



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: CAD / CAM

Course / Subject Code : ME01000601

Course / Subject Name: Advance engineering material

w. e. f. Academic Year:	2024-25
Semester:	1 st Semester
Category of the Course:	PEC

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Demonstrate an understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites.
02	Understand existence of imperfections and their effects on mechanical properties of materials and cause of failure.
03	Demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure.
04	Understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact.
05	Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites.
06	Understand the economic considerations in usage and recycling of materials in human use.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction, Atomic Structure, Inter atomic Bonding and Structure of Crystalline Solids: Historical perspective of Materials Science. Why study properties of materials? Classification of materials. Advanced Materials, Future materials and modern materials, Atomic structure. Atomic bonding in solids, Crystal structures, Crystalline and noncrystalline materials. Miller indices. An isotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers. Structure and properties of ceramics.	06	14
2	Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocations and Strengthening Mechanisms: Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Latticeristance to dislocation motion.	09	19
3.	Phase Diagrams Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron carbon system	07	17
4.	Failure: Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized Creep behaviour. Stress and temperature effects	07	17



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5.	Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites: Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behavior of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. Fiber reinforced composites. Structural composites	07	14
6.	Electrical, Thermal, Optical and Magnetic Properties and economic Considerations: Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behaviour. Ferroelectricity. piezoelectricity Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses Diamagnetism and Para magnetism. Ferromagnetism. Antiferromagnetism and ferrimagnetism. Influence of temperature on magnetic behaviour. Domains and Hysteresis, Basic concepts. Optical properties of metals. Optical properties of non-metals. Application of optical phenomena. Economic, Environmental and Social Issues of Material Usage - Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design	09	19
Total		45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	50	20	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

References/Suggested Learning Resources:

(a) Books:

1. Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons



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2. Modern Physical Metallurgy and Material Engineering, Science, Process, application, Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 1999.
3. Materials Science and Engineering, V. Raghvan, Pearson Education
4. Introduction to Physical Metallurgy, S. Avner, McGraw Hill

Suggested Course Practical List:

1. Identification of engineering materials
2. Bravais lattice and crystal geometry
3. Preparation of specimen and examination
4. Mounting techniques
5. Liquid penetration test
6. Magnetic particle test
7. Ultrasonic test
8. Rockwell hardness test
9. Effect of quenching media
10. Jominy hardenability test

List of Laboratory/Learning Resources Required:

Major Equipments:

1. Wet polishing bench
2. Engineering Microscope
3. Equipments/Accessories needed for non-destructive testing methods
4. Mounting press
5. Hardness tester
6. Furnace

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