City University of Hong Kong
Course Syllabus

offered by School of Energy and Environment
with effect from Semester A 2023/24

Part I Course Overview

Course Title:	Environmental Engineering Science
Course Code:	SEE8224
Course Duration:	One semester
Credit Units:	3
Level:	R8
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)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course will provide students with knowledge of important environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them. Topics covered can include chemical kinetics, reaction dynamics, reactions of gas-phase species, reactions in liquid solutions, environmental reactor and box models, transport mechanisms, photochemistry, spectroscopy, mass spectrometry, and chromatography.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Demonstrate an understanding of important environmental engineering concepts and related fundamental chemistry and physics principles, focusing on chemical kinetics, reaction dynamics, reactions of gas-phase species, reactions in liquid solutions, photochemical processes, and transport mechanisms.	40%	√	√	
2.	Demonstrate an understanding of the fundamentals and application of environmental reactor models and box models to quantitatively describe the fates and lifetimes of pollutants in different types of environmental systems	40%	√	√	√
3.	Demonstrate an understanding of the principles and application of analytical instrumentation and techniques that are commonly used to measure trace level concentrations of environmental pollutants	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	
Classroom lectures	Learning in the presence of the teacher.	√	√	√	3.0

Project for class presentation	Projects will be made by the student that require to use the content of the course	√	√	√	
Homework assignments	Homework and problems are used to get the students to apply the content of the course	√	√	√	
Midterm exams	Students should also learn from the exercises and the questions they have to do during the midterm exam	√	√	√	
Final exams	Students should also learn from the exercises and the questions they have to do during the final exam	√	√	√	

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.			Weighting*	Remarks
	1	2	3		
Continuous Assessment: 60%					
Mid-term	√	√	√	30%	
Homework assignments	√	√	√	15%	
Project	√	√	√	15%	
Examination: 40% (duration: 2 hours, if applicable)					
** The weightings should add up to 100%.*				100%	

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

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

5. Assessment Rubrics

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

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Mid-term	Ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates superior understanding of and superior ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates good understanding of and good ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates basic understanding of and basic ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Not even reaching marginal levels of understanding of and ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them
2. Homework assignment	Ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates superior understanding of and superior ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates good understanding of and good ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates basic understanding of and basic ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Not even reaching marginal levels of understanding of and ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them

3. Project	Ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates superior understanding of and superior ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates good understanding of and good ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates basic understanding of and basic ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Not even reaching marginal levels of understanding of and ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them
4. Final exam	Ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates superior understanding of and superior ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates good understanding of and good ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Demonstrates basic understanding of and basic ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them	Not even reaching marginal levels of understanding of and ability to analyze and solve problems related to environmental engineering concepts and related fundamental chemistry and physics principles that govern different processes in the environment, and the different analytical instrumentation and techniques that can be used to study them

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Mid-term	Ability to explain key concepts and solve problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignment	Ability to apply key concepts and solve problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Final exam	Ability to explain key concepts and solve problems	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

1. Gas-phase kinetics, reaction rates and mechanisms
a. Pressure, temperature and energy of an ideal gas
b. Molecular collisions and mean free path
c. Rate laws: First, second, pseudo-first order and higher order reactions
d. Temperature dependence of rate constants
e. Reaction mechanisms: Elementary reactions; Opposing reactions; Parallel reactions; Consecutive reactions and the steady-state approximation; Unimolecular decomposition; Free radical chain and branched reactions
f. Reaction dynamics

2. Reactions in liquid solutions
a. Cage effect, friction and diffusion control
b. Uptake and reaction of gases in liquids

3. Environmental reactor models and transport mechanisms
a. Batch reactor model, completely mixed flow reactor model, plug flow reactor model
b. Box models
c. Turbulence and mixing
d. Transport mechanisms of gases, liquids, and particles

4. Photochemistry
a. Absorption and emission of light
b. Photophysical processes

5. Analytical techniques
a. Spectroscopy: Components of optical instruments, UV-vis absorption spectroscopy, Infrared spectroscopy, Raman spectroscopy
b. Mass spectrometry: Ionization sources, Ionization techniques, Components of mass spectrometers
c. Chromatography: Gas chromatography, Liquid chromatography, Ion chromatography

2. Reading List

2.1 Compulsory Readings

1.	McQuarrie and Simon, *Physical Chemistry: A Molecular Approach*, 1st Edition, University Science Books (1997)
2.	Atkins and de Paula, *Physical Chemistry*, 9th Edition, Oxford University Press (2010)
3.	Houston, *Chemical Kinetics and Reaction Dynamics*, 1st Edition, Dover Books (2006)
4.	Skoog, Holler and Crouch, *Principles of Instrumental Analysis*, 6th Edition, Thomas Brooks/Cole (2007)
5.	Kundu, Cohen & Dowling, *Fluid Mechanics*, 5th Edition, Academic Press (2012)
6.	Nazaroff & Alvarez-Cohen, Environmental Engineering Science, Wiley (2004)

2.2 Additional Readings

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

1.	Hollas, *Modern Spectroscopy*, 4th Edition, Wiley (2004)