGraw
3. **Introduction to Fluid Mechanics and Fluid Machines** By S. K. Som and G. Biswas | Tata McGraw Hill
4. **Engineering Fluid Mechanics** By K.L. Kumar | Eurasia Publication HouseEngineering
5. **Fluid Mechanics and Hydraulic Machines** By R.K. Rajput | S.Chand & Co.

- a. **Course Name:** Manufacturing Processes - II
- b. **Course Code:** 03010904PC05
- c. **Prerequisite:** Knowledge of Manufacturing Processes
- d. **Rationale:** Manufacturing Technology focuses on manufacturing process of conventional and non-conventional methods, gear manufacturing process and techniques used for holding and fixing of work piece during manufacturing process. This subject is helpful for getting basic knowledge of casting, metal forming processes, Gear and threads manufacturing and welding.
- e. **Course Learning Objective:**

CLOBJ 1	Explain the principles of moulding and casting processes, including pattern making, moulding sand properties, gating system design, types of casting methods, and common casting defects.
CLOBJ 2	Differentiate between forming and generating methods for gear and thread manufacturing, and identify appropriate processes and tools based on application requirements.
CLOBJ 3	Classify presses, dies, and sheet metal operations, and interpret the parameters influencing cutting forces, clearance, and center of pressure in press work.
CLOBJ 4	Analyze the role of temperature, yield criteria, and material behavior in metal forming processes, and distinguish between hot working, cold working, and bulk deformation mechanisms.
CLOBJ 5	Compare fusion and non-fusion welding processes (arc, resistance, oxy-fuel, diffusion) in terms of principle, characteristics, applications, and welding defects.
CLOBJ 6	Identify suitable manufacturing processes (casting, forming, joining, or pressing) for a given industrial component based on process capabilities and material requirements.

f. Course Learning Outcomes:

CLO 1	Understand the role of casting process in the industrial application.
CLO 2	Acquire fundamental knowledge of the gears and threads manufacturing
CLO 3	Analyze the mechanisms of sheet metal forming processes, including Presses and Press Work.
CLO 4	Understand mechanism and state applications of metal forming processes.
CLO 5	Apply concept of different welding process for a different application.
CLO 6	Understand the fundamental of underwater welding.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	-	2	2	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Moulding and Casting Processes: Patterns, Requirements of a good pattern, pattern materials, types of patterns, pattern allowances – Mould making, types of moulds, moulding processes, types of sand moulding - Core making, types of cores, core prints, core box - Moulding Sand, Properties of moulding sand, types of moulding sand, Gating system and its design, Introduction to casting, Different types of Casting processes, Casting Defects, Cleaning and Inspection of casting.	25%	8
2	Gear and Threads Manufacturing: Different types of threads, manufacturing methods, and tools involved. Different types of gears, it's forming and generating methods with their special features. Gears finishing processes. Gear manufacturing machines.	10%	02
3	Presses and Press Work: Classification of presses and Press operations. Classification of dies, cutting actions in dies, clearance, cutting forces, center of pressure. Sheet metal forming processes.	10%	02
4	Introduction and mechanism of metal forming processes: Plastic deformation and yield criteria, Material behavior in metal forming processes, Role of temperature in forming processes, Classification of metal forming processes. Hot and Cold Working, Rolling, Extrusion, Wire and Tube Drawing, Cold working processes: Shearing, Drawing Squeezing, Blanking, Piercing, Deep Drawing, Bending, Coining and embossing, Metal working defects. Mechanism of bulk deformation processes (rolling, forging, wire drawing, and extrusion) and Applications of metal forming processes.	30%	10
5	Metal Joining Processes: Importance, classification, advantages and limitations in general, comparison between fusion & non-fusion welding processes. Principle of operation, characteristics and applications of: Diffusion welding (arc welding, resistance welding, oxy-fuel welding), Welding defects and its remedies. Overview of modern welding processes. Welding joints and positions.	25%	8

i. Text Book and Reference Book:

1. "Fundamentals of machining and machine tools." by Boothroyd.
2. "A Textbook of Production Engineering "by P C Sharma.
3. "Workshop Technology" by Raghuvanshi.
4. "Production Technology" by R.K. Jain.
5. "Metal Cutting Principles", by M C Shaw.

- a. **Course Name:** Manufacturing Technology - II Lab
- b. **Course Code:** 03010904PC06
- c. **Prerequisite:** Knowledge of Manufacturing Processes
- d. **Rationale:** Manufacturing Technology focuses on manufacturing process of conventional and non-conventional methods, gear manufacturing process and techniques used for holding and fixing of work piece during manufacturing process. This subject is helpful for getting basic knowledge of casting, metal forming processes, Gear and threads manufacturing and welding.
- e. **Course Learning Objective:**

CLOBJ 1	Identify and describe different types of signals, such as continuous-time, discrete-time, analog, and digital signals.
CLOBJ 2	Apply mathematical operations, such as scaling, shifting, time-reversal, integration, and differentiation to manipulate signals.
CLOBJ 3	Analyse linear time-invariant (LTI) systems and understand their properties.
CLOBJ 4	Analyse signals and systems in the frequency domain using techniques like Fourier series and Fourier transforms.
CLOBJ 5	Demonstrate the conversion of continuous-time signals to discrete-time signals and vice versa.

f. Course Learning Outcomes:

CLO 1	Prepare sand moulds using single-piece patterns and demonstrate the basic procedure of casting.
CLO 2	Construct simple patterns while incorporating standard pattern allowances.
CLO 3	Analyze strip layout and compute the center of pressure for different press tool dies.
CLO 4	Operate and compare gas welding, gas cutting, and arc welding processes including TIG, MIG, and SMAW.
CLO 5	Demonstrate and distinguish advanced welding processes such as FSW (Friction Stir Welding) and resistance spot welding.
CLO 6	Perform basic metal forming operations including deep drawing, wire drawing, and extrusion on soft materials.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Text Book and Reference Book:

1. "Fundamentals of machining and machine tools." by Boothroyd.
2. "Workshop Technology" by Raghuvanshi.
3. "Production Technology" by R.K. Jain.
4. "Tool Design" by Donaldson.

- a. **Course Name:** Dynamics of Machines
- b. **Course Code:** 03010904PC07
- c. **Prerequisite:** Fundamental knowledge of Kinematics and Theory of Machines
- d. **Rationale:** Balancing and mechanical vibrations play a vital role in reducing unbalanced forces, resonance, and failures in rotating and reciprocating machinery. This course builds core analytical skills and introduces modern techniques such as smart balancing and vibration-based condition monitoring for industrial applications.
- e. **Course Learning Objective:**

CLOBJ 1	Explain the role of balancing in machine dynamics, and analyze static and dynamic unbalanced forces in rotating masses for single-plane and multi-plane systems.
CLOBJ 2	Calculate primary and secondary inertia forces in reciprocating mechanisms, and evaluate balancing requirements for single-cylinder, multi-cylinder in-line, V-engines, and radial engines.
CLOBJ 3	Classify mechanical vibrations based on damping, excitation, and degrees of freedom, and determine natural frequency of single degree of freedom (SDOF) systems using equilibrium, energy, and Rayleigh's methods.
CLOBJ 4	Analyze undamped and damped free vibrations, forced vibrations with harmonic excitation, and evaluate transmissibility and vibration isolation for rotating unbalance systems.
CLOBJ 5	Determine critical speed of shafts with transverse vibrations, and analyze two-rotor torsional vibration systems for power transmission applications.
CLOBJ 6	Explain recent advances in vibration monitoring and balancing including IoT-based sensors, AI/ML-based fault diagnosis, digital twin prediction, and predictive maintenance strategies.

f. Course Learning Outcomes:

CLO 1	Analyze and balance rotating and reciprocating machinery.
CLO 2	Determine vibration characteristics of mechanical systems.
CLO 3	Evaluate transverse and torsional vibrations in shafts and beams.
CLO 4	Apply modern vibration measurement and condition monitoring techniques.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Balancing Of Rotating Masses: Role of balancing in machine dynamics and vibration control; Concept of static and dynamic balancing; Unbalanced forces and couples; Analysis of unbalanced rotating masses in single plane and multiple planes; Balancing of rigid rotors; Graphical and analytical methods of balancing; Balancing of rotors with several masses in different planes; Effects of unbalance on bearings and machine foundations; Field balancing techniques and industrial applications.	15%	07
2	Balancing Of Reciprocating Parta: Introduction to reciprocating mass unbalance; Primary and secondary inertia forces; Partial balancing of single-cylinder engines; Effects of unbalanced forces in reciprocating locomotive mechanisms—swaying couple, variation in tractive force and hammer blow; Balancing of multi-cylinder in-line engines; Balancing of primary and secondary forces in V-engines and radial engines; Design constraints and practical considerations in reciprocating mass balancing.	25%	12
3	Introduction To Mechanical Vibrations: Definition and significance of vibrations in mechanical systems; Simple harmonic motion (SHM); Natural frequency and resonance; Classification of vibrations—free and forced, damped and undamped, linear and nonlinear; Basic elements of vibrating systems, Degrees of freedom (DOF); Equivalent stiffness of spring systems; Methods for determining natural frequency of single degree of freedom systems—equilibrium method, energy method and Rayleigh’s method.	15%	06
4	Single Degree Of Freedom System: Undammed free vibrations of single degree of freedom systems; Equivalent mechanical systems; Determination of natural frequency; Damped vibrations—viscous damping, damping coefficient and damping factor; Types of damping—underdamped, overdamped and critically damped systems; Damped natural frequency and logarithmic decrement; Forced vibrations with harmonic excitation—analytical solution and vector representation; Magnification factor; Response of rotating unbalance systems; Transmissibility and vibration isolation.	25%	12
5	Transverse And Torsional Vibration: Transverse vibrations of beams; Whirling of shafts with a single disc—critical speed analysis with and without damping; Rayleigh’s method for frequency estimation of shafts under transverse point loads; Torsional vibrations—torsionally equivalent systems; Stepped shafts; Two-rotor torsional systems; Practical applications in power transmission, turbines and rotating machinery.	10%	4
6	Recent Advances In Balancing And Mechanical Vibrations: Smart	10%	4

	and adaptive rotor balancing; Active and semi-active vibration control; Magnetic bearings and self-balancing rotors; IoT-based real-time vibration monitoring using wireless MEMS sensors; Advanced vibration signal processing techniques; AI/ML-based fault diagnosis and prognostics; Digital twin-based vibration prediction; Condition-based and predictive maintenance; Applications in aerospace, wind energy, high-speed machinery, and electric vehicles.		
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i. Text Book and Reference Book:

1. "Theory of Machine "by S S Ratan.
2. "Theory of Machine "by P.L. Ballaney.
3. "Mechanical Vibration "by G K Groover.
4. "Mechanical Vibration "by V P Singh.
5. "Machinery Vibration and Rotor dynamics", by Vance, J. M.; Zeidan, F. Y.; Murphy, B. | Wiley.

- a. **Course Name:** Dynamics of Machines Lab
- b. **Course Code:** 03010904PC08
- c. **Prerequisite:** Fundamental knowledge of Kinematics and Theory of Machines.
- d. **Rationale:** Balancing and mechanical vibrations play a vital role in reducing unbalanced forces, resonance, and failures in rotating and reciprocating machinery. This course builds core analytical skills and introduces modern techniques such as smart balancing and vibration-based condition monitoring for industrial applications.
- e. **Course Learning Objective:**

CLOBJ 1	Demonstrate static and dynamic balancing of rotating mass systems and analyze the effects of unbalance.
CLOBJ 2	Calculate frequency, time period, and equivalent stiffness of pendulum, spring, and single/two rotor systems.
CLOBJ 3	Analyze free damped vibration of torsional systems and demonstrate whirling of shaft systems.
CLOBJ 4	Demonstrate the use of vibration measuring devices for industrial applications.
CLOBJ 5	Compare theoretical and experimental values of natural frequency and damping ratio for different vibrating systems.

f. Course Learning Outcomes:

CLO 1	Perform static and dynamic balancing experiments on rotating mass systems and interpret the effects of unbalance.
CLO 2	Calculate natural frequency, time period, and equivalent stiffness for various mechanical systems including pendulum, spring, and rotor systems.
CLO 3	Analyze free damped torsional vibrations and whirling of shafts, and determine critical speed.
CLO 4	Demonstrate the working principle and application of vibration measuring instruments.
CLO 5	Compare theoretical and experimentally obtained values of natural frequency and damping ratio, and validate results.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	-	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Text Book and Reference Book:

1. "Theory of Machine "by S S Ratan.
2. "Theory of Machine "by P.L. Ballaney.
3. "Mechanical Vibration "by G K Groover.
4. "Mechanical Vibration "by V P Singh.
5. "Machinery Vibration and Rotor dynamics", by Vance, J. M.; Zeidan, F. Y.; Murphy, B. | Wiley.

- a. **Course Name:** Applied Thermodynamics
- b. **Course Code:** 03010904PE01
- c. **Prerequisite:** Basic knowledge of Thermodynamics
- d. **Rationale:** To apply thermodynamic principles for the analysis of practical energy conversion and thermal systems used in real engineering applications.
- e. **Course Learning Objective:**

CLOBJ 1	Analyze ideal and actual Brayton cycles, and evaluate methods to improve thermal efficiency including intercooling, reheating, and regeneration.
CLOBJ 2	Explain the limitations of the Carnot vapor cycle, analyze the Rankine cycle using p-v, T-s, and h-s diagrams, and evaluate methods to improve its thermal efficiency through reheating and regeneration.
CLOBJ 3	Classify steam turbines, construct velocity diagrams for impulse turbines, and calculate efficiency and work output under various operating conditions.
CLOBJ 4	Analyze one-dimensional steady isentropic flow in nozzles, determine critical properties and choking conditions, and explain the significance of Mach number and shock waves.
CLOBJ 5	Compare the construction, working principles, and performance characteristics of reciprocating, centrifugal, and axial flow compressors, including multistage compression with intercooling.
CLOBJ 6	Explain recent technological advancements in power systems including supercritical power plants, sCO ₂ Brayton cycles, combined cycles, and jet propulsion systems such as the Ramjet engine.

f. Course Learning Outcomes:

CLO 1	Apply the knowledge of gas power cycle and vapor power cycles for thermal analysis for certain specific criteria.
CLO 2	Analyze the behavior of compressible flows in nozzles.
CLO 3	Describe the working principle and operation of compressors and steam turbines.
CLO 4	Compare the performance of prime movers for different thermal systems.
CLO 5	Recognize recent power and propulsion technologies using applied thermodynamic principles.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme		
L	T	P	C	Internal Evaluation	ESE	Total

				MSE	CE	P	Theory	P	
3	1	-	4	20	20	50	60	-	150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Gas Power Cycles: Introduction, Ideal and actual Brayton cycle, methods to improve the thermal efficiency of Brayton cycle – intercooling, reheat, regeneration; optimum pressure ratio for maximum thermal efficiency, work ratio, effect of operating variables on the thermal efficiency and work ratio, compressor and turbine efficiency.	20%	9
2	Vapor Power Cycles: Limitations of Carnot vapour power cycle, Rankine cycle - p-v, T-s and h-s diagrams, and methods to improve the thermal efficiency of Rankine cycle - Reheating and Regeneration; feed water heaters, Case study on Thermal Power Plant.	15%	7
3	Steam Turbine: Principle and types of steam turbines, Impulse turbine: De-Laval turbine, compounding of steam turbines: Pressure compounding (Reateu Stage) and Velocity compounding (Curtis Turbine), Impulse turbine, velocity diagram and calculations for impulse turbines, condition for maximum efficiency, Reaction turbines: degree of reaction, Parsons' reaction turbine.	15%	7
4	Compressible Flow and Nozzles: Introduction, nozzle and diffuser, velocity of sound, Mach number and its significance, subsonic and supersonic flows, Mach waves, Mach cone and Mach angle, static and stagnation states, relationship between stagnation temperature, pressure, density and enthalpy in terms of Mach number, stagnation velocity of sound, various regions of flow, Effect of Mach number on compressibility, one-dimensional steady isentropic flow in nozzle, area velocity relationship, critical properties-choking in isentropic flow, Shock waves and expansion waves. Wind tunnel and its classification.	20%	9
5	Air Compressors: Reciprocating Compressors: Construction and working, work transfer, efficiency, multistage compression with intercooling. Centrifugal Compressors: Construction and working, static and total head properties, velocity diagram, degree of reaction, surging and choking, losses in centrifugal compressors. Axial Flow Compressors: Construction and working, Performance characteristics.	20%	8
6	Recent Research and Technological Advancements: Supercritical and Ultra-Supercritical Power Plants, Supercritical	10%	5

	CO ₂ (sCO ₂) Brayton Cycles, Combined cycles with heat recovery steam generators (HRSG), Jet propulsion and Ramjet engine.		
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i. Text Book and Reference Book:

1. Engineering Thermodynamics, By P. K. Nag, Tata McGraw-Hill Education, Pub. Year 2017
2. Fundamentals of Engineering Thermodynamics, By Michael J. Moran & Howard N. Shapiro, John Wiley & Sons. Pub. Year 2018
3. Fundamentals of Thermodynamics, By Claus Borgnakke and Richard E. Sonntag, John Wiley & Sons (Wiley)., Pub. Year 2012
4. Thermal Science and Engineering, By Dr. D. S. Kumar, Pub. Year 2022
5. Engineering Thermodynamics, By R K Rajput, Laxmi Publication (P) Ltd., Pub. Year, 2023

- a. **Course Name:** Advanced Materials
- b. **Course Code:** 03010904PE03
- c. **Prerequisite:** Zeal to learn the subject
- d. **Rationale:** To provide in-depth knowledge of advanced engineering materials, their structure–property–processing relationships, and selection criteria for high-performance engineering applications, with emphasis on recent technological advancements.
- e. **Course Learning Objective:**

CLOBJ 1	Classify advanced engineering materials and apply material selection methodologies using performance indices and Ashby charts for engineering applications.
CLOBJ 2	Analyze the structure, properties, processing techniques, and applications of advanced metallic materials including HSLA steels, superalloys, shape memory alloys, and amorphous metals.
CLOBJ 3	Explain the properties, processing methods, and industrial applications of advanced non-metallic materials including polymers, engineering ceramics, glasses, and carbon-based materials.
CLOBJ 4	Analyze the structure-property relationships of composite materials (polymer, metal, and ceramic matrix composites) and functional materials including piezoelectric, magnetostrictive, and biomaterials.
CLOBJ 5	Explain synthesis and characterization techniques for nanomaterials, and evaluate applications of carbon nanotubes and graphene in aerospace, biomedical, and energy sectors.
CLOBJ 6	Compare conventional and advanced materials based on performance, cost, sustainability, and current research trends for extreme service conditions.

f. Course Learning Outcomes:

CLO 1	Analyze the structure–property relationships of advanced metallic and non-metallic materials for engineering applications
CLO 2	Evaluate suitable advanced materials for extreme service conditions such as high temperature, corrosion, and wear.
CLO 3	Compare conventional and advanced materials based on performance, cost, and sustainability.
CLO 4	Apply material selection methodologies to solve complex engineering problems.
CLO 5	Assess recent research trends and technological developments in advanced and smart materials.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1		4	20	20	50	60	-	150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Classification And Selection Of Advanced Materials : Classification of engineering and advanced materials; Performance indices; Ashby charts; Material selection methodology; Requirements and challenges of advanced materials	25%	10
2	High-Strength Low-Alloy Steels; Super Alloys: Shape memory alloys; Amorphous metals; Processing techniques, properties, and applications.	20%	8
3	Advanced Non-Metallic Materials: Advanced polymers; Engineering ceramics; Glasses; Carbon-based materials; Properties, processing, and industrial applications.	15%	6
4	Composite And Functional Materials: Polymer, metal and ceramic matrix composites; Nano-composites; Functional and smart materials; Piezoelectric, magnetostrictive, and biomaterials.	20%	8
5	Nanomaterials And Recent Technological Advancements: Synthesis and characterization of nanomaterials; Carbon nanotubes and graphene; Applications in aerospace, biomedical, and energy sectors; Current research trends.	20%	8

i. Text Book and Reference Book:

1. Materials Science and Engineering, By Callister & Rethwisch, Wiley
2. Elements of Materials Science and Engineering, By Lawrence H. Van Vlack, Pearson Education India
3. Biomaterials Science, By Buddy D. Ratner, Allan S. Hoffman, Jack E. Lemons, Elsevier
4. Nanocomposite Science and Technology, By Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley
5. Mechanical Metallurgy, By George E Dieter, McGRAW Hill

- a. **Course Name:** MATLAB Programming
- b. **Course Code:** 03010904PE05
- c. **Prerequisite:** Basic knowledge of Engineering Mathematics (algebra, calculus, and matrices) and fundamentals of Mechanical Engineering.
- d. **Rationale:** To introduce basic MATLAB programming skills for solving simple numerical and mechanical engineering problems. The course aims to develop computational thinking and data visualization skills relevant to Mechanical Engineering applications.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the MATLAB computing environment, basic programming syntax, data types, and mathematical operations for engineering computations.
CLOBJ 2	Apply programming constructs, control statements, and user-defined functions to develop structured MATLAB programs for engineering applications.
CLOBJ 3	Analyze vectors, matrices, and systems of linear algebraic equations using MATLAB tools and linear algebra techniques.
CLOBJ 4	Develop graphical representations and engineering visualizations using two-dimensional and three-dimensional plotting techniques in MATLAB.
CLOBJ 5	Apply numerical methods such as differentiation, integration, interpolation, curve fitting, and root-finding techniques to solve engineering problems.
CLOBJ 6	Solve ordinary differential equations using MATLAB solvers and interpret solutions for mechanical engineering and dynamic system applications.

f. Course Learning Outcomes:

CLO 1	Identify the MATLAB computing environment, basic syntax, variables, and built-in functions.
CLO 2	Apply programming constructs and user-defined functions to solve basic computational problems.
CLO 3	Solve linear algebra problems using arrays, matrices, and matrix operations in MATLAB.
CLO 4	Use two and three-dimensional plotting techniques to visualize engineering data in MATLAB.
CLO 5	Analyze mechanical engineering problems using numerical methods in MATLAB.
CLO 6	Simulate simple dynamic systems using ordinary differential equation solvers in MATLAB.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	-	4	20	20	50	60	-	150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weight age	Teaching Hours
1	Introduction to MATLAB and Computing Environment MATLAB environment and interface, command window, editor and workspace, basic syntax rules, variables and data types, built-in mathematical functions, arithmetic operations, use of help and documentation, creation and execution of script files.	15%	07
2	Programming Constructs and User-Defined Functions Script files and function files, conditional statements (if-else, switch), looping constructs (for, while), nested loops, user-defined functions with input and output arguments, formatted input/output commands, basic debugging techniques.	20%	09
3	Arrays, Matrices and Linear Algebra Vectors and matrices, array operations and matrix operations, matrix arithmetic, transpose, inverse, determinant, rank, solution of systems of linear algebraic equations, numerical approximation errors, engineering numerical problems.	20%	09
4	Data Visualization and Plotting Two-dimensional plotting, multiple plots, subplots, plot customization, legends, labels and grids, three-dimensional plotting using mesh and surface plots, visualization of engineering data.	18%	08
5	Numerical Methods for Engineering Computation Numerical differentiation, numerical integration, root-finding techniques, curve fitting, interpolation, application of numerical methods to basic mechanical engineering problems.	15%	07
6	Ordinary Differential Equations and Applications Solution of first- and second-order ordinary differential equations using MATLAB solvers, graphical interpretation of	12%	05

	solutions, applications to motion, vibration and simple dynamic systems.		
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i. Text Book and Reference Book:

1. MATLAB Programming for Engineers By Stephen J. Chapman| Cengage Learning
2. MATLAB: A Practical Introduction to Programming and Problem Solving
By Stormy Attaway | Elsevier (Academic Press)
3. Getting Started with MATLAB By The MathWorks, Inc.| The MathWorks, Inc.
4. Mastering MATLAB By David C. Hanselman, Bruce L. Littlefield| Pearson Education
5. MATLAB Programming By Rudra Prakash, N. Pradeep | Oxford University Press