MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Deemed University)
Department of Mechanical Engineering

12251101: Engineering Materials

Category	Title	Code	Credit-3			Theory Paper
Departmental Core-DC	Engineering Materials	**12251101**	L	T	P	Major Evaluation: 30 marks
			3	-	-	Duration: 2 Hr

Course Objectives: To make the students to understand:

1. The basic fundamentals of materials science and engineering.
2. The different classes of materials, their properties, structures and imperfections present in them.
3. The functional properties of materials and the roles of microstructure, heat treatment defects andenvironment play in typical engineering applications.

Course Pre-Requisites: NIL

Syllabus

Unit-1: Engineering Materials

Basic Introduction and applications of engineering Materials: Classifications of engineering materials, Ferrous (Steels and Cast irons with role of different alloying elements), non-ferrous metals and alloys (Aluminum, Magnesium, Titanium, Copper, Nickel alloys), Composite Materials, Polymers and ceramics.

Unit-2: Structure of materials

Fundamentals of crystal structures and crystal system, crystallographic planes and directions, linear and planar density, single crystal, polycrystalline material and non-crystalline materials, Crystal imperfections: point, line, surface and volume defects.

Unit-3: Material Characterization and mechanical properties

Mechanical properties: stress-strain response (elastic, anelastic and plastic deformation) Strength, hardness, Fatigue, Creep etc.

Characterization techniques: Tensile testing, compression and bending tests, hardness testing, Impact testing, Cyclic stresses, S-N curve, crack initiation and propagation, factors affecting fatigue life; Creep: Generalized creep behavior, stress and temperature effects. Strengthening Mechanisms, Role of dislocations in plastic deformation, Mechanism of ductile and brittle fracture.

Unit-4: Phase diagrams and phase transformation of metal alloys

Concept of phases, Gibb's phase rule, Lever-rule, binary isomorphous and eutectic phase diagrams, Eutectoid, Peritectic and Peritectoid systems, allotropy in iron, Fe-Fe_3C phase diagram; Isothermal transformation of austenite, continuous cooling transformation of austenite,

Processing of Materials: heat treatments; Annealing, Normalizing, Hardening (bulk and surface)

Unit-5: Emerging Trends in Engineering Materials

Advanced Engineering Materials: Nano-materials, Smart materials, Bio-materials, Functionally Graded Materials (FGMs).

Course Outcomes: After successful completion of this course students will be able to:

CO1. Classify the different materials for engineering applications.

CO2. Analyse crystal structure and imperfections present in the materials

CO3. State the basic properties of materials and their characterization techniques.

CO4. Determine the effect of different phases Compare the different processes to alter the material properties

CO5. Analyze emerging engineering materials such as nano-materials, smart materials, and biomaterials, understand types of corrosion and prevention methods

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	3	1	1	1	-	1	-	3	-	1
CO2	3	1	2	2	3	1	1	-	-	1	-	3	1	1
CO3	3	3	3	2	3	2	-	1	-	-	2	3	1	2
CO4	3	3	3	2	3	1	2	1	-	1	2	3	-	-
CO5	3	3	3	3	3	2	1	1	1	1	2	3	1	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Text & Reference Books

1. Material Science and Engineering: An Introduction, William D. Callister, John Willey & Sons Inc., 7th edition
2. Elements of Material Science and Engineering **by** Lawrence, H. Vanvlackdison; Wesley.Mention the Year or the Edition and Publisher and Place of Publication
3. Material Science and Engineering **by** Raghvan, V; Prentice Hall of India.
4. Introduction to Engineering Materials **by** Agrawal, B.K; Tata McGraw Hill, N. Delhi.

NPTEL Link for Material Science

https://onlinecourses.nptel.ac.in/noc18_mm05/preview

12251103: Manufacturing Science

Category	Title	Code	Credit-3			Theory Paper
			L	T	P	
Departmental Core-DC	Manufacturing Science	12251103	2	1	-	Major Evaluation: 30 marks Duration: 2 Hr

Course Objectives: To make students:

1. Able to learn the various methods and types of castings, welding processes, sheet metal forming, powder metallurgy

2. Able to **e**xamine the principles associated with basic operations involving the forming, machining and welding of engineering materials;

3. Aware of the necessity to manage manufacturing processes and systems for the best use of material and human resources.

Course Pre-Requisites: NIL

Syllabus

Unit-I Casting: Brief History, Basic principle & survey of casting processes. Sand casting, pattern materials, and allowances. Green and dry moulding, moulding methods, moulding sand properties and testing. Elements of mould and design considerations. Cores use, core materials and core making practice. Die, investment and centrifugal casting processes. Melting practice and concepts in solidification. Inspection and defects analysis.

Unit-II Forming: Elastic and plastic deformation, Concept of strain hardening. Rolling, forging, extrusion, spinning, wire and tube drawing processes, machines and equipment's, parameters and force calculations.

Unit-III Sheet Metal Working: Role of sheet metal components. Cutting mechanism. Description of cutting processes like blanking. Piercing, lancing etc. Description of forming processes like bending cup drawing, coining, embossing etc. Basic elements of presses for sheet metal working. Punch and Die clearances and dieelements.

Unit-IV Welding: Principle of welding, soldering, brazing and adhesive bonding. Survey of welding and allied processes. Arc welding: power sources and consumables. MMAW, TIG& MIG processes and their parameter selection. Resistance Welding: principle and equipment. Spot, projection and Seam welding processes, Gas welding and cutting: Processes and equipment,

Unit-V Emerging Trends in Manufacturing Processes: 3D printed molds in casting, hybrid welding techniques, e-foundry, Robot Welding, Casting process improvement by application of AI.

Course Outcomes: After successful completion of this course students will be able to:

CO1- Select appropriate pattern materials and apply knowledge of pattern allowances to ensure accurate and efficient casting.
CO2- Explain the rolling process, differentiate between hot and cold rolling, and perform basic calculations related to rolling force, torque, and power requirements.
CO3- Develop the skills to calculate the correct punch and die clearances for various materials and thickness.

CO4- Apply theoretical knowledge to practical scenarios, making informed decisions in welding process selection, parameter optimization, and equipment usage.
CO5- Explore the diverse applications of powder metallurgy in various industries, including automotive, aerospace, medical, and electronics, and evaluate the suitability of P/M for different applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	3	1	1	1	2	1	-	3	1	1
CO2	3	1	2	2	3	1	1	1	1	1	-	3	1	1
CO3	3	3	3	2	3	2	1	1	1	1	2	3	1	2
CO4	3	3	3	2	3	1	2	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	1	1	1	1	2	3	1	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Text &Reference Books

1. Jain R.K., Production Technology, Khanna Publishers, 2001.
2. Hajra Choudhry, Elements of Workshop Technology, Vol – II Media Promoters & Publishers, 1994.
3. Production Technology by HMT, Tata McGraw-Hill.
4.Chapman, W.A.J., Workshop Technology, Vol - II, Oxford & IBH Publishing Co. Ltd.,
5. Manufacturing Processes by Amstead, B.H., P.F. Oswald and M.L. Begeman, John Wiley and Sons Inc., New York.
6. Manufacturing Technology Vol. 1 by P.N. Rao.
7. Modern Manufacturing Process Engineering by Neibel, B.W., Alan B. Draper and R.A. Wysk, McGraw-Hill Publishing Co., New York.
8. Manufacturing Engineering and Technology by Kalpakjian, S, Addison-Wesley Publishing Co., New York.
9. Materials and Processes in Manufacturing by E. Paul DeGarmo, J. Temple Black, and Ronald Kohser, Macmillan Publishing Co., New York.
10. Introduction to Manufacturing Processes John A. Schey, McGraw-Hill Book Co., New York.

NPTEL Link for Manufacturing Process

http://nptel.ac.in/courses/112107145/

12251104: Basic Mechanical Engineering

Category	Title	Code	Credit-3			Theory Paper
			L	T	P	
Departmental Core-DC	Basic Mechanical Engineering	12251104	2	1	-	Major Evaluation: 30 marks Duration: 2 Hr

Course Objectives: To make the students:

1. Develop the fundamentals of Engineering materials, measurement and reciprocating machines.
2. Develop an ability to understand the Thermodynamic laws, steam generator and reciprocating machines for solving engineering problems.
3. Demonstrate Engines and Boiler fundamentals using models.

Course Pre-Requisites: NIL

Syllabus

UNIT-I:

Materials: Classification of engineering material, composition of cast iron and carbon steels on iron-carbon diagram and their mechanical properties; Alloy steel and their applications; Stress-Strain diagram, Hooks law and modulus of elasticity. Tensile, shear, hardness and fatigue testing of materials.

UNIT-II:

Measurement: Temperature, pressure, velocity, flow, strain, force and torque measurement, concept of measurement error & uncertainty analysis, measurement by Vernier caliper, micrometer, dial gauges, slip gauges, sine-bar and combination set; introduction to lathe drilling, milling and shaping machines.

UNIT-III

Thermodynamics: Zeroth, First, second and third law of thermodynamics; steam properties, steam processes at constant pressure, volume, enthalpy & entropy, steam table, mollier chart. Classification and working of boilers, Refrigeration, vapour compression cycles, coefficient of performance (COP),

UNIT-IV

Reciprocating Machines: Steam engines, hypothetical and actual indicator diagram; Carnot cycle and ideal efficiency; Otto and diesel cycles; working of two stroke & four stroke petrol and diesel IC engines.

UNIT-V

Advances in Mechanical Engineering: Heating, Ventilation, and Air Conditioning (HVAC) software. Artificial Intelligence (AI)-Driven Combustion Control, Coordinate Measuring Machine (CMM), Electric Vehicle Technology.

Course Outcomes: After successful completion of this course students will be able to:

CO1. Apply the knowledge of material properties and testing methods to select appropriate materials for specific engineering applications.

CO2. Develop a foundational understanding of measurement principles, focusing on the accurate and precise measurement of physical quantities such as temperature, pressure, velocity, flow, strain, force, and torque.

CO3. Apply these thermodynamics laws to analyze energy exchanges and transformations in various thermodynamic systems.

CO4. Study the Otto and Diesel cycles in detail, learning how these cycles govern the operation of internal combustion (IC) engines and influence their efficiency and performance.

CO5. Apply modern tools such as HVAC simulation software, AI-driven combustion control systems, Coordinate Measuring Machines (CMM), and electric vehicle technologies to analyze, design, and optimize mechanical systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	3	1	1	1	1	1	-	3	1	1
CO2	3	1	2	2	3	1	1	1	1	1	-	3	1	1
CO3	3	3	3	2	3	2	1	1	1	1	2	3	1	-
CO4	3	3	3	2	3	1	2	1	1	1	2	3	1	-
CO5	3	3	3	3	3	2	1	1	1	1	2	3	1	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Reference Books:

1. Narula; Material Science; TMH
2. Agrawal B & CM; Basic Mechanical Engineering; TMH
3. Nag PK, Tripathi et al; Basic Mechanical Engineering; TMH
4. Rajput; Basic Mechanical Engineering;
5. Sawhney GS; Fundamentals of Mechanical Engibneering; PHI
6. Nakra and Chaudhary; Instrumentation and Measurement; TMH
7. Nag PK; Engineering Thermodynamics; TMH
8. Ganesan; Combustion Engines; TMH.

12251105: Basic Electrical & Electronics Engineering

Category	Title	Code	Credit-2			Theory paper
			L	T	P	
ESC	Basic Electrical & Electronics Engineering	12251105	2	-	-	Major Evaluation-30

Course Objectives:

- Impart foundational knowledge in Electrical and Electronics Engineering.
- Enable students to analyse electric circuits, understand electrical machines, and implement digital systems.
- Explore emerging applications in industrial automation, smart grids, and renewable systems.

Syllabus

Unit I D.C. Circuits Analysis: Voltage and Current Sources: Dependent and independent source. Source conversion. Kirchhoff's Law, Mesh and Nodal analysis. Network theorems: Superposition theorem, Thevenin's theorem & Norton's theorem and their applications.

Unit II Single-phase AC Circuits: Generation of sinusoidal AC voltage, definitions: Average value, R.M.S. value, Form factor and Peak factor of AC quantity, Concept of Phasor, analysis of R-L, R-C, R-L-C Series and Parallel circuit, Power and importance of Power factor, Resonance in AC circuits.

Unit III Transformer & Electrical Machines: Magnetic Circuits and Electromagnetism, Transformers: Construction, principle, types, losses & efficiency, OC & SC test DC Machines: Motor and Generator working Principles, Characteristics, Introduction to Induction Motors and Synchronous Machines.

Unit IV Digital Electronics, Devices & Circuits: Number Systems, Logic Gates and Truth Tables, Diodes, Transistors (BJT, FET, MOSFET), Multiplexers, Demultiplexers, Flip-Flops, Counters.

Unit V Emerging Trends and Applications: Smart Grids and Smart Meters, Application of Motors in Industrial Automation, Electric Vehicles and Renewable Systems, Sensors and Basic IoT Applications.

Course Outcomes (COs):

At the end of the course, the student will be able to:

CO1. **Apply** fundamental laws and network theorems to analyze DC circuits
CO2. **Analyze** single-phase series & parallel AC circuits for calculation of power, power factor, and resonance conditions.
CO3. **Explain** the working principles, construction, and operational characteristics of transformers, DC machines, and induction motors.
CO4. **Design** basic digital logic circuits using logic gates, flip-flops, and counters
CO5. **Discuss** the concepts of smart grids, electric vehicles, and IoT systems to emerging industrial applications in automation and renewable energy systems.

Course Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	*PSO1	*PSO2
CO1	3	3	2	2	1	-	-	-	-	-	-	1	2	2
CO2	3	3	2	2	1	-	-	-	-	-	-	1	2	2
CO3	3	2	3	2	2	1	-	-	-	-	-	2	1	1
CO4	3	3	3	2	1	-	-	1	2	2	-	1	1	1
CO5	3	2	3	2	3	2	2	2	-	1	1	2	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Recommended Books:

1.Basic Electrical and Electronics Engineering, D.P. Kothari &I.J. Nagrath-Tata McGraw Hill

2.Basic Electrical and Electronics Engineering, V N Mittle& Arvind Mittal -Tata McGraw Hill

3.Basic Electrical and Electronics Engineering, S. K Bhattacharya -Pearson

4.Principles of Electrical Engineering- Vincdent Del Toro- Prentice Hall.

5.Basic Electrical Engineering -A,E. Fitzgerald, Higginbotham and Grabel -TMH