GUJARAT TECHNOLOGICAL UNIVERSITY

Advanced Engineering Materials

SUBJECT CODE: 3710911

M.E. 1st SEMESTER

Type of course: Post Graduate

Prerequisite: Zeal to learn the Subject

Rationale: Course gives idea about the behavioral properties of various materials. Also internal structure and its relation to material's property are established in this subject. Subject is also useful for proper materials selection for various engineering applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Sr. No.	Topic	Teaching Hrs	ModuleWeightage
1	**Introduction, Atomic Structure, Inter atomic Bonding and Structure of Crystalline Solids:** Historical perspective of Materials Science. Why study properties of materials? Classification ofmaterials. Advanced Materials, Future materials and modern materials, Atomicstructure. Atomicbonding in solids, Crystal structures, Crystalline and noncrystalline materials. Miller indices.Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers.Structure and properties of ceramics.	6	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 orvolume defects. Atomic vibrations;Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yieldingunder multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Propertyvariability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocationand plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization andgrain growth. Strengthening by second phase particles. Optimum distribution of	8	19%

	particles. Latticeresistance to dislocation motion.		
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 ironcarbonsystem	7	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 creepbehaviour. Stress and temperature effects	7	17%
5	**Applications and Processing of Metals and Alloys, Polymers, Ceramics, andcomposites:** Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment.Precipitation hardening. Types and applications of ceramics. Fabrication and processing ofceramics, Mechanicalbehaviour of polymers. Mechanisms of deformation and strengthening ofpolymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis andprocessing, Particle reinforced composites. Fibre reinforced composites. Structural composites	6	14%
6	**Electrical, Thermal, Optical and Magnetic Properties and economic Considerations:** Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionicceramics and in polymers. Dielectric behaviour. Ferroelectricity. PiezoelectricityHeat capacity. Thermal expansion. Thermal conductivity. Thermal stressesDiamagnetism 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 ofoptical phenomena.Economic, Environmental and Social Issues of Material Usage - Economic considerations.Environmental and societal considerations. Recycling issues. Life cycle analysis and its use indesign	8	19%

References:

1. Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons
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, Pearsion Education
4. Introduction to Physical Metallurgy, S. Avner, McGraw Hill

List of Experiments:

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

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

Course Outcomes:

At the end of the course the student will

1. Demonstrate an understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites.
2. Understand existence of imperfections and their effects on mechanical properties of materials and cause of failure.
3. Demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure.
4. Understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact.
5. Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites.
6. Understand the economic considerations in usage and recycling of materials in human use.