Approval : 2nd Senate Meeting

Materials Science for Engineers

Code: IC 241

Credits: 3-0-0-3

Objective: Materials are an integral part of the technological development. The objective of this course is to impart basic essential knowledge about materials to the engineering graduates. By the end of this course the student should be able to understand:

a) the classes of materials available for various applications and selection strategies.
b) properties that influence the behavior of these materials and how to measure them.
c) the structures in materials that control these properties.
d) the processing strategies that can alter these structures and properties.

Syllabus

Overview of materials science and materials engineering, Property considerations for specific application, Ashby-style charts, Impact of structure and bonding over materials properties, Change in properties over time, Economic considerations, Sustainability and Green Engineering. Structure in materials: Amorphous, crystalline and polycrystalline materials, Crystalline defects and their significance. Classes of engineering materials (metals, polymers, ceramics, composites). [6 Lectures]

Solid Solutions- Substitutional and interstitial, how to draw phase diagrams of solid solutions, intermediate phases and intermetallic compounds, lever rule, isomorphous, monotectic, eutectic, peritectic, eutectoid, peritectoid reactions. Fe-Fe_3C phase diagram, effect of non equilibrium cooling on structure, phase transformations, nucleation and growth process [6 Lectures]

(a)Structural Application of Materials:

Static Structural Application – Uniaxial stress, strain, engineering and true stress and strain, stress strain diagram, elastic, yielding and plastic behavior, properties to characterize each, stress-strain curve of plastic, effect of temperature and creep. Application of metals, ceramics, polymers and composites in static structures like buildings, bridges, furnace structure, bulb filaments, etc, strength requirement in transmission lines. [6 Lectures]

Dynamic structural applications - Fatigue, low cycle and high cycle fatigue, S-N curves, creep-fatigue interaction; Application of materials in automobiles, hydroelectric and thermal power plants. [6 Lectures]

Manipulation of materials properties through different treatments. Surface engineering. [4 Lectures]

(b) Electrical and Electronic Application:

Band structures for conductors, semiconductors and insulators, I-V characteristics, resistance of alloy, conductor alloy, zone refining. [4 Lectures]

Dielectric Materials and Insulation: Matter polarization and relative permittivity, Polarization mechanisms, frequency dependence of dielectric constant and dielectric loss, dielectric strength, piezo, ferro and pyro-electricity-elemental ideas. Choice of materials for various specific applications: capacitors, sensors, actuators and transducers, in the context of applications. [5 Lectures]

Magnetic and Superconducting materials: dia, para, ferro, antiferro and ferrimagnetism. Soft and Hard magnetic materials, Colossal magneto resistance (CMR) materials, magnetic sensors, read- write heads, spintronic devices; Superconductivity- zero resistance and the Meissner effect. Type I and Type II superconductors. High temperature superconducting materials, selection and their applications in magnets. [6 Lectures]

Suggested Books:

1. Engineering Materials: Properties and Selection by Kenneth G. Budinski, Prentice Hall, [New Edition] USA.
2. Principles of Electronic Materials and devices by S. O. Kasap, 2009, Third Edition, Tata-McGraw Hill Education Pvt. Ltd., New Delhi
3. Solid State Electronic Devices by Ben G. Streetman and Sanjay Bannerjee, 2000, Fifth edition, Pearson-Prentice Hall, USA.
4. Materials Science and Engineering- An introduction, William D. Callister, Jr. John Wiley and Sons, Inc.