Course Description and Outline

Course Title: Materials Science

Course Code: PHY 3204

Course Level: Year 3, Semester 2

Hours: 3 hours per week

Purpose of the Course

The purpose of this course is to present to students the basic principles necessary to understand structure-property relations in material science. The course assumes a basic knowledge in general Physics, general chemistry, and mathematics. With these tools and the subject matter outlined in this course, students obtain a wide knowledge of modern challenges to the application of modern materials. Where appropriate, state-of-the-art problems are discussed in the form of examples. The student grasps concepts of structure from bonding through to microstructure, and then learns to consider the interrelationships between structure and property. The properties ranging from structural, electrical, optical to thermal in nature are all considered.

By the end of this unit, students should be able to:

1. Explain the diverse activities with material science.
2. Discuss basic concepts regarding structure-property-processing relations across all material classes.
3. Discuss the structure dimensions range from bonds lengths to defect scales through to microstructure and device scale.
4. Explain the importance of quantification and characterization of properties and phenomena.
5. Examine the factors that ultimately determine a material selection for a given application.
6. Describe the major crystal structures of solids and label crystallographic planes and directions, explain why some materials are non-crystalline, Carry out a simple metallographic sample, examine it under the microscope and explain its structure,
7. Explain the relationship between structure and properties of alloys,

Course Content

The course content is divided into three study units;

Unit One: Introduction to Materials Science, Bonding and Structure of Solid Materials

Historical perspectives of materials, meaning of materials science, types of materials, classification of materials. Atomic bonding and bonding types, Crystallography and x-ray diffraction, Defect structures, Amorphous structures in metals, ceramics, and polymers crystalline, crystal systems, crystallography, indices of planes and directions.

Unit Two: Properties of Materials

Physical property, chemical property, electrical property. Mechanical properties; Elastic and plastic behavior is contrasted in ceramics, metals, and polymers, Stress-strain curves, Hardening mechanisms in polymers and metals, Time dependent mechanical properties, creep mechanisms, Fracture toughness.

Unit Three: Crystal defects

Geometrical, chemical. Frenkel and Scrottky defects and their concentration. Types of non-stoichiometry in compounds and their electrical consequences. Introduction to dislocations, Amorphous materials; organic and inorganic glasses, RSM, Mixed structures; partially crystalline polymers, particle and fibre reinforced materials. Defects in materials; Point defect, Linear defect, Planar defect and Volume defect.

Unit Four: Diffusion

Diffusion coefficient, atomic mechanisms, use of tracers. Diffusion of vacancies, Nabarro-Herring Creep, the Kirkendall effect. Vacancy sources and sinks. Activated diffusion and activation energy. Grain boundary diffusion. Analytical and graphical techniques for indexing cubic and non-cubic patterns. Accurate Lattice parameter measurement and errors involved. Principles of [structure determination]. Atomic scattering, integrated intensities. Structure Factor.

Mode of Delivery

Blended Learning
Lecture
Discussion
Presentation

Assessment

Course Work 15%
Quiz and Short Test 15%
Attendance and Participation 10%
Examination 60%