

MTPE3004 CORROSION AND ENVIRONMENTAL DEGRADATION OF MATERIALS (3-0-0)

Objectives of the Course:

The course aims to familiarize students with the fundamental principles of corrosion and environmental degradation of materials. It emphasizes the thermodynamic and kinetic aspects of corrosion, types and mechanisms of degradation, and methods for prevention and control. The course also focuses on industrial corrosion issues, corrosion testing, and materials selection for enhanced durability and sustainability in engineering applications.

Module – I: (06 hours)

Introduction to Corrosion and Thermodynamics of Corrosion

Definition and importance of corrosion in engineering applications. Electrochemical nature of corrosion; distinction between chemical and electrochemical corrosion. Thermodynamics of corrosion: free energy changes, electromotive force series, Pourbaix (potential–pH) diagrams. Concept of corrosion rate and its measurement. Factors influencing corrosion rate: temperature, medium, and metal composition.

Module – II: (06 hours)

Kinetics and Mechanisms of Corrosion

Electrochemical kinetics: polarization, activation, and concentration polarization. Mixed potential theory. Types of corrosion: uniform, galvanic, pitting, crevice, intergranular, selective leaching, erosion-corrosion, stress corrosion cracking, and hydrogen embrittlement. Corrosion under different environments — atmospheric, aqueous, soil, and high-temperature oxidation.

Module – III: (06 hours)

Corrosion Testing and Evaluation

Laboratory methods for corrosion rate measurement. Potentiodynamic polarization and electrochemical impedance spectroscopy. Weight loss tests. Surface examination and analysis techniques.

Module – IV: (06 hours)

Prevention and Control of Corrosion

Material selection and design considerations. Protective coatings: metallic, inorganic, and organic coatings. Cathodic and anodic protection methods. Inhibitors and environmental modification. Surface engineering techniques: carburizing, nitriding, cladding, and thermal spraying.

Module – V: (06 hours)

Environmental Degradation and Case Studies

High-temperature oxidation and scaling of metals and alloys. Corrosion in specific environments — marine, industrial, and biological. Corrosion in power plants, chemical industries, and refineries. Sustainability and corrosion economics.

Course Outcomes:

After completing this course, the student will be able to:

- CO1: Explain the thermodynamic and kinetic principles governing corrosion and oxidation processes.
- CO2: Identify and analyze different types of corrosion and environmental degradation mechanisms.
- CO3: Evaluate corrosion testing methods and interpret results for material performance.
- CO4: Recommend suitable prevention and protection techniques for industrial applications.
- CO5: Analyzing environment degradation mechanism

Books:

1. Fontana, M. G. Corrosion Engineering, McGraw-Hill Education.
2. Uhlig, H. H., and Revie, R. W. Corrosion and Corrosion Control, Wiley.
3. Raj Narayan. An Introduction to Metallic Corrosion and Its Prevention, Oxford & IBH.

Reference Books:

1. Trethewey, K. R., and Chamberlain, J. Corrosion for Students of Science and Engineering, Longman.
2. Jones, D. A. Principles and Prevention of Corrosion, Prentice Hall.
3. Schweitzer, P. A. Corrosion and Corrosion Protection Handbook, CRC Press.

Digital Learning Resources:

Course Name: Corrosion Failures and Control

Course Link: <https://nptel.ac.in/courses/113/106/113106152>

Course Instructor: Prof. K. Balasubramanian, IIT Madras

Course Name: Environmental Degradation of Materials

Course Link: <https://nptel.ac.in/courses/113/107/113107151>

Course Instructor: Prof. S. K. Bhaumik, IIT Kanpur