

B. E. MECHANICAL ENGINEERING			
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)			
SEMESTER - III			
MATERIAL SCIENCE			
Course Code	18ME34	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> The foundation for understanding the structure and behaviour of materials common in mechanical engineering. Topics to explore the mechanical properties of metals and their alloys, polymers, ceramics, smart materials and composites. To understand modifications of material properties by heat treatment processes. Selections of different materials for various applications are highlighted. Impart knowledge of various failure modes of materials. 			
Module-1			
Introduction to Crystal Structure: Coordination number, atomic packing factor, Simple Cubic, BCC, FCC and HCP Structures, Crystal imperfections—point, line, surface and volume imperfections. Atomic Diffusion: Phenomenon, Fick's laws of diffusion (First and Second Law); Factors affecting diffusion. Mechanical Behaviour: Stress-strain diagrams showing ductile and brittle behaviour of materials, Engineering stress and true strains, Linear and non-linear elastic behaviour and properties, Mechanical properties in plastic range: Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness. Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals.			
Module-2			
Failure of Materials Fracture: Type I, Type II and Type III, Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, S-N diagram, fatigue testing. Creep: Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness, numerical on diffusion, strain and stress relaxation. Alloys, Steels, Solidification: Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), Binary phase diagrams: Eutectic, and Eutectoid systems, Lever rule, Intermediate phases, (The same type of process will study in Iron Carbon Phase Diagrams) Gibbs phase rule, Effect of non-equilibrium cooling, Coring and Homogenization Iron-Carbon (Cementite) diagram: description of phases, Effect of common alloying elements in steel, Common alloy steels, Stainless steel, Tool steel, Specifications of steels. Solidification: Mechanism of solidification, Homogeneous and Heterogeneous nucleation, Crystal growth,			
Module-3			
Heat Treatment, Ferrous and Non-Ferrous Alloys: Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth, Types of annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Concept of hardenability, Factors affecting hardenability. Surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of aluminium-copper alloys and PH steels. Ferrous materials: Properties, Compositions and uses of Grey cast iron and steel.			
Module-4			
Composite Materials : Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber-reinforced composites, Fundamentals of production of composites, characterization of composites, constitutive relations of composites, determination of composite properties from component properties, hybrid composites. Applications of composite materials. Numerical on determining properties of composites.			

Module-5**Other Materials, Material Selection**

Ceramics: Structure type and properties and applications of ceramics. Mechanical/ Electrical behaviour and processing of Ceramics.

Plastics: Various types of polymers/plastics and their applications. Mechanical behaviour and processing of plastics, Failure of plastics.

Other materials: Brief description of other materials such as optical and thermal materials.

Smart materials—fiber optic materials, piezo-electrics, shape memory alloys—Nitinol, superelasticity.

Biological applications of smart materials—materials used as implants in human body, selection of materials, performance of materials in service. Residual life assessment—use of non-destructive testing, economics, environment and Sustainability.

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

CO1: Understand the mechanical properties of metals and their alloys.

CO2: Analyze the various modes of failure and understand the microstructures of ferrous and non-ferrous materials.

CO3: Describe the processes of heat treatment of various alloys.

CO4: Acquire the Knowledge of composite materials and their production process as well as applications.

CO5: Understand the properties and potentialities of various materials available and material selection procedures.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Foundations of Materials Science and Engineering	Smith	McGrawHill	4th Edition, 2009.
2	Material science and Engineering and Introduction	William D. Callister	Wiley	2006
3	Materials Science	Shackelford, & M. K. Muralidhara	Pearson Publication	2007
Reference Books				
3	Materials Science and Engineering	V. Raghavan	PHI	2002
4	The Science and Engineering of Materials	Donald R. Askeland and Pradeep P. Phule	Cengage Learning	4th Ed., 2003
5	Mechanical Metallurgy	George E. Dieter	McGraw-Hill.	
6	ASM Handbooks	American Society of Metals		
7	Elements of Materials Science and Engineering	H. Van Vlack,	Addison-Wesley Edn	1998
8	An introduction to Metallurgy	Alan Cottrell	University Press India	1974.


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