CORROSION ENGINEERING

ENCH 351

Lecture	**: 3**	**Year : III**
Tutorial	**: 1**	**Part : II**
Practical	**: 3/2**	

Course Objectives:

The objective of this course is to introduce the fundamental concepts, mechanisms, and engineering aspect of corrosion and its prevention. It integrates theoretical understanding with practical applications in industries, infrastructure and biomedical system.

1 Fundamental Concepts of Corrosion (10 hours)

1.1 An overview of corrosion, definition, types and factors affecting the corrosion
1.2 Corrosion tendency, electrode-electrolyte interface, galvanic cell and bimetallic couples
1.3 Galvanic series and galvanic corrosion
1.4 Corrosion in extreme environments: Corrosion at high temperature, corrosion in aviation, fouling, marine, buried pipelines
1.5 Potential pH (H_2O, Fe, Zn, Pb) diagram and their applications in corrosion engineering
1.6 Societal and economic impact of corrosion

2 Corrosion Theory (6 hours)

2.1 Chemical and electrochemical theory of corrosion (Rusting)
2.2 Activation controlled and diffusion-controlled process in corrosion
2.3 Heterogeneous theory, homogeneous theory and mixed potential theory

3 Electrochemical Behavior and Corrosion Kinetics (6 hours)

3.1 Electrochemical parameters of corrosion: Corrosion current, effect of stray current, corrosion potential
3.2 Evans diagram, Tafel plot, open circuit potential (OCP) measurement
3.3 Corrosion kinetics and rate determination: Weight loss method, electrochemical method (Polarization, Impedance spectroscopy method and related numerical)

4 Preventive Strategies of Corrosion (10 hours)

4.1 Corrosion control by design: Material selection and design, alloying, avoidance of galvanic coupling, drainage and crevice elimination

4.2 Chemical treatment strategies: Oxygen scavengers, pH control and alkalinity management, environmental issues
4.3 Protective coatings and surface engineering: Organic coatings, Metallic coating, thermal spray
4.4 Passivation: Theory of oxide film formation and adsorption, application of mixed potential theory, anodic passivation
4.5 Corrosion inhibitors, types and mechanism of inhibitors, green corrosion inhibitors, industrial applications
4.6 Cathodic protection strategies: Principle, classifications, affecting factors, monitoring and design aspects

5 Corrosion and Monitoring (6 hours)

5.1 Reinforced control in reinforced concrete structure
5.2 Corrosion control in water treatment and steam system, buried metal pipes
5.3 Corrosion issues and control in bio-implants, biocompatibility and ion release issues
5.4 Corrosion monitoring and standards: Corrosion sensors and probes, non-destructive Technique (NDT) in corrosions, overview of ASTM and NACE standards

6 Engineering Aspect of Corrosion (7 hours)

6.1 Corrosion and control aspect of metallurgical and mechanical properties of iron and steels
6.2 Corrosion challenges and control aspect in process equipment (Reactors, heat exchangers, storages tanks)
6.3 Corrosion under insulation: Causes, detection challenges, inspection strategies and prevention strategies
6.4 High temperature corrosion and control aspect in refineries and process plants
6.5 Integration of corrosion management into plant design and maintenance planning

Tutorial (15 hours)

1. Green corrosion inhibitors and calculation of corrosion inhibition capacity
2. Pourbaix diagram interpretation (H_2O, Fe)
3. A Survey report on case studies of corrosion failure (Engineering structure, building, bridge)
4. Calculation of corrosion rate by potentiodynamic polarization method
5. Calculation of corrosion rate by electrochemical impedance spectroscopy method
6. Green inhibitors versus chemical inhibitors for corrosion prevention
7. A Report on effect of corrosion on national GDP and global economy

Practical **(22.5 hours)**

1. Study the effect of pH on corrosion rate of steel (or any appropriate material)
2. Study the effect of brine with or without oxygen on steel corrosion
3. Demonstrate the effect of electrically connecting together two dissimilar metals in a solution to form an electrochemical cell (Study of Galvanic corrosion)
4. Effect of stray voltage between metals in a corrosive environment
5. Study the cathodic protection by impressed voltage
6. Study the effect of internal stress on corrosion rate of steel
7. Experimental works on mechanical properties of corroded metal/alloy (Post corrosion testing)

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	10	14
2	6	8
3	6	8
4	10	14
5	6	8
6	7	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Revie, R.W., Uhlig, H.H. (2008). Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering. John Wiley & Sons.
2. Roberge, P.R. (2008). Corrosion Engineering: Principles and Practice. McGraw-Hill.
3. Shreir, L.L. (1976). Corrosion, Vol I and II. Butterworth's (Latest Edition).
4. Pourbaix, M. (1974). Atlas of Electrochemical Equilibria in Aqueous Solutions (Latest Edition). NACE.
5. Bockris, J.O'M., Reddy, A.K.N., Gamboa-Aldeco, M. (2000). Modern Electrochemistry: Fundamentals of Electrodics, Vol. 2A (Latest Edition). Kluwer/Plenum Publishers.