香港城市大學
City University of Hong Kong

SYL

Course Syllabus

offered by Department of Chemistry
with effect from Semester A 2020/21

This form is for the completion by the *Course Leader*. The information provided on this form is the official record of the course. It will be used for the City University's database, various City University publications (including websites) and documentation for students and others as required.

Please refer to the Explanatory Notes on the various items of information required.

Prepared / Last Updated by:

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Part I Course Overview

Course Title:	Green Chemistry
Course Code:	CHEM3055
Course Duration:	1 semester
Credit Units:	3 credits
Level:	B3
Proposed Area: *(for GE courses only)*	☐ Arts and Humanities ☐ Study of Societies, Social and Business Organisations ☐ Science and Technology
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	CHEM2006/BCH2006 Principles of Inorganic Chemistry CHEM2007/BCH2007 Principles of Organic Chemistry CHEM2008/BCH2008 Principles of Physical Chemistry
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	BCH3055 Green Chemistry
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

(A 150-word description about the course)

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.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*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%	✓		
2.	Describe the 12 principles of green chemistry and provide examples for each.	20%	✓		✓
3.	Compare and contrast the advantages and disadvantages of alternative media including water, fluorous and ionic liquids, supercritical media, and extended liquids.	20%		✓	
4.	Evaluate the advantages and disadvantages of homogeneous and heterogeneous catalysis.	25%		✓	✓
5.	Discuss the chemistry of reusable chemicals and materials.	10%			✓
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%	✓	✓	✓
		100%			

** If weighting is assigned to CILOs, they should add up to 100%.*

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

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 self-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.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5	6	
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.	✓						
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.		✓					
Videos	Use of videos to illustrate the advantages and disadvantages of various solvents.			✓				
Videos	Using videos to illustrate the advantages and disadvantages of various solvents different catalytic systems.				✓			
Tutorials	Tutorial activities including debate, role play and online discussion.					✓		
Group work	Group work to compose a list of criteria for online discussion.						✓	

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5	6		
Continuous Assessment: 50%								
Group Presentations		✓					10%	
Individual Presentations	✓		✓	✓			15%	
Written Report						✓	25%	
Examination: 50% (duration: 2 hours)								
** The weightings should add up to 100%.*							100%	

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."

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Group Presentation	ABILITY to EXPLAIN in DETAIL the principles of green chemistry and their use in the design of green technologies	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Individual Presentation	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	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Written Report	3.1 CAPACITY for SELF-DIRECTED LEARNING to understand the principles of green chemistry 3.2 ABILITY to EXPLAIN the design and procedures	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	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.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

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

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

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.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

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/

Annex
(for GE courses only)

A. Please specify the Gateway Education Programme Intended Learning Outcomes (PILOs) that the course is aligned to and relate them to the CILOs stated in Part II, Section 2 of this form:

GE PILO	**Please indicate which CILO(s) is/are related to this PILO, if any** ***(can be more than one CILOs in each PILO)***
PILO 1: Demonstrate the capacity for self-directed learning	
PILO 2: Explain the basic methodologies and techniques of inquiry of the arts and humanities, social sciences, business, and science and technology	
PILO 3: Demonstrate critical thinking skills	
PILO 4: Interpret information and numerical data	
PILO 5: Produce structured, well-organised and fluent text	
PILO 6: Demonstrate effective oral communication skills	
PILO 7: Demonstrate an ability to work effectively in a team	
PILO 8: Recognise important characteristics of their own culture(s) and at least one other culture, and their impact on global issues	
PILO 9: Value ethical and socially responsible actions	
PILO 10: Demonstrate the attitude and/or ability to accomplish discovery and/or innovation	

GE course leaders should cover the mandatory PILOs for the GE area (Area 1: Arts and Humanities; Area 2: Study of Societies, Social and Business Organisations; Area 3: Science and Technology) for which they have classified their course; for quality assurance purposes, they are advised to carefully consider if it is beneficial to claim any coverage of additional PILOs. General advice would be to restrict PILOs to only the essential ones. (Please refer to the curricular mapping of GE programme: http://www.cityu.edu.hk/edge/ge/faculty/curricular_mapping.htm.)

B. Please select an assessment task for collecting evidence of student achievement for quality assurance purposes. Please retain at least one sample of student achievement across a period of three years.

Selected Assessment Task