# Integral University, Lucknow

| Effective from Session: 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME202 | **Title of the Course** | APPLIED THERMODYNAMICS | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | III | 3 | 0 | 2 | 4 |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | • To have the basic concepts of thermal sciences and their application in formulating the thermal engineering problems.<br>• To have knowledge of steam generation, steam properties.<br>• To analyze steam nozzles and turbines, evaluate efficiencies.<br>• To analyze air-compressor and gas turbines, evaluate performance and efficiency.<br>• To analyze air standard cycles for I.C. engine, refrigeration and air-conditioning systems and understand their performance.<br>• To explain the working of boiler, refrigerator and air conditioner.<br>• To explain the operation of petrol and diesel engines and evaluate their performance. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Learners will be able to analyze thermodynamic principles, solve related numerical problems, and apply key equations to engineering applications. |
| **CO2** | Learners will be able to explain steam generation, evaluate steam properties, and analyze its applications. |
| **CO3** | Learners will be able to analyze steam nozzles and turbines, evaluate efficiencies, solve numerical problems. |
| **CO4** | Learners will be able to analyze air-compressor and gas turbines, evaluate performance and efficiency, solve numerical problems, and compare different power producing systems. |
| **CO5** | Learners will be able to analyze air standard cycles for I.C. engine, refrigeration and air-conditioning systems. |
| **CO6** | Learners will be able to explain the working of boiler, refrigerator and air conditioner. |
| **CO7** | Learners will be able to explain the operation of petrol and diesel engines and evaluate their performance. |

| **Unit No.** | **Title of the Unit** | **Content of Unit** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|---|
| 1 | **Basic Thermodynamics** | Thermodynamics-Definition, application, systems, laws of thermodynamics, concept of Entropy, change in entropy of universe, change of entropy of gases in thermodynamics process. simple numerical problems, availability of energy and irreversibility, Helmholtz and Gibb's function, mathematical conditions for exact differential, Maxwell's Relations, Calapeyron's equation and joule-thompson inversion curve, simple numerical problems based on the above topics. | 8 | CO1 |
| 2 | **Properties of Steam and Steam generators** | Temperature Versus Total heat graph during steam formation, sensible heat of water, properties of steam-wet, dry, superheated steam, Advantages of superheated steam, Uses of steam tables and Mollier chart. External work done during evaporation, Internal energy of steam. Rankine cycle, Simple numerical problems on above topics. Measurement of dryness fraction by throttling calorimeter. Definition, classification and working of fire-tube and water-tube boilers, Draught and its calculations, Boiler Efficiency, Equivalent Evaporation, Numerical problems. | 8 | CO2 |
| 3 | **Steam Nozzles and Steam Turbines** | Steam nozzles, types, nozzle efficiency, steam flow through nozzles, mass of steam discharged, critical pressure ratio. Numerical problems.<br>Classification and working of steam turbines, staging, efficiencies, velocity triangles for single stage moving blades, power produced, , re-heat factor, Bleeding of turbines, Simple Numerical Problems. Governing of steam turbines, Comparison of impulse and reaction turbines. | 8 | CO3 |
| 4 | **Air compressor and Gas Turbines** | Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. Working of a Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles with intercooling, reheat and regeneration, Stage efficiency, Polytropic efficiency. Deviation of actual cycles from ideal cycles. Numerical problems. | 8 | CO4 |
| 5 | **I.C. Engine, Refrigeration and Air-conditioning** | Classification of I.C. Engines. Analysis of Air standard cycles: Otto cycle, Diesel cycle, dual cycle. Work done and efficiencies calculation. Numerical Problems on analysis of air standard cycles of I.C. Engines.<br>Introduction of refrigeration, Mechanism of a domestic refrigerator, Vapour compression cycle. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its and its use, elementary psychometric processes and its representation on psychometric chart. Introduction to air-conditioning. | 8 | CO5 |

**Practical**

| **S. No.** | **List of experiments** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|
| 1 | Study of La-Mont Boiler. | 2 | CO6 |
| 2 | Study of Loeffler Boiler. | 2 | CO6 |
| 3 | Study and working of a domestic Refrigerator. | 2 | CO6 |
| 4 | Study and working of an Air Conditioner. | 2 | CO6 |
| 5 | Study and working of a 2 Stroke Petrol Engine. | 2 | CO7 |
| 6 | Study and working of a 4 Stroke Petrol Engine. | 2 | CO7 |
| 7 | Study and working of a 4 Stroke Diesel Engine. | 2 | CO7 |
| 8 | To determine the brake power of four stroke diesel engine and draw the heat balance sheet for 4-Stroke Diesel Engine. | 2 | CO7 |

**Reference Books:**

- Engineering Themodynamics : R.K. Rajput, Laxmi Publishing.
- Thermal Engineering : P.L. Balaney, Khanna Publishing
- Heat Engineering: V.P. Vasandani and D.S. Kumar P.M.B. Co. Pvt. Ltd.
- Thermal Engineering: P.S. Khurmi and J.K. Gupta, S. Chand and Co.
- Steam and Gas Turbine: R.Yadav LPH Allahabad.
- Engineering Thermodynamics: Jones and Dugon, PHI

**e-Learning Source:**

https://www.youtube.com/watch?v=AwbhbN20xl8&list=PLwdnzlV3ogoVJnW1S9GgOKYj5heOzl1dn

https://www.youtube.com/watch?v=6JwhQtw3JFg&list=PLFD532699BF29580A

https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8

| PO-PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | 2 | 2 | | | | | 3 | 3 | 2 | 2 |
| CO2 | 3 | 2 | 3 | 2 | 2 | 2 | | | | | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 2 | 2 | | | | | 3 | 3 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 2 | 2 | 2 | | | | | 3 | 3 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 2 | | | | | 2 | 3 | 2 | 2 |
| CO6 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | | 2 | 2 | 2 | 2 |
| CO7 | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | | 2 | 2 | 2 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| Name & Sign of Program Coordinator | Sign & Seal of HOD |
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# Integral University, Lucknow

| Effective from Session: 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME201 | **Title of the Course** | MATERIALS SCIENCE | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | III | 3 | 0 | 2 | 4 |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | • To analyze the relationship between crystal structures, material properties, and behavior to develop predictive models for engineering applications using mathematical and scientific principles.<br>• To evaluate and conduct experiments on mechanical properties (stress-strain, hardness, impact, fatigue, and creep) and microstructural analysis to validate material performance and recommend engineering solutions.<br>• To classify, analyze, and optimize the manufacturing processes of ferrous and non-ferrous metals, alloys, and heat treatment techniques for enhancing material properties and their applications in engineering.<br>• To critically assess and recommend magnetic materials, superconductors, polymers, ceramics, and advanced materials for sustainable and innovative engineering technologies.<br>• To investigate and evaluate heat treatment processes, material behavior under loading, and corrosion prevention strategies to design durable and efficient solutions for engineering challenges. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Learners will be able to distinguish and appraise the relationship between crystal structures (space lattice, unit cell, Bravai's lattices) and material properties to design and provide solutions that predict their behavior in engineering applications. |
| **CO2** | Learners will be able to evaluate mechanical testing methods (stress-strain behavior, hardness, impact, fatigue, and creep), microstructural analysis techniques (microscopy, X-ray diffraction, and grain size determination) and phase diagrams (Unary, Binary, and TTT) to assess material properties and predict their performance in engineering applications. |
| **CO3** | Learners will be able to classify and reframe the manufacturing processes of ferrous and non-ferrous metals, their alloys and heat treatment techniques to recommend their optimal properties and applications in engineering. |
| **CO4** | Learners will be able to analyze and evaluate the properties and applications of magnetic materials, superconductors and thermal and electrical materials, including semiconductors, insulators, and dielectrics, to conclude their effectiveness and suitability for advanced engineering technologies. |
| **CO5** | Learners will be able to differentiate, recommend, and formulate the structure, properties, processing, and applications of polymers, ceramics and advanced materials, including composites, smart materials, biomaterials, and superalloys, to develop effective solutions for engineering applications while mitigating corrosion risks. |
| **CO6** | Learners will be able to conduct mechanical property tests (impact, tensile, compressive, torsion, and hardness) under varying loading conditions to interpret material behavior, evaluate stiffness, elasticity and resistance to deformation, and assess corrosion effects for practical engineering applications. |
| **CO7** | Learners will be able to perform specimen preparation, heat treatment processes, microstructural analysis, and mechanical tests (tensile, fatigue, and sheet metal testing) to examine material structure, hardness and endurance and evaluate their influence on mechanical properties for engineering applications. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | **Introduction**<br><br>**Crystallography and Imperfections** | Classification of materials, Engineering requirements of materials, Important properties of engineering materials.<br>Crystal structure, Space lattice, Unit cell, Bravai's lattices, Atomic packing factor; Miller Indices, X-ray crystallography techniques; Types of imperfections. | 8 | CO1 |
| 2 | **Mechanical Properties and Testing**<br><br>**Micro-Structural Examination**<br><br>**Phase Diagram and Equilibrium Diagram** | Stress strain diagram for ductile and brittle materials, Hardness, Impact, Fatigue and Creep testing, Non-destructive testing.<br>Microscope principle and methods, preparation of samples and micro structure examination, X-ray diffraction, Grain size determination.<br>Unary and Binary phase diagrams, lever rule, Iron-carbon equilibrium diagram. Time Temperature Transformation (TTT) diagrams. | 8 | CO2 |
| 3 | **Ferrous and Non-ferrous Metals and Alloys**<br><br>**Heat Treatment** | Iron and steel manufacturing, Furnaces, Various types of carbon steels, alloy steels and cast iron, Non- ferrous metals such as Cu, Al, Zn, Cr, Ni etc and their applications, Various types of Brass, and Bronze,Aluminium alloys.<br>Introduction, heat treatment processes such as Annealing, Normalizing, Hardening Tempering, Case hardening and Surface hardening. | 8 | CO3 |
| 4 | **Magnetic Properties**<br><br>**Thermal and Electrical Propertiesof Materials** | Types of Magnetism. Ferromagnetic domains, Soft and hard magnetic materials, Measurement of magnetic susceptibility, Applications of magnetic materials.<br>Superconductor, Type I and II superconducting materials, Applications of superconductors.<br>Specific heat, Thermal conductivity, Thermal expansion, Thermal shock resistance, Thermo electric effect **:** Introduction, Resistivity, Conductivity, Semiconductors, P-N junction and Transistors,Insulators, Dielectrics. | 8 | CO4 |
| 5 | **Plastics**<br><br>**Ceramics**<br><br>**Environmental Degradation**<br><br>**Advanced Materials** | Polymers, Plastics and their applications, Mechanical behavior and Processing of plastics, Future of plastics.<br>Ceramic, types, properties and their applications, Processing ceramics, Mechanical behaviour and applications of traditional and advanced ceramics.<br>Corrosion, oxidation and prevention.<br>Composite materials, Smart materials, Biomaterials, Super alloys, Shape Memory alloys. | 8 | CO5 |
| **Practical** | | | | |
| **S. No.** | **List of experiments** | | **Contact Hrs.** | **Mapped CO** |

| | | | |
|---|---|---|---|
| 1 | Determination of energy required for breaking the mild steel specimen by applying sudden load using impact testing machine. | 2 | CO6 |
| 2 | To perform compressive and tensile test on helical spring and determine stiffness and modulus of rigidity using spring testing machine. | 2 | CO6 |
| 3 | To determine Brinell hardness number for a metal specimen on hardness tester. | 2 | CO6 |
| 4 | To perform the torsion test on metal specimen with the help of torsion testing machine and modulus of rupture and modulus of rigidity. | 2 | CO6 |
| 5 | To find the value of young modulus of elasticity and bending stress of the material in a circular beam simply supported at the ends and carrying concentrated load at the center. | 2 | CO6 |
| 6 | Material identification of about 50 common items. | 2 | CO6 |
| 7 | Study of corrosion and its effect. | 2 | CO6 |
| 8 | To conduct heat treatment process of annealing, normalizing and quenching and see the difference of hardness before and after heat treatment. | 2 | CO7 |
| 9 | To prepare specimen by grinding, polishing and etching | 2 | CO7 |
| 10 | Comparative study of micro structure of different materials like Mild steel, Grey cast iron, Brass, High speed steel and discuss the effect of micro structure of steel and cast iron on their mechanical properties | 2 | CO7 |
| 11 | To study the Erichsen sheet metal testing machine & perform the Erichsen cupping test. | 2 | CO7 |
| 12 | To perform tensile test on tensile testing machine & find out the tensile strength of test piece. | 2 | CO7 |
| 13 | To determine the endurance limit of the given specimen under fatigue or cyclic loading. | 2 | CO7 |

**Reference Books:**


- Material Science and Engineering: W.D. Callister, John Wiley and Sons
- Introduction to Materials Science for Engineers, James F. Shackelford, Prentice Hall
- Mechanical Behavior of Materials, T.H. Courtney, McGraw-Hill
- Mechanical Metallurgy, George E. Dieter; MCGRAW-HILL Publications
- Fundamentals of Materials Science, Eric J. Mittemeijer, Springer
- Mechanical Behaviour of Materials, M.A. Meyers and K.K. Chawla, Cambridge University Press


**e-Learning Source:**

https://www.youtube.com/watch?v=KMcsjCXfLQw&list=PLyAZSyX8Qy5Am_2StOOQ5vCUE3VIcAenE

https://www.youtube.com/watch?v=5nBBUahtz-c&list=PLyAZSyX8Qy5C8ciqBBlypbx91j4nowUbL

https://www.youtube.com/watch?v=2rxbxNem1iI&list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYSJ

**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**

| PO-PSO CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | | | | | 3 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 3 | | | | | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 3 | | | | | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 3 |
| CO7 | 3 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 3 | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

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| **Name & Sign of Program Coordinator** | **Sign & Seal of HOD** |

# Integral University, Lucknow

| **Effective from Session:** 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME203 | **Title of the Course** | STRENGTH OF MATERIALS | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | III | **3** | **0** | **0** | **3** |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | 1. To analyze the significance of the strength of materials and the testing of newly developed engineering materials to understand their behavior under elastic and plastic deformations in industrial and research applications.<br>2. To classify various mechanical engineering components based on their structural requirements and evaluate their performance under static loading conditions to ensure safe and efficient design.<br>3. To investigate advanced design methodologies in strength of materials to critically assess and implement innovative design elements that enhance engineering applications.<br>4. To evaluate the behavior of beams, thin and thick cylinders, columns, struts, open and closed coiled springs, and other common mechanical engineering elements to optimize their performance under diverse loading conditions.<br>5. To create reliable and efficient structural models by integrating fundamental principles of strength of materials with modern simulation tools, enabling accurate prediction of material behavior under complex loading scenarios. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students will be able to define key concepts like compound stresses, Mohr's Circle, 3D stress, failure theories, and strain energy, and apply them to analyze structural behavior and evaluate mechanical components under complex loading conditions. |
| **CO2** | Students will be able to describe key concepts of beam deflection, torsion, and combined loading, apply methods like Macaulay's and area moment, compare beam types under various loads, and solve related problems using analytical techniques. |
| **CO3** | Students will be able to illustrate the concepts of helical and leaf springs, analyze their deflection under loads, and distinguish between columns and struts using stress principles. They will evaluate structural stability using Euler's theory, Rankine-Gordon formula, and experimental methods. |
| **CO4** | Students will be able to classify key concepts of thin and thick cylinders, assess stresses and strains under pressure, and analyze compound cylinders for various pressure conditions using engineering principles. |
| **CO5** | Students will be able to discuss curved beam behavior, calculate stresses and neutral axis positions for various cross-sections, and analyze stress distribution in crane hooks and circular rings under load. |

| **Unit No.** | **Title of the Unit** | **Content of Unit** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|---|
| 1 | **Introduction** | Introduction of simple and compound stresses, Mohr's Circle. 3-D Stress, Theory of Failure, Castigliano's Theorem, Impact Load<br>Three-dimensional state of stress & strain, equilibrium equations. Generalized Hooke's Law. Theories of Failure. Castigliano's Theorem. Impact load & stresses, Strain Energy. | 8 | CO1 |
| 2 | **Stresses in Beams. Deflection of Beams Torsion** | Review of pure Bending. Direct and shear stresses in beams due to transverse and axial loads, composite beams. Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams. Review of Torsion, combined bending & torsion of solid & hollow shafts. | 8 | CO2 |
| 3 | **Helical and Leaf Springs Columns and Struts** | Deflection of springs by energy method, helical springs under axial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs. Combined bending and direct stress, middle third and middle quarter rules, Struts with different end conditions. Euler's theory and experimental results, Ranking Gordon Formulae,<br>Examples of columns in mechanical equipment's and machines. | 8 | CO3 |
| 4 | **Thin Cylinders and Spheres. Thick Cylinders** | Hoop and axial stresses and strains. Volumetric strain. Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, Compound cylinders. Stresses due to interference fits. | 8 | CO4 |
| 5 | **Curved Beams: Unsymmetrical Bending** | Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.<br>Properties of beam cross-section, slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear Centre and flexural axis (for symmetry about both axis and about one axis) for I-section and channel-section. | 8 | CO5 |

| **Reference Books:** |
|---|
| 1. Strength of Materials: Ryder Macmillon, Palgrave |
| 2. Strength of Materials: Rajput, S.Chand. |
| 3. Strength of Materials: R K Bansal, Laxmi Publication |
| 4. Advanced Mechanics of Solids: Kazmi, THM. |
| 5. Strength of Materials: Lehri , S.K. Kataria& Sons. |
| **e-Learning Source:** |

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| https://www.youtube.com/watch?v=xMCReTC--Dg&list=PLbP4qbTd-5UfbzcWgQ3EY-GeLs5Feg95V |
| https://www.youtube.com/watch?v=A1SWKe6ZwVc&list=PL521D094C8752CE67 |
| https://www.youtube.com/watch?v=_2d8YsXwm7M&list=PL35EBF66D99E7A0EC |

| PO- PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 2 | | | | | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | | | | | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 3 | | | | | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 3 | 3 | | | | | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 1 | 1 | 1 | 1 | 3 | | | | | 2 | 3 | 2 | 2 |

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

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| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

# Integral University, Lucknow

| Effective from Session: 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME214 | **Title of the Course** | Engineering Fluid Mechanics | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | III | 3 | 0 | 2 | 4 |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | 1. Understand the physical properties of fluids, pressure distribution, buoyancy, and apply these principles to analyze fluid behavior in real-world scenarios like capillary action and stability of floating bodies.<br>2. Explore fluid flow types, Eulerian & Lagrangian descriptions, and key fluid motion concepts, including Euler's and Bernoulli's equations, vortex flow, and Navier–Stokes equations.<br>3. Learn dimensional analysis, Buckingham's π theorem, similitude, and model studies, along with equations of motion for laminar flow and viscosity measurement techniques.<br>4. Analyze turbulent flow, velocity distribution, and boundary layers, with a focus on boundary layer separation and shear measurement techniques.<br>5. Apply Darcy-Weisbach and Moody's chart to laminar and turbulent flows, understand pipe configurations, water hammer phenomena, and study drag, lift, and the Magnus effect in fluid dynamics.<br>6. To experimentally study fluid mechanics concepts, including metacentric height, flow nets, Bernoulli's equation, venturi-meter calibration and forced vortex flow.<br>7. To experimentally verify the Impulse-Momentum equation, study flow transitions, velocity distribution and friction factors. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Learners will understand the physical properties of fluids, pressure distribution, and buoyancy. Apply these principles to analyze fluid behavior in various real-world scenarios, including capillary action and stability of floating bodies. |
| **CO2** | Learners will understand fluid flow types, Eulerian & Lagrangian descriptions, and key fluid motion concepts. They understand Euler's and Bernoulli's equations, their applications, and the basics of vortex flow and Navier–Stokes equations. |
| **CO3** | Learners will understand dimensional analysis, Buckingham's π theorem, similitude, and model studies, along with the equations of motion for laminar flow and viscosity measurement. |
| **CO4** | Learners will analyze turbulent flow, velocity distribution, and boundary layers. They will understand boundary layer separation and apply shear measurement techniques. |
| **CO5** | Learners will apply Darcy-Weisbach and Moody's chart to laminar and turbulent flows, analyze pipe configurations, and understand phenomena like water hammer. They will study drag, lift, and the Magnus effect in fluid dynamics. |
| **CO6** | Students will experimentally apply fluid mechanics principles to determine metacentric height, verify Bernoulli's equation, calibrate a venturi-meter, analyze vortex flow, and validate the Impulse-Momentum equation. |
| **CO7** | Students will experimentally verify the Impulse-Momentum equation, analyze flow transitions, velocity distribution and friction factors. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | **Introduction**<br><br>**Fluid Statics** | Definition of fluid and the concept of continuum; essential physical properties of fluids. Classification of different types of fluids. Phenomena such as capillarity and surface tension, including their effects on liquid droplets and soap bubbles.<br><br>The relationship between pressure, density, and height. Techniques for pressure measurement, including the use of manometers. Analysis of pressure forces on flat and curved surfaces, determination of the center of pressure. Principles of buoyancy and the stability of submerged and floating objects. | 8 | CO1 |
| 2 | **Kinematics of Fluid Flow**<br><br>**Dynamics of Fluid Mechanics** | Various types of fluid flow, with descriptions based on Eulerian and Lagrangian approaches. Concepts of fluid velocity and acceleration, and the definitions of streamline, pathline, and streakline. The continuity equation and fundamental ideas of rotation and circulation in fluid motion. Basic introduction to stream function and velocity potential.<br><br>Euler's equation of motion applied along a streamline, and derivation of Bernoulli's equation from it. Practical uses of Bernoulli's principle in devices such as Venturimeters, Orifice meters, and Pitot tubes. Understanding both free and forced vortex flows. Introduction to the Navier–Stokes equations for incompressible fluids, along with the linear momentum equation. Combined use of energy and momentum equations for flow analysis, including determination of discharge coefficients: Cv (velocity coefficient), Cc (contraction coefficient), and Cd (discharge coefficient). | 8 | CO2 |
| 3 | **Dimensional Analysis and Similarity**<br><br>**Laminar Flow** | Fundamentals of dimensional analysis and the use of Buckingham's π theorem. Key dimensionless numbers and their physical significance in fluid mechanics. Concept of similitude and the different types of similarity—geometric, kinematic, and dynamic. Overview of model testing and its applications in fluid studies.<br>Entrance region and development length in pipe flow. Derivation of motion equations for laminar flow in circular pipes and between parallel plates. Introduction to Stoke's Law and the concept of fluidization. Techniques for measuring viscosity. | 8 | CO3 |
| 4 | **Turbulent Flow and Measurement Techniques**<br><br>**Boundary Layer Concepts** | Transition process from laminar to turbulent flow and the governing equations for turbulent motion. Concepts of eddy viscosity and mixing length theory, along with velocity profiles in turbulent flow over both smooth and rough surfaces. Introduction to flow measurement instruments like the hot-wire anemometer and Laser Doppler Anemometry (LDA).<br>Different types of boundary layer thickness and behavior over a flat surface. Characteristics of laminar and turbulent boundary layers, including the laminar sub-layer. Discussion on smooth versus rough surface effects, as well as local and average friction coefficients. Causes and control of boundary layer separation. Techniques for measuring shear forces in fluid flow. | 8 | CO4 |

| | | | | |
|---|---|---|---|---|
| 5 | **Pipe Flow**<br><br>**Compressibility Effects in Pipe Flow**<br>**Flow Past Submerged Bodies** | Empirical formulas for analyzing both laminar and turbulent flows, including the friction factor and the Darcy-Weisbach equation. Use of Moody's chart for determining flow resistance. Analysis of flow behavior in scenarios such as sudden expansions, contractions, pipe bends, and siphons. Introduction to the concept of equivalent pipe length, and flow analysis in branched piping systems as well as pipes arranged in series and parallel.<br>Water hammer, Transmission of pressure waves in rigid and elastic pipes;<br><br>Drag and lift, drag on sphere, Cylinder and disc, Magnus effect and circulation. | 8 | CO5 |

**Practical**

| S. No. | List of experiments | Contact Hrs. | Mapped CO |
|---|---|---|---|
| 1 | To determine experimentally metacentric height of a ship model. | 2 | CO6 |
| 2 | To plot the flow net using the Hele-Shaw apparatus. | 2 | CO6 |
| 3 | To verify Bernoulli's Equation experimentally. | 2 | CO6 |
| 4 | To calibrate a venturi-meter and study the variation of the coefficient of discharge with the Reynold's number. | 2 | CO6 |
| 5 | To calibrate a orifice-meter and study the variation of the coefficient of discharge with the Reynold's number. | 2 | CO6 |
| 6 | To obtain the surface profile and the total head distribution on a forced vortex flow | 2 | CO6 |
| 7 | To verify Impulse-Momentum Equation experimentally. | 2 | CO7 |
| 8 | To study the transition from laminar to turbulent flow and determine the lower critical Reynold's number. | 2 | CO7 |
| 9 | To study the velocity distribution in a pipe. | 2 | CO7 |
| 10 | To study the variation of friction factor 'f', for turbulent flow in commercial pipes. | 2 | CO7 |

**Reference Books:**


- Grade, R.J. and A.G Mirajgaoker, Engineering Fluid Mechanics (including Hydraulic Machines), Nem Chand and Bros.
- R. K. Bansal, Fluid Mechanics and Hydraulic Machines , Laxmi Publication.
- R.K. Rajput, Fluid Mechanics and Hydraulic Machines, S.Chand Publication.
- Hunter Rouse, Elementary Mechanics of Fluid, John Wiley & Sons.
- Grade, R.J , Fluid Mechanics through Problems, Wiley Eastern Limited.
- Dr. Jagdish Lal, Fluid Mechanics & Hydraulic with Computer Applications, Metropolitan Publication.


**e-Learning Source:**

https://www.youtube.com/watch?v=fa0zHI6nLUo&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGvBEm&index=1

https://www.youtube.com/watch?v=lGL7Dp8xK_U&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGvBEm&index=13

https://www.youtube.com/watch?v=dvbYN28PuFM&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGvBEm&index=30

https://www.youtube.com/watch?v=NKpXpx_oDWM&list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGvBEm&index=47

**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**

| PO-PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 2 | | 3 | 2 | | 2 | 3 | 3 | 3 |
| CO7 | 3 | 3 | 3 | 3 | 3 | 2 | | 3 | 2 | | 2 | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HOD** |

# Integral University, Lucknow

| **Effective from Session:** 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME206 | **Title of the Course** | MACHINE DRAWING LAB | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | III | **0** | **0** | **2** | **1** |
| **Pre-Requisite** | | **Co-requisite** | | | | | |
| **Course Objectives** | 1. To analyze and reinforce the knowledge and skills acquired in the earlier course to enhance proficiency in machine drawing.<br>2. To classify various dimensioning, sectioning, and view development practices to ensure accurate technical representation.<br>3. To investigate fundamental machine parts and prepare part or assembly drawings in accordance with industry conventions.<br>4. To evaluate machine drawings to interpret design intent and assist in the preparation of accurate production drawings.<br>5. To create digital models using Computer-Aided Design (CAD) methods and procedures for industrial applications. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Describe the principles of basic and intermediate geometry and their applications in machine drawing, compare different projection methods to understand their significance in technical drawing, and apply the theory of projection to create accurate graphical representations of objects. |
| **CO2** | Sketch detailed assembly drawings of machine elements, measure their dimensions accurately, and conclude their functional significance. |
| **CO3** | Chart communicative drawings using material fundamentals, limits, fits, tolerances, and surface standards, reframe technical concepts visually, and develop effective technical communication skills. |
| **CO4** | Define key visualization techniques, discuss their applications in design, and choose appropriate methods to develop new products. |
| **CO5** | Distinguish basic and advanced concepts of AutoCAD, measure geometric parameters for precise engineering drawings, and plan projections using intermediate geometry principles. |

| **Unit No.** | **Title of the Unit** | **Content of Unit** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|---|
| 1 | Review | Orthographic projections, missing lines, interpretation of views and sectioning. | 02 | CO1 |
| 2 | Part and Assembly Drawing | Introduction, assembly drawing of stuffing box, steam engine, cross head, air valve, lathe tailstock, gate valve, screw jack, connecting rods, spark plug, tool post, safety valves etc. Drawing exercise. | 02 | CO2 |
| 3 | Materials Specifications & Tolerances | Engineering Materials: Steel, Copper & Aluminum Alloys, Code Designation, Limit Systems, Tolerances, Fits, Drawings & Exercises. | 02 | CO3 |
| 4 | Surface Roughness | Introduction, surface roughness, machining symbols, indication of surface roughness, drawing exercises. | 02 | CO3 |
| 5 | Production Drawing | Introduction to Developing and Interpreting Production Drawings of Simple Machine Elements including Helical Gears, Bevel Gears, Flanges, Pinion Shafts, Connecting Rods, Crankshafts, Belt Pulleys, and Piston Details, with an Overview of Tool Drawings. | 02 | CO4 |
| 6 | Manufacturing & Process Drawings | Jigs and fixture drawings, Tool and die drawings for metal forming and machining | 02 | CO4 |
| 7. | Computer Aided Drafting | Introduction, input, output devices, introduction to drafting software like. Auto CAD, basic commands and development of simple 2D and 3D drawing. | 02 | CO5 |
| 8 | Computer Aided Drafting | Development of simple 3Dimensional and 3Dimensional drawings. | 02 | CO5 |

**Reference Books:**


A Textbook of Machine Drawing, R.K. Dhawan, S. Chand

Machine Drawing by K.L. Narayana, New Age International Publishers


## e-Learning Source:

http://vlabs.iitkgp.ernet.in/mr/exp6/index.html

| PO-PSO CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 3 | | | | | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 2 | 3 | | | 2 | | 3 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 2 | | | 2 | | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 2 | | | | | 3 | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 2 | 2 | 3 | | | 2 | | 3 | 3 | 2 | 2 |

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |
|---|---|

# Integral University, Lucknow

| **Effective from Session:** 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME207 | **Title of the Course** | KINEMATICS OF MACHINE | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | IV | 3 | 0 | 0 | 3 |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | 1. To impart an understanding of different types of mechanisms, their inversions, and mobility criteria for planar mechanisms.<br>2. To analyze velocity and acceleration in planar mechanisms using graphical and analytical methods.<br>3. To synthesize planar mechanisms based on motion requirements and understand the kinematic design of linkages.<br>4. To understand the classification, motion characteristics, and design principles of cams and followers.<br>5. To evaluate different types of gear trains and gear drives for effective motion and power transmission. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Student will be able to identify and analyze the mechanisms necessary to achieve specific motion requirements in mechanical systems. |
| **CO2** | Student will be able to calculate and evaluate the velocity and acceleration parameters of planar mechanisms. |
| **CO3** | Student will be able to synthesize and design planar mechanisms based on specified motion parameters. |
| **CO4** | Student will be able to design and analyze various types of cam mechanisms to meet functional requirements. |
| **CO5** | Student will be able to evaluate and select suitable gear drives for motion and power transmission, and analyze different types of gear trains. |

| **Unit No.** | **Title of the Unit** | **Content of Unit** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|---|
| 1 | **Links, mechanism** | Links, Kinematics pairs, Linkage, Mechanisms, Inversion of slider crank chain, Number of degrees of freedom for a plane mechanism, Kutzbach Criterion for Plane mechanism, Gruber's Criterion for Plane mechanism, Inversion of four bar chain, Single slider crank chain, Double slider crank Chain | 8 | CO1 |
| 2 | **Method for determining the velocity** | Method for determining the velocity of a point on a link, Instantaneous center, Number of Instantaneous centers in a mechanism, Types of instantaneous Centers, Kennedy's theorem, velocity of a point on a link by instantaneous center method. velocity of a point on a link by relative velocity method, Acceleration diagram for a link, Acceleration of a point on a link, Acceleration in slider crank mechanism, Coriolis Component of acceleration. | 8 | CO2 |
| 3 | **Pantograph, Straigh t line motion mechanisms** | Pantograph, Straight line motion mechanisms, Peucellier's mechanism, Hart's straight line mechanism, Scott Reusel's mechanism, Grasshopper mechanisms. Analysis of Hooke's joint.Introduction to the analysis of complex mechanisms, Davis and Ackermann steering gear mechanism. Introduction to kinematic synthesis of planar linkages, geometrical methods. 3 position synthesis of coupling rod, analytical method, Frendenstem equation for function generation (3 position. | 8 | CO3 |
| 4 | **Classification of Cams and followers** | Classification of Cams and followers, Displacement, Velocity and acceleration diagram for different motions of follower, construction of cam profile for different motions of follower, cams with specified contours like tangent cam with reciprocating roller follower, Circular arc cam with flat faced follower. | 8 | CO4 |
| 5 | **Classification of Gear** | Classification of Gear, Terminology of gears, Law of gearing, minimum number of teeth to avoid interference. Path of contact, Arc of Contact, Gear Trains (Simple, Compound and planetary), Introduction to kinematics. | 8 | CO5 |

**Reference Books:**


1. Theory of Machines: Thomas Bevan, ELBS/CBS
2. Theory of Machines: S.S. Ratan, TMH
3. Theory of Machines: R.K. Bansal, Laxmi Publication
4. Mechanisms and Machines Theory: A.K. Ambekar, Jain Bros.
5. Theory of Machines: W.G. Green. Blackie


**e-Learning Source:**

https://www.youtube.com/watch?v=MJeRFzs4oRU&list=PLBEA57F7E7560C8E8

https://www.youtube.com/watch?v=yDEJxYGAoso&list=PLbRMhDVUMngdCkMipemSKP_dCgZLLfOe8

| **PO-PSO CO** | **Course Articulation Matrix: (Mapping of COs with POs and PSOs)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 2 | 1 | 1 | 3 | | | | | 3 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 1 | 1 | 2 | | | | | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 1 | 2 | | | | | 3 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 1 | 2 | | | | | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 1 | 2 | | | | | 2 | 2 | 2 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

# Integral University, Lucknow

| Effective from Session: 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME208 | **Title of the Course** | MANUFACTURING SCIENCE- 1 | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | IV | 3 | 0 | 2 | 4 |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | 1. Understand manufacturing processes, material behavior, and load requirements.<br>2. Analyze wire drawing, extrusion, and rolling for process optimization.<br>3. Evaluate die-punch assemblies, cutting, and forming operations.<br>4. Explore advanced forming, powder metallurgy, and plastic manufacturing.<br>5. Study casting, gating design, and jigs for precision manufacturing. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Will be able to analyze and optimize the importance of manufacturing, economic, and technological considerations, along with material selection, to enhance metal forming processes for engineering applications. |
| **CO2** | Will be able to investigate and optimize Drawing, Extrusion, and Rolling processes, including maximum reduction conditions, to enhance efficiency and precision in metal forming applications. |
| **CO3** | Will be able to evaluate and design die and punch assemblies, press working methods, cutting mechanisms, and various forming operations to optimize material flow, defect prevention, and process efficiency in sheet metal working. |
| **CO4** | Will be able to examine and assess unconventional metal forming processes, powder metallurgy, and plastic manufacturing methods while evaluating the applications of plastics, resins, and adhesives in modern and sustainable technologies. |
| **CO5** | Will be able to analyze and refine casting processes, gating system design, and defect prevention strategies while assessing various casting methods and the role of jigs and fixtures in enhancing manufacturing precision and efficiency. |
| **CO6** | Will be able to apply and implement pattern design principles, sand molding techniques, and metal melting processes to produce sound castings and improve quality in foundry operations. |
| **CO7** | Will be able to evaluate and improve tube bending, jigs and fixtures, sheet metal operations, and sand testing methods to enhance manufacturing precision and process efficiency. |

| **Unit No.** | **Title of the Unit** | **Content of Unit** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|---|
| 1 | **Introduction Metal Forming Processes.** | Importance of manufacturing. Economic and technological considerations in manufacturing. Survey of manufacturing processes. Materials and Manufacturing processes for common items. Elastic and Plastic deformation, yield criteria. Hot working vs cold working. Load required accomplishing metal forming operation. Analysis (equilibrium equation method) of forging process with sliding and sticking friction and mixed condition for slab and disc. Work required for forging. Hand power and drop forging | 8 | CO1 |
| 2 | **Drawing, Extrusion and Rolling** | Analysis of wire and strip drawing and maximum reduction. Analysis of Tube drawing, Extrusion and its application. Condition for Rolling force and power in rolling. Rolling mills. | 8 | CO2 |
| 3 | **Sheet Metal Working.** | Die and punch assembly and press working methods and processes. Cutting mechanisms, blanking Vs piercing, Compound vs progressive die. Flat face vs Inclined face punch. Analysis of forming process likes cup/deep drawing and bending. | 8 | CO3 |
| 4 | **Unconventional Metal Forming Processes. Plastic Components.** | Unconventional metal forming processes such as explosive forming, electromagnetic and electro-hydraulic forming. Powder Metallurgy: Introduction, process, advantages and applications. Manufacturing of Plastics, its past, present and future. Injection molding, Extrusion of plastic Section, Welding of plastics, Applications of plastics, Resins and adhesives. | 8 | CO4 |
| 5 | **Casting (Foundry) Jigs and Fixtures** | Introduction: Basic principle and survey of casting processes. Types of patterns and allowances. Types and properties of moulding sands. Elements of a mould and design considerations of gating, riser, runner, cores, Solidification of casting. Sand casting, defects, remedies and inspection of castings. Cupola furnace. Die casting. Centrifugal casting, Investment casting. Locating and clamping devices, Principles of Jigs and fixtures and their applications. | 8 | CO5 |

**Practical**

| **S. No.** | **List of experiments** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|
| 1 | Designing of pattern for a desired Casting. | 2 | CO6 |
| 2 | Pattern making using a given design of Pattern. | 2 | CO6 |
| 3 | Study of oil fired tilting furnace and melting of metal for a casting. | 2 | CO6 |
| 4 | Study of tube bending process on tube bending machine | 2 | CO6 |
| 5 | Study of jigs & fixtures and drilling of holes with the help of jigs. | 2 | CO7 |
| 6 | Mould sand testing (any one) (a) Permeability test (b) Moisture content test | 2 | CO7 |
| 7 | Making of Mould for desired Casting. | 2 | CO7 |

| | | | |
|---|---|---|---|
| 8 | Study of Power Press and to perform Power Press operation (Blanking/Piercing). | 2 | CO7 |

**Reference Books:**

- Manufacturing Technology: P.N. Rao, TMH.
- Manufacturing Science: Ghosh and Mallik, East West Press.
- Manufacturing Processes for Engineering Materials: Kalpakian, Pearson Education.
- Materials and Processes in Manufacturing: Degarmo, PHI.
- Production Technology: R.K. Jain, Khanna Publishers.
- A Text Book of Production Engineering: P.C. Sharma, S. Chand.

**e-Learning Source:**

https://www.youtube.com/watch?v=jdFrBtHeJbs&list=PLSGws_74K01-g9nnTMBssGURHawYYQfMQ

https://www.youtube.com/watch?v=uRVaLUQUmA8&list=PLACB124F79F677B6A

| PO-PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 2 | 2 | | 1 | | 2 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | | 2 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | | 1 | | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | | 1 | | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | | 3 | 3 | 3 | 3 | 3 |
| **CO7** | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | | 3 | 3 | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

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| **Name & Sign of Program Coordinator** | **Sign & Seal of HOD** |

# Integral University, Lucknow

| Effective from Session: 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME209 | **Title of the Course** | MEASUREMENTS, METROLOGY AND CONTROL | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | IV | 3 | 0 | 2 | 4 |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | 1. To define and explain the principles of measurement, functional elements of a measuring system, and the characteristics of measuring instruments for accurate data acquisition.<br>2. To explain and classify different measuring parameters and instrumentation techniques<br>3. To apply IoT-based measurement techniques and sensor technologies for monitoring of physical and virtual quantities in engineering applications.<br>4. To examine and evaluate metrological standards and measurement errors for precision engineering and reliability in industrial inspection and quality control.<br>5. To evaluate advanced measurement techniques for geometric, surface analysis, and microstructural analysis using optical and contact-based inspection tools.<br>6. To explain and apply advanced metrological techniques such as CMM and surface roughness analysis for quality inspection in engineering applications.<br>7. To analyze and evaluate the application of automatic control components and systems, including servomechanisms and transducers. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Identify and describe fundamental measurement concepts, generalized measuring instruments, and their static and dynamic performance characteristics. |
| **CO2** | Explain and compare the working principles of analog and digital sensors, transducers, and IoT-based measurement systems. |
| **CO3** | Assess and validate dimensional accuracy, geometric tolerances, and surface roughness using advanced metrology tools like CMM, profile projector, and interferometry. |
| **CO4** | Critically evaluate surface roughness geometric tolerances, thread parameters, and form measurements using profile projectors, interferometry, and other quantities Methods. |
| **CO5** | Design and develop an experimental setup integrating servomechanisms, transducers, and precision measuring instruments for automated mechanical measurement applications. |
| **CO6** | Evaluate precision instruments, measure mechanical parameters, analyze errors, compare sensors, and study measurement systems, promoting practical and interdisciplinary learning. |
| **CO7** | Evaluate measurement accuracy, analyze threads, optimize pitch diameter, assess surface roughness, and explore metrological instruments for engineering applications. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | **Introduction to Mechanical Measurements** | Introduction to measurement and measuring instruments, Generalized measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices, calibration of measuring instruments, concept and sources of errors in measurement.<br>Introduction to basic measuring parameters and devices like time, pressure, strain, force, torque, temperature and vibration measurement. | 10 | CO1 |
| 2 | **IoT based Sensors and transducers** | Introduction to IoT based measurements, Measuring physical and virtual quantities in digital world, Introduction to Sensors and Transducers, Analog Vs Digital Sensors, Wired Vs Wireless Sensor, Smart sensors, MEMS based sensors, etc., Introduction to Converters and Actuator, Microcontroller and Microprocessor, Encoders, Touchpad, Finger print scanner etc. | 08 | CO2 |
| 3 | **Metrology and Inspection** | Coordinate measuring machine (CMM): Need, constructional features and types<br>Metrology and Inspection: Standards of linear measurement, Line and end standards. Limit fits and tolerances. Interchangeability and standarisation. Linear and angular measurements devices and systems Comparators: Sigma, Johansson's Microkrator, Limit gauges classification, Taylor's Principle of Gauge Design. | 08 | CO3 |
| 4 | **Measurement of geometric forms and Surface** | Measurement of geometric forms like straightness, flatness, roundness. Tool markers microscope, profile projector, autocollimator. Interferometry: Principle and use of interferometry, optical flat. Measurement of screw threads and gears. Surface texture: Quantitative evaluation of surface roughness and its measurement | 08 | CO4 |
| 5 | **Automatic Controls** | Components and Systems: Translation and rotational mechanical components, series and parallel combinations, cascade system, analogous system. Servomechanisms. | 06 | CO5 |

**Practical**

| S. No. | List of experiments | Contact Hrs. | Mapped CO |
|---|---|---|---|
| 1 | To evaluate the least count and calibration of Vernier Caliper and Micrometer | 2 | CO6 |
| 2 | To measure the ovality of a shaft using a dial indicator | 2 | CO6 |
| 3 | To measure rotational speed using a Tachometer and Stroboscope | 2 | CO6 |
| 4 | To determine errors in measurement and calibration of an instrument using a strain gauge | 2 | CO6 |
| 5 | To measure the unknown taper angle of a given object using a sine bar and slip gauges | 2 | CO6 |
| 6 | To compare analog and digital sensors by measuring temperature | 2 | CO6 |

| | | | |
|---|---|---|---|
| 7 | To study and compare translation and rotational mechanical components in measurement systems | 2 | CO6 |
| 8 | To evaluate the accuracy and sensitivity of a pressure transducer in real-time applications | 2 | CO7 |
| 9 | To determine the pitch of a given screw thread using a profile projector | 2 | CO7 |
| 10 | To evaluate the accuracy of angular measurements using a Vernier Bevel Protractor | 2 | CO7 |
| 11 | To design and optimize the effective pitch circle diameter of a threaded component using the Two and three-Wire Method. | 2 | CO7 |
| 12 | Explain fundamental concepts of metrological instruments such as Coordinate Measuring Machine (CMM) | 2 | CO7 |
| 13 | Define the fundamental concepts of surface texture, roughness parameters, and their importance in engineering applications. | 2 | CO7 |

**Reference Books:**


- Mechanical Measurements: Beckwith Thomas G., Narosa Publishing House, New Delhi
- Metrology and Measurement: Anand Bewoor & Vinay Kulkarni: McGraw-Hill
- Hand Book of Modern Sensors: physics, Designs and Applications, Jacob Fraden, 3rd edition, Springer, New York
- Measurement Systems, Application Design: Deoblein E.O., McGraw Hill
- Engineering Metrology: Jain, R.K., Khanna Publishers
- Mechanical Measurements and Control: Kumar D.S., Metropolitan, New Delhi
- Modern Control Engineering, Katsuhiko Ogata, 5th ed., Prentice Hall, New Jersey USA


**e-Learning Source:**

**https://www.youtube.com/watch?v=tN7iAzVEqa0&list=PLwdnzlV3ogoXJLQ8lSGb1hsztt24l9kZZ**

**https://www.youtube.com/watch?v=Z0GrR1hSrfI&list=PLwdnzlV3ogoXJLQ8lSGb1hsztt24l9kZZ&index=3**

**https://www.youtube.com/watch?v=HpIEeBtJupY&list=PLbMVogVj5nJSZiwuh_tp50dKry8mCxzKA**

**https://www.youtube.com/watch?v=TtQE3lol6fU**

**https://www.youtube.com/watch?v=njgixrZOT1E**

**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**

| PO- PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | | | | | 3 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 1 | | | | | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | 2 | | 3 | 3 | 3 | 3 |
| CO7 | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | 2 | | 3 | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HOD** |

# Integral University, Lucknow

| Effective from Session: 2025-26 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | ME213 | **Title of the Course** | POLYMER SCIENCE AND TECHNOLOGY | **L** | **T** | **P** | **C** |
| **Year** | II | **Semester** | IV | **3** | **0** | **0** | **3** |
| **Pre-Requisite** | NONE | **Co-requisite** | NONE | | | | |
| **Course Objectives** | 1. To analyze the fundamental principles of polymer science to understand their significance in material applications.<br>2. To classify various polymerization processes and methods based on their mechanisms and industrial relevance.<br>3. To investigate recent advancements in the polymer industry to stay updated on emerging trends and technologies.<br>4. To evaluate different polymers and their properties for their suitability in developing innovative products.<br>5. To create an understanding of various plastic processing methods to optimize manufacturing efficiency. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Describe the key design features of a product that are directly influenced by the materials used in its construction, summarize the various processes and methods involved in the manufacturing of different plastic products, and apply appropriate manufacturing techniques to produce plastic products efficiently. |
| **CO2** | Compare the properties of polymeric materials to identify their potential applications in product design, explain how these properties can be exploited to enhance performance and functionality, and measure the reaction parameters involved in the polymerization of different polymers. |
| **CO3** | Interpret the role of rubber-toughening in enhancing the mechanical properties of polymers, reframe its significance in improving impact resistance and durability, and produce insights on its applications in material design. |
| **CO4** | Record the repeat units of specific polymers, chart the possible isomeric structures that can exist for those repeat units, and organize them based on their structural variations and properties. |
| **CO5** | Choose appropriate methods to determine the number- and weight-average molecular masses of polymer samples, differentiate between molecular mass calculations based on the degree of polymerization and mass fraction of chains, and develop a systematic approach for accurate polymer characterization. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | **Introduction** | Introduction, chemistry of polymer synthesis, polymer reaction kinetics, Mechanical properties of polymers, effect of structure on properties of polymers, Introduction to high performance polymers, polymer composite. | 8 | CO1 |
| 2 | **Manufacturing of polymer products** | Manufacturing of Polymer products: Introduction of composites, Manufacturing of polymer<br>composite. Hand lay Up method, Polymer processing technique, Extrusion moulding, Injection moulding, compression moulding. | 8 | CO2 |
| 3 | **Polymerization:** | Polymerization: Introduction, step-growth polymerization, frees radical chain growth<br>polymerization, Emulsion polymerization, ionic and cationic polymerization, chain statistics and rubber elasticity | 8 | CO3 |
| 4 | **Welding of polymer** | Welding of Polymer: Methods of Polymer joining, Friction method, Hot air technique, and the process in general, The hot gas (air) generating equipment, Material preparation, Weld parameter in polymer welding. Weld factor, comparison of polymer weld bead and metal<br>weld bead. | 8 | CO4 |
| 5 | **Preparation and applications** | Preparation and Applications: Preparation, properties and technical applications of thermo-plastics (PVC, PVA), thermostats (PF, UF) and elastomer (SBR, GR-N), silicones.<br>Application of polymers in space, ocean, electronics, medical, agriculture, automobile, sports and building construction. | 8 | CO5 |

**Reference Books:**


1. Polymer Science and Technology: Dr Premamoy Ghosh, McGraw Hill Education (India) Private Limited.
2. Polymer Science and Technology: Joel R. Fried (University of Cincinnati). Prentice Hall: New Jersey.
3. Polymer Science and Technology: Robert O Ebewele, CRC Press, Boca Raton New York.


**e-Learning Source:**

https://www.youtube.com/watch?v=54urJPOnaeU&list=PLvqSpQzTE6M_KQ5MqUkoOqAxxOrdvFOMB

https://www.youtube.com/watch?v=RMzGBRL_o3E&list=PLSGws_74K01_G67ptndBraskY3jCW7FLQ

https://www.youtube.com/watch?v=IaD2GlwPdOI&list=PLanXeDkWrN6zRnDVFhhNcccGLmKRn4fFB

| PO-PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 2 | 1 | 2 | 3 | | | | 1 | 1 | 1 | - | - |
| **CO2** | 2 | 2 | - | - | 2 | 2 | | | | 2 | 2 | 3 | 1 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | 1 | 2 | 1 | 2 | - | 2 | | | | 1 | 1 | - | 2 | 1 |
| **CO4** | 1 | - | 3 | - | 1 | 1 | | | | 3 | 3 | 1 | - | 2 |
| **CO5** | 1 | 1 | - | - | 2 | - | | | | 1 | 1 | - | 3 | - |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**