



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**

**Subject Code: 3152110**

**Semester – V**

**Subject Name: Environmental Degradation of Materials**

**Type of course:** Engineering Science

**Prerequisite:** Knowledge of Elements of Metallurgy and basic science skills

**Rationale:** The Environmental Degradation of Materials course is familiarize the student with the extent and importance of material degradation. Knowledge of Characteristic features, causes and remedial measures of degradation of materials is must for a metallurgist to select a candidate material for a given engineering application as well as to provide solution of a given material degradation problem. This course will enable students to solve different metallurgical problems upon graduation while at the same time, provide a firm foundation for the pursuit of graduate studies in metallurgy engineering.

**Teaching and Examination Scheme:**

| Teaching Scheme |   |   | Credits | Examination Marks |        |                 |        | Total Marks |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|
| L               | T | P |         | Theory Marks      |        | Practical Marks |        |             |
|                 |   |   |         | ESE (E)           | PA (M) | ESE (V)         | PA (I) |             |
| 3               | 0 | 2 | 4       | 70                | 30     | 30              | 20     | 150         |

**Content:**

| Sr. No. | Content                                                                                                                                                                                                                                                                                                                                                                                                                          | Total Hrs |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 1       | Introduction, Definition, Forms of material degradation, Classification of corrosion, Importance of corrosion studies and cost of corrosion.<br>Corrosion principles: Electrochemical aspects, Thermodynamic aspects of corrosion – Gibbs energy and electrochemical potential, Reference electrodes, EMF and galvanic series, Nernst relationship and Pourbaix Diagram for Metal Water System.                                  | 12        |
| 2       | Kinetic aspects of corrosion: Corrosion rate, Current density, Exchange current density, Mixed potential theory, Polarization and Passivation.                                                                                                                                                                                                                                                                                   | 06        |
| 3       | Forms of corrosion: Characteristic features, causes and remedial measures of Uniform Corrosion, Pitting Corrosion, Crevice Corrosion, Galvanic Corrosion, Intergranular Corrosion, Erosion, Selective leaching, Stress corrosion cracking, Hydrogen Damage etc.                                                                                                                                                                  | 11        |
| 4       | Corrosion Measurements: Exposure studies, Electrochemical work bench, DC and AC methods of testing, Polarization measurements-Corrosion rate assessment by Tafel's extrapolation method.<br>Corrosion Control: Material selection, Design considerations, Control of environment including Inhibitors and Passivators, Coatings (Electroplating, Anodising, Galvanizing, Thermal spraying etc.), Cathodic and Anodic protection. | 11        |
| 5       | Wear of materials, Wear rate measurement, Wear resistant materials and coatings, Surface modification to improve wear resistance.                                                                                                                                                                                                                                                                                                | 02        |



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|  |       |    |
|--|-------|----|
|  | Total | 42 |
|--|-------|----|

**Suggested Specification table with Marks (Theory):**

| Distribution of Theory Marks |         |         |         |         |         |
|------------------------------|---------|---------|---------|---------|---------|
| R Level                      | U Level | A Level | N Level | E Level | C Level |
| 15                           | 35      | 35      | 10      | 05      | 0       |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

## Reference Books:

1. Corrosion Engineering, Mars. G. Fontana, McGraw Hill Education, 2017
2. Electrochemical Techniques in Corrosion Science and Engineering. R.G. Kelly, J.R Scully, D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002
3. Principles and Prevention of Corrosion, Denny A. Jones, Pearson, 1995.
4. Corrosion and Corrosion Control, 3rd ed., H.H.Uhlig Wiley, 1986
5. An introduction to electrometallurgy- Satya Narayan & Rajendra Sharan, Standard Publishers & Distributors, New Delhi
6. An introduction to metallic corrosion & its prevention by Rajnarain
7. Corrosion Engineering, ASM Vol. 13
8. Wear of Metals by A. D. Sarkar, Elsevier Science & Technology

## Course Outcomes:

| Sr. No. | CO statement                                        | Marks % Weightage |
|---------|-----------------------------------------------------|-------------------|
| CO-1    | Describe different aspects of material degradation. | 40                |
| CO-2    | Identify the various forms of corrosion.            | 20                |
| CO-3    | Measure and control corrosion.                      | 40                |

## List of Experiments:

1. To study electrochemical and thermodynamic aspects of corrosion.
2. To study different forms of corrosion.
3. To observe and study pitting corrosion in steel.
4. To determine corrosion rate of given sample by weight loss method.
5. To determine corrosion rate of given sample using potentiostate.



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6. To study different types of corrosion protection methods.
7. To perform the electroplating on a given base metal.
8. To study and perform the anodizing of Aluminium.
9. To study different hot dipping process
10. To measure the wear rate of given specimen.

**Major Equipment:** Ultrasonic cleaner, oven, single pan balance, potentiostat, DC regulated power supply, electrolytic tank, anodizing tank, wear test unit etc.

### **List of Open Source Software/learning website:**

1. <https://nptel.ac.in/courses>
2. <https://ocw.mit.edu>