Materials Science

1.1 Course Number: CH211
1.2 Contact Hours: 3-0-0 Credits: 9
1.3 Semester-offered: 4th
1.4 Prerequisite: Basic Physics, Physical Chemistry, Mathematics, and Thermodynamics

2. Objective: The course objective is to understand how nature of atomic bonding influences the structure of the materials, and how structure and processing influence the properties of the materials. To understand perfect and imperfect crystalline structures and its measurement techniques. To understand inter-relationship between the microstructure and materials properties. To understand how phase diagram can be utilized to design the thermal processing steps to cause the materials to undergo phase transformations in a controlled manner to develop a desired microstructure and thereby examine the macroscale properties of the materials. To understand origins of mechanical behavior of the materials such as their stress-strain response, elasticity, plasticity, creep, viscoelasticity, and fatigue, and applying this understanding for engineering applications. Understand origins of electronic properties of the materials, and their applications in areas related to energy such as semiconductor device engineering, photovoltaics, and catalysis. To understand the basic operational principles of some material characterization techniques for mechanical, structural, and electronic characterization. Understand electrochemical interactions between materials in different phases and their applications in corrosion engineering.

3. Course Content:

Unit wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Structure of Material	Nature of interatomic bondings and crystallographic description of the crystalline materials	5
2	Measurement Techniques	XRD characterization of materials, Microscopy (scanning electron microscopy and optical microscopy)	4
3	Defects	Imperfections in crystalline materials and alloys. Point, line, and plane defects, Diffusion in materials	7
4	Phase Diagram	Binary phase diagrams in solid-solid systems and microstructures, Phase transformations,	8
5	Mechanical properties of materials	Elasticity, anelasticity, plasticity, viscoelasticity, creep, fatigue, fracture.	6

6	Electronic properties of materials	Metals and semiconductors. Origin and applications in device engineering,	5
7	Applications	(Brief Introduction of Engineering Alloys)	2
		Polymers, Ceramics and Glass materials their engineering applications	3

4. **Readings**

4.1 Text Books:

1. V. Raghavan, Materials Science and Engineering: A First Course, 6th Edition, Prentice Hall India.
2. William J. Callister and David G. Rethwisch, Materials Science and Engineering: An Introduction, 10th Edition, , Wiley

5. **Outcome of the Course:** The students will be able to identify the periodic structures in crystalline materials and correlate it with the XRD data. The students will also be able to find the nature of the phase under given thermodynamic conditions and calculate their relative abundance in a solid solution from its given phase diagram. They can predict the microstructure and mechanical behavior in iron carbon and other binary systems from the given thermal history and phase diagram. Qualitatively draw the stress strain behavior of the materials given their microscopic details such as nature of bonding, structure etc. and design engineering materials for a given mechanical application.