GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3150508
Semester – V
Subject Name: Material Science and Engineering

Type of course: Open elective

Prerequisite: Basic Concepts of physics and chemistry.

Rationale: This course is intended to familiarize students with essential concepts in material science with an emphasis on particulate solids, their behavior and processing in various engineering applications. It will briefly cover basic concepts behind the chemistry of organic and inorganic compounds, chemical bonding and structure, and structure-property relationships in different engineering materials.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Introduction** : Classification of Engineering Materials; Levels of Structure; Structure–Property Relationships in Materials	5
2	**Atomic structure & Chemical bonding**: Quantum states, Ionization Potential, Electron Affinity and Electronegativity, Types of chemical bonds- Ionic, covalent, metallic and secondary bonding, Bond Energy, Bond Type and Bond Length	7
3	**Structure of solids**: The Crystalline and the Noncrystalline States, ionic solid, covalent solids, metals and alloys, Classification of Polymers, Structure of Long Chain Polymers	6
4	**Crystal defects**: Point Imperfections, The Geometry of Dislocations, Other Properties of Dislocations, Surface Imperfections	6
5	**Phase rule**: Single-component Systems, Binary Phase Diagrams, Some Typical Phase Diagrams and applications, phase transfornmation, nucleation and growth, transformations in steel, precipitation process, solidification and crystallization, glass transition	7
6	**Plastic deformation and creep in crystalline materials:** The Tensile Stress-Strain Curve, Plastic Deformation by Slip, The Shear Strength of Perfect and Real Crystals, The Effect of Temperature on the Stress to Move a Dislocation, mechanism of creep and creep resistant materials	7
7	**Oxidation and corrosion**: Mechanisms of Oxidation, Oxidation Resistant Materials, The Principles of Corrosion, Protection against Corrosion	7
8	**Conductors, resistors and semiconductor materials**, resistivity range, free electron theory, superconducting materials, intrinsic and extrinsic semiconductors, fabrication of	7

	integrated circuits, Magnetic and dielectric materials: Ferromagnetism and Related Phenomena, soft and hard magnetic materials,	

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	26	23	7		

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (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.

Reference Books:

1. Materials Science and Engineering: A first course, by V Raghavan, (5th Edition) PHI learning Centre, New Delhi.
2. Materials Science and Engineering: An Introduction, 10th Edition, William D. Callister Jr., David G. Rethwisch (WILEY)
3. Introduction to Materials Science for Engineers (8th Edition) 8th Edition by James F. Shackelford, Pearson
4. Elements of Materials Science and Engineering, L. H. Van Vlack (Addison-Wesley)

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

Sr. No.	CO statement	Marks % weightage
CO-1	To understand the basic structure of materials at the molecular, microscopic, and macroscopic scales	20
CO-2	To promote an understanding of the relationship between material structure, processing and properties	35
CO-3	To acquire basic knowledge of crystal defects, phase rule, plastic deformation and corrosion in materials	25
CO-4	To Gain a broad perspective on materials chemistry and physics for selection of engineering materials for specific applications.	20

List of Open Source Software/learning website:

Preparation of power-point slides, which include videos, animations, Pictures, graphics for better understanding theory – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus of Advanced analytical techniques is covered.

List of Open Source Software/learning website: Software:

Students can refer to video lectures available on the websites including NPTEL

Students can refer to the CDs which are available with some reference books for the solution of problems using softwares.

Collaborative Open Resource Environment – for Materials

The CORE-Materials repository contains 1670 open educational resources (OERs) in Materials Science and Engineering, freely available under a range of Creative Commons licenses. (Source: CORE webpage)

Suggested topics for tutorials:

The tutorials will be consisting of solving the numerical problems/critical evaluation/higher order thinking problems based on the following topics:

1. Bonding Properties of Atoms
2. Properties of Crystals & Defects
3. Diffusion
4. Mechanical Properties
5. Plastic Deformation & Strengthening
6. Failure, Creep, Fatigue, & Fracture
7.Phases and Phase Diagrams
8. TTT (Time-Temperature-Transformation)Diagrams
9. Ceramics, Polymers, & Electronic Properties