

MSE-103 Materials Chemistry

Credit Hours: 2-1

Pre-requisites: Nil

Course Objectives

This course provides students with an essential foundation in chemistry that is tailored to their field of metallurgical and materials engineering. The course primarily focuses on relevant principles and applications. The students will gain an understanding of the applications of materials chemistry in a wide range of fields, such as metal extraction, corrosion prevention, polymer synthesis, energy conversion and storage, biomedical devices, electronics and optoelectronics.

Course Contents

- Introduction to chemistry, its scope and importance in Metallurgical and Materials Engineering.
- Classification of elements, periodic table and electronic configuration, transition metals, noble metals, active metals, rare earths, semimetals, and semiconductors. Chemical bonding in materials.
- Chemical reactions; stoichiometry, mass and heat balance, oxidation, and reduction reactions in ferrous and non-ferrous materials extraction. Solution chemistry. Physical chemistry: equilibrium, kinetics and reaction rate laws, effect of physical variables (pressure, temperature etc.) on equilibrium and kinetics, phase rule. Introduction to oxidation and reduction reactions in ferrous and non-ferrous extraction.
- Organic chemistry: Introduction, nature and sources of compounds, hydrocarbon compounds, polymeric materials, introduction to biochemistry, biomaterials.
- Analytical chemistry: Introduction, qualitative and quantitative analysis of ferrous and non-ferrous metals, analysis of various ores, coals, liquid solution, introduction to analytical instrumentation.
- Applications of materials chemistry in energy conversion and storage, electronics and optoelectronics, and biomedical devices.

Course Outcome

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

- Describe fundamental principles of physical, analytical, solution and organic chemistry.
- Analyze the role of physical, analytical, and solution chemistry in materials engineering.
- Evaluate the role of organic chemistry in materials engineering.

Weekly Plan

Week	Topics
1	Introduction to chemistry, its scope and importance in Metallurgical and Materials Engineering
2	Classification of elements, periodic table and electronic configuration, transition metals, noble metals, active metals, rare earths, semimetals, and semiconductors. Chemical bonding in materials
3	
4	Chemical reactions; stoichiometry, mass and heat balance, oxidation, and reduction reactions in ferrous and non-ferrous materials extraction
5	
6	Solution chemistry. Physical chemistry: equilibrium, kinetics and reaction rate laws, effect of physical variables (pressure, temperature etc.) on equilibrium and kinetics, phase rule
7	
8	
9	Mid-Semester Exams
10	Introduction to oxidation and reduction reactions in ferrous and non-ferrous extraction
11	Organic chemistry: Introduction, nature and sources of compounds, hydrocarbon compounds, polymeric materials, introduction to biochemistry, biomaterials
12	
13	Analytical chemistry: Introduction, qualitative and quantitative analysis of ferrous and non-ferrous metals, analysis of various ores, coals, liquid solution, introduction to analytical instrumentation
14	
15	Applications of materials chemistry in energy conversion and storage, electronics and optoelectronics, and biomedical devices
16	
17-18	End Semester Exams

Suggested Books

- Materials Chemistry by B. D. Fahlman. 4th ed., Springer (2023).
- Materials Chemistry: For Scientists and Engineers by M. A. Benvenuto. De Gruyter (2022).
- Chemistry for Engineer: an applied approach by M. J. Shultz. Houghton Mifflin (2007).
- Chemical Metallurgy by J.J. Moore. 2nd ed., Elsevier (Butterworth Heinemann) (1990).
- Applied Chemistry: A Textbook for Engineers and Technologists by O. Roussak, H. D. Gesser. 2nd ed., Springer (2013).
- Chemistry for Engineers by T .F. Yen. Imperial College Press (2008).