COURSE CODE:	ENE-213
COURSE NAME:	Environmental Chemistry
CREDIT HOURS:	Theory = 2 Practical = 1 Total = 3
CONTACT HOURS:	Theory = 32 Practical = 48 Total = 80
PREREQUISITE:	None
MODE OF TEACHING:	Two hours of lecture per week
	Three hours of lab work per week

COURSE DESCRIPTION:

During this course students will study the chemistry of the air, water, and soil, and how anthropogenic activities affect this chemistry on planet Earth. Specifically, the course will examine the sources, reactions, transport, effects, and fates of chemical species in air, water, and soil environments, and the effects of technology thereon. This course is divided into 6 major parts that reflect the most pressing issues in Environmental Chemistry today: The Atmosphere and Atmospheric Chemistry, Inorganic Air Pollutants, Organic Air Pollutants and Photochemical Smog, The Geosphere and Geochemistry, Environmental Chemistry of Water, and Water Pollution.

COURSE OBJECTIVES:

The primary objectives of this course are to acquire basic knowledge in the field of environmental chemistry and to study sources, chemical transformations, and fates of pollutants in air, water, and soil systems.

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☑
2	Problem Analysis:	☐	8	Ethics:	☑
3	Design/Development of Solutions:	☐	9	Individual and Teamwork:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will demonstrate competency by being able to:

S. No.	CLOs	Domain	Taxonomy Level	PLOs
1	**EXPLAIN** the basic concepts involved in Environmental Chemistry.	Cognitive	2	7
2	**CLASSIFY** the types of pollutants in air, water, soil, and biological matrices, and understand their fate in ecosystems.	Cognitive	2	7
3	**FOLLOW** standard analytical procedures to identify the types of pollutants harmful to human health and environment.	Psychomotor	3	4
4	**Maintain** ethical conduct in lab and adhere to lab safety procedures while contributing effectively towards individual and/ or group goals.	Affective	5	8

Open Ended Lab

5	**ANALYZE** the phosphorous content in NUST lake water and propose treatment strategy to cope with eutrophication.	Psychomotor	4	4

PRACTICAL APPLICATIONS:

The course will help the students to understand the modern concepts of chemistry and the applications for improving environmental conditions. Moreover, this course will also help the students interested in further pursuing research in various environmental domains including atmospheric science, water pollution and green chemistry.

TOPICS COVERED:

Theory:

Week	Topics Covered	Reading Assignment/ Homework	CLO #
1	Introduction to Basic Concepts	Chapter 1	1
2	The Atmosphere and Atmospheric Chemistry: The Atmosphere & Energy Transfer in The Atmosphere		
3	The Atmosphere and Atmospheric Chemistry: Reactions in Atmosphere		

4	Inorganic Air Pollutants: Inorganic Air Pollutants & Nitrogen Oxides in The Atmosphere	Chapter 2 Assignment 1	2
5	Organic Air Pollutants: Organic & Non-hydrocarbon Organic Compounds ln The Atmosphere	Chapter 3 Quiz 1	2
6	Organic Air Pollutants: Photochemical Smog	Chapter 4 Assignment 2 Quiz 2	1,2
7	The Geosphere and Geochemistry: Introduction & Chemical Weathering	Chapter 5 Assignment 3 Quiz 3	1
8-9	Soil Environmental Chemistry: Introduction & Macronutrients in Soil Wastes and Pollutants in Soil		
Mid Semester Exam			
10	Environmental Chemistry of Water: Water's Unique Properties, Aquatic Chemistry	Chapter 6 Assignment 4 Quiz 4	1, 2
11	Environmental Chemistry of Water: Metal Ions in Water. Oxidation-Reduction		
12	Environmental Chemistry or Water: Complexation and Chelation		
13	Microbially Mediated Elemental Transitions and Cycles	Chapter 7 Quiz 5	1
14	Water Pollution: Trace Elements, Heavy Metals & Metalloids, Organically Bound Metals and Metalloids, Algal Nutrients and Eutrophication	Chapter 8 Assignment 5 Quiz 6	1,2
15	Water Pollution: Pesticides & Herbicides, Polychlorinated Biphenyls PCBs.		
16	Water Pollution: Soaps, Detergents and Detergent Builders		
End Semester Exam			

LIST OF PRACTICALS:

Sr. No.	Practical	CLO #
1.	Preparation of Molar/Normal solutions/reagents.	3,4
2.	Standardization of solutions	3,4
3.	Measurement of temperature, pH and conductivity of water samples	3,4
4.	Measurement of DO by Winkler method.	3,4
5.	Measurement of turbidity - Nephelometric Method	3,4
6.	Measurement of Total solids, suspended solids, and dissolved solids in water	3,4
7.	Determination of chlorides and hardness in water.	3,4
8.	Determination of water alkalinity using titrimetric method	3,4

9.	OEL	5
10.	Measurement of chlorine by iodometric method.	3,4
11.	Determination of Acidity by titration method	3,4
12.	Vinegar Analysis (Calculation of the percentage composition of acetic acid in vinegar)	3,4
13.	Determination of residual Chlorine	3,4
14.	Determination of Oil & Grease in wastewater samples	3,4
15.	Determination of Phosphorous through Spectrophotometer method	3,4
16	Understanding gas chromatography application	3,4
17	Lab Quiz/Viva	

TEXT AND MATERIAL:

Textbook (s)

1. Stanley E. Manahan. Fundamentals of Environmental Chemistry, 9th Edition, CRC Press, 2010.

References Material:

1. Clair N. Sawyer, Perry L. McCarty, Gene F. Parkin, Chemistry for Environmental Engineering and Science, 5th Edition. McGraw-Hill, Inc. 2003.
2. Harrison R. M., De Mora S. J., Introductory Chemistry for the Environmental Sciences, Cambridge Environmental Series No. 17, Macmillan Press Ltd. 2004.
3. Brimblecombe, P., Jickells T. D., Liss, P. S., An Introduction to Environmental Chemistry, 2003.
4. Stumm, W. and Morgan J., Aquatic Chemistry, Chemical Equilibria and Rates in Natural Waters, John Wiley and Sons, Inc. 2012.
5. Ronald A. Hites, Jonathan D. Raff., Elements of Environmental Chemistry, John Wiley Publishers, USA. 2012.

ASSESMENT SYSTEM:

Theoretical/Instruction	**66.67%**
Assignments	10%
Quizzes	15%
Midterm Exams	25%
End Semester Exam	50%
Practical Work	**30%**
Laboratory Report	30%
Laboratory Quiz/Viva	30%
OEL	10%
Laboratory Rubrics	30%
Total	**100%**