CH-432 Materials Science

Credit Hours: 2-1

Prerequisite: Nil

Course Objectives

1. This course introduces the fundamentals of materials science, focusing on the classification and properties of metals, ceramics, polymers, and composites. It covers atomic bonding, crystal structures, and defects, along with differences between amorphous and crystalline materials. Key characterization techniques like XRD, SEM, and TEM are discussed. The course also explores mechanical, electrical, magnetic, and optical properties, corrosion testing, and basic processing methods such as casting, forging, extrusion, CVD, and PVD. Case studies and emerging materials like biodegradable polymers and smart materials are included to highlight real-world applications

Detailed Contents

2. Introduction to materials science. Classification of materials such as metals, ceramics, polymers & composites. Atomic bonding and structure (ionic, covalent, metallic, van der Waals forces). Crystal systems and defects (point, line & planar). Structure (amorphous vs crystalline) and characterization (X-ray diffraction, SEM and TEM) of materials. Mechanical, electrical, magnetic & optical properties of polymers & composite materials. Corrosion and degradation testing of materials. Materials processing (casting, forging, extrusion, thin films and coatings: CVD & PVD). Case studies: aerospace, electronics & biomedical implants. Emerging materials (biodegradable polymers and smart materials).

Course Outcomes

3. By the end of this course, the students will be able to:

   Explain the relationship between chemical structure, properties, and applications of different materials, including metals, ceramics, and polymers etc.

   Characterize materials using techniques such as X-ray diffraction and electron microscopy etc.

   Evaluate the selection and design of materials for specific industrial and technological applications.

Relevant Experiments

4. Crystal structure analysis of materials using different techniques. Mechanical

testing of materials. Conductivity and resistivity testing of materials. Applying impact resistance on polymers and composites.

Recommended Books

5. Callister Jr, W. D. & Rethwisch, D. G. (2021). Fundamentals of Materials Science and Engineering: An Integrated Approach (6th ed.). Wiley. ISBN: 978- 1-119-68894-5.
6. Sharma, S. K., Verma, D. S., Khan, L. U., Kumar, S. & Khan, S.B. (2018)
7. Handbook of Materials Characterization. Springer. ISBN: 978-3-319-92955-2.
8. Smith, J. (2024). Material Science Step by Step: Principles and Fundamentals of Materials for Engineering & Design. Tag Vault Publishing. ISBN: 979-8340254610.
9. Kaspar, S. & Capper, P. (Eds.). (2017). Springer Handbook of Electronic and Photonic Materials (2nd ed.). Springer. ISBN: 978-3-319-48931-5.
10. Srivatsan, T.S. (2024). Advanced Materials for Emerging Applications. Bentham Science Publishers. ISBN: 978-9815196795.

Current Literature and Reviews