

SEE2002: CHEMICAL SCIENCES FOR ENERGY AND ENVIRONMENTAL ENGINEERS

Effective Term

Semester A 2024/25

Part I Course Overview

Course Title

Chemical Sciences for Energy and Environmental Engineers

Subject Code

SEE - School of Energy and Environment

Course Number

2002

Academic Unit

School of Energy and Environment (E2)

College/School

School of Energy and Environment (E2)

Course Duration

One Semester

Credit Units

4

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

BCH1100 Chemistry OR CHEM1300 Principles of General Chemistry

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

The course aims to equip students with the fundamentals in analytical, physical chemistry, organic chemistry and polymeric materials. The acquired knowledge shall enable students to apply the principles of chemistry in describing as well as engineering innovative solutions to the wider and increasingly complex Energy & Environment-related problems.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the basic principles of analytical chemistry such as spectroscopy, principles of chromatography and mass spectrometry, gas and liquid chromatography, chromatographic methods and capillary electrophoresis; apply knowledge in creative energy and environment-related applications.	30	x	x	
2	Describe the fundamentals of organic chemistry, inorganic chemistry, and electrochemistry; apply knowledge in creative energy and environment-related applications.	20		x	
3	Describe the structures of four basic solid materials and its relevant industrial applications, including energy and environment-related applications; apply knowledge in creative applications.	20		x	
4	Plan and execute quantitative experimental work, to record and interpret the results of such work, and to understand and communicate what has been done.	30	x	x	

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

LTAs		Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Students will learn the key concepts, theories and applications of chemistry topics related to energy and environmental applications, including the basic principles of analytical chemistry, and the fundamentals of organic chemistry, inorganic chemistry, electrochemistry, and material chemistry	1, 2, 3, 4	3
2	Lab-based experiment	Students will be allowed to deepen their understanding of the key concepts and theories and apply them to practice through laboratory experiment	1, 2, 3, 4	15 (for the whole semester)

Assessment Tasks / Activities (ATs)

ATs		CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Homework Assignment Three assignments will be given throughout the semester. Students will complete the assignments to demonstrate their understanding of the knowledge in inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science and their ability to apply the knowledge to solve problems related to energy and environmental applications.	1, 2, 3	20	

2	Laboratory experiments & reports Students will perform experiments in groups in three lab sessions on synthesis of alum crystals from scrap metal, determination of rates of chemical reactions, and determination of alkalinity of water by titration and write individual lab reports to analyse and their results and present their understanding of relevant chemistry knowledge.	1, 2, 3, 4	30	
3	Mid-term test Students will complete a midterm test to demonstrate their ability to apply their knowledge in inorganic chemistry and analytical chemistry.	1, 2, 3	10	

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Additional Information for ATs

Final exam will test students' comprehensive understanding of various aspects of chemistry and their ability to apply their knowledge learned throughout the course in solving chemistry-related problems.

Examination duration: 2 hrs

Percentage of continuous assessment, examination, etc.: 60% by continuous assessment; 40% by exam

To pass a course, a student must do ALL of the following:

- obtain at least 30% of the total marks allocated towards continuous assessment (combination of assignments, pop quizzes, term paper, lab reports and/ or quiz, if applicable);
- obtain at least 30% of the total marks allocated towards final examination (if applicable); and
- meet the criteria listed in the section on Assessment Rubrics.

Assessment Rubrics (AR)**Assessment Task**

- Homework Assignment

Criterion

Ability to evaluate and analyse chemistry problems related to energy and environmental applications.

Excellent (A+, A, A-)

Excellent analysis and problem solving skills to demonstrate in-depth understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Good (B+, B, B-)

Good analysis and problem solving skills to demonstrate good understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Fair (C+, C, C-)

Acceptable analysis and problem solving skills to demonstrate adequate understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Marginal (D)

Marginally acceptable analysis and problem solving skills to demonstrate some understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Failure (F)

Poor analysis and problem solving skills and is barely able to demonstrate an understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Assessment Task

2. Laboratory experiments and reports

Criterion

Ability to work in a group and to perform chemistry experiments for solving practical problems related to environmental applications.

Excellent (A+, A, A-)

Excellent report writing and experimental skills with in-depth understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Good (B+, B, B-)

Good report writing and experimental skills with good understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Fair (C+, C, C-)

Acceptable report writing and experimental skills with adequate understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Marginal (D)

Marginally acceptable report writing and experimental skills with some understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Failure (F)

Poor report writing and experimental skills with poor understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Assessment Task

3. Mid-term test

Criterion

Ability to analyse, calculate and solve chemistry problems related to environmental applications.

Excellent (A+, A, A-)

Excellent analysis and problem solving skills to demonstrate in-depth understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Good (B+, B, B-)

Good analysis and problem solving skills to demonstrate good understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Fair (C+, C, C-)

Acceptable analysis and problem solving skills to demonstrate adequate understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Marginal (D)

Marginally acceptable analysis and problem solving skills to demonstrate some understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Failure (F)

Poor analysis and problem solving skills and is barely able to demonstrate an understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Assessment Task

4. Exam

Criterion

Ability to analyse, calculate and solve chemistry problems related to energy and environmental applications.

Excellent (A+, A, A-)

Excellent analysis and problem solving skills to demonstrate in-depth understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Good (B+, B, B-)

Good analysis and problem solving skills to demonstrate good understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Fair (C+, C, C-)

Acceptable analysis and problem solving skills to demonstrate adequate understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Marginal (D)

Marginally acceptable analysis and problem solving skills to demonstrate some understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Failure (F)

Poor analysis and problem solving skills and is barely able to demonstrate an understanding of inorganic chemistry, organic chemistry, electro chemistry, and analytical chemistry, and solid material science

Part III Other Information**Keyword Syllabus**

ORGANIC CHEMISTRY

- Functional groups in organic compounds
- Isomers and stereochemistry

- Organic acids and bases
- Organic reactions and mechanisms

ANALYTICAL CHEMISTRY

- Gravimetry
- Calibration
- Equilibrium and Titration
- Optical absorption and fluorescence
- Electrochemistry
- X-ray spectroscopy
- Atomic and mass spectrometry
- Chromatography

SOLID AND MODERN MATERIALS

ACID-BASE EQUILIBRIA

Reading List**Compulsory Readings**

Title	
1	Brown, T.E., LeMay, H.E.H., Bursten, B.E., Murphy, C., Woodward, P., 2023. Chemistry: The Central Science, Pearson. 15th ed.
2	McMurry, 2011. Fundamentals of Organic Chemistry. Cengage Learning, 7th Ed.
3	Callister, W.D., Rethwisch, D.G., 2018. Materials Science and Engineering: An Introduction. John Wiley & Sons .10th Ed.
4	Bruice, P. Y. 2017. Organic Chemistry, Pearson. 8th Ed.

Additional Readings

Title	
1	Harris, D.C., 2012. Exploring Chemical Analysis. W. H. Freeman and Company, 5th edition.
2	Klein, D., 2016. Organic Chemistry as a second language - First Semester Topics, 4th ed. John Wiley & Sons, Inc., USA.
3	Klein, D., 2016. Organic Chemistry as a second language - Second Semester Topics, 4th ed. John Wiley & Sons, Inc., USA.
4	Hill, J.W., McCreary, T.W., Kolb, D.K. 2015. Chemistry for Changing Times. 14th ed. Pearson Education International.