CHEM3055: GREEN CHEMISTRY

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Green Chemistry

Subject Code
CHEM - Chemistry
Course Number
3055

Academic Unit
Chemistry (CHEM)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

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

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
CHEM2006/BCH2006 Principles of Inorganic Chemistry
CHEM2007/BCH2007 Principles of Organic Chemistry
CHEM2008/BCH2008 Principles of Physical Chemistry

Precursors
Nil

Equivalent Courses
BCH3055 Green Chemistry

Exclusive Courses
Nil

Part II Course Details

Abstract

The rapidly increasing worldwide demand for environmentally friendly chemical products and processes requires the application of novel and cost-effective technologies for pollution prevention. Green Chemistry is an emerging new approach focusing on a simple principle that it is better to prevent waste than to treat or clean up waste after it is formed. The course will provide the basic knowledge to select greener solutions in the design and applications of chemicals and chemical processes.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the evolution of the concept of sustainability in general and the origin of the negative image of chemicals and the chemical and petrochemical industry.	5	x		
2	Describe the 12 principles of green chemistry and provide examples for each.	20	x		x
3	Compare and contrast the advantages and disadvantages of alternative media including water, fluorous and ionic liquids, supercritical media, and extended liquids.	20		x	
4	Evaluate the advantages and disadvantages of homogeneous and heterogeneous catalysis.	25		x	x
5	Discuss the chemistry of reusable chemicals and materials.	10			x
6	Design a list of criteria to evaluate the feasibility of a project / plan related to sustainable development for energy and carbon based chemicals.	20	x	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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	The major milestones of the evolution of the concept of sustainability will be described. Examples for the negative effect of chemicals will be demonstrated.	1	
2	Lectures	The 12 principles will be shown and several examples for each will be presented. Students will calculate E-factor and atom economy for the examples.	2	
3	Videos	Use of videos to illustrate the advantages and disadvantages of various solvents.	3	
4	Videos	Using videos to illustrate the advantages and disadvantages of various solvents different catalytic systems.	4	
5	Tutorials	Tutorial activities including debate, role play and online discussion.	5	
6	Group work	Group work to compose a list of criteria for online discussion.	6	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Group Presentations	2	10	
2	Individual Presentations	1, 3, 4	15	
3	Written Report	6	25	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for courses offered by CHEM:
"A minimum of 40% in both coursework and examination components."

Assessment Rubrics (AR)

Assessment Task

Group Presentation

Criterion

ABILITY to EXPLAIN in DETAIL the principles of green chemistry and their use in the design of green technologies

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Individual Presentation

Criterion

ABILITY to EXPLAIN in DETAIL the definition of sustainability and the principles of green chemistry and their combined use in the design of green technologies

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Written Report

Criterion

CAPACITY for SELF-DIRECTED LEARNING to understand the principles of green chemistry
ABILITY to EXPLAIN the design and procedures

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Examination

Criterion

ABILITY to ANSWER QUESTIONS in DETAIL concerning the definition of sustainability and the principles of green chemistry, their use in the design of reaction environments including solvents, reagents, catalysts, efficient energy supply systems, in situ monitoring, renewable resource options, recycling and their integration to green and sustainable technologies.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Accidents, Algae, Aqueous, Atom economy
Biodiesel, Bioethanol, Biofuels, Bio-inspired, Biomass
Catalysis, Chemicals, Chemofobia
Environmental factor, Enzymes, Extended liquids
Fluorous
Glass, Global warming, Green chemistry

Heterogeneous, Homogeneous
Ionic liquids
Metals, Microwave, MTBE
Organic, Ozone hole
Plastics, Pollution, Prevention, Principles
Real time monitoring, Recycling, Rubber
Sonocation, Super critical media, Sustainability, Sustainable developments
Toxicity
Unleaded gasoline
Zeolites

Reading List

Compulsory Readings

	Title
1	Anastas, P. T. and Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press, Oxford, 1998.
2	Anastas, P. T. Origins and Early History of Green Chemistry, Series on Chemistry, Energy and the Environment, Advanced Green Chemistry, Part 1: Greener Organic Reactions and Processes, Horváth, I. T.; Malacria, M. (Eds.) World Scientific: Singapore, 2018.
3	Horváth, I. T. Sustainable Chemistry, Chemical Reviews 2018, 118, 369.

Additional Readings

	Title
1	Mike Lancaster, Green Chemistry 3rd Edition: An Introductory Text, RSC Publishing, 2016.
2	Online Resources Green Chemistry at the University of Oregon, http://greenchem.uoregon.edu/