City University of Hong Kong
Course Syllabus

offered by School of Energy and Environment
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	**Environmental Engineering Science**
Course Code:	**SEE6224**
Course Duration:	**One semester**
Credit Units:	**3 credits**
Level:	**P6**
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)*	**SEE8224 Environmental Engineering Science**
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 water and air quality problems, the strategies implemented to control them or manage their effects, and the common analytical techniques that can be used to study them. Students are expected to be present a balanced perspective on water and air pollution science by covering: chemical kinetics, reaction dynamics, transformation processes, environmental reactor models, transport phenomena, photochemistry, spectroscopy, mass spectrometry, and chromatography.

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.	Explain the scale and process of current air and water pollution problems using fundamental chemistry and physics principles	10%	✓		✓
2.	Relate fundamental chemistry and physics principles to different air and water pollution problems	35%		✓	✓
3.	Apply mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	35%		✓	✓
4.	Demonstrate critical thinking skills to develop and implement strategies to control the severity and manage the effects of air and water pollution problems	20%	✓	✓	✓
		100%			

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.

3. Learning and Teaching Activities (LTAs)

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

LTA	Brief Description	CILO No.				Hours/week (if applicable)
		1	2	3	4	
1	Key topics related to the scale and process of current air and water pollution problems, including the fundamental chemistry and physics principles to different air and water	✓	✓	✓	✓	

	pollution problems, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems, and measuring air and water pollutants will be discussed during lectures. Students will form small groups (2 – 3) during lectures to work with their peers to organize their understandings and relate the presented lecture material to those taught in previous lectures and other courses.					
2	Individual project requires students to identify, analyze, and discuss their findings on an air or water pollution issue in the form of a presentation using concepts that they learnt in lectures.		✓	✓	✓	

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		
Continuous Assessment: 60 %						
Mid-terms There will be two midterm exams for instructor to assess students' learning progress on the concepts as outlined in LTA 1.	✓	✓	✓	✓	30%	
Assignments Students will complete the assignments to demonstrate their ability to explain and apply their knowledge in key concepts as outlined in LTA 1.		✓	✓	✓	20%	
Project Students will consolidate their learnings to identify, analyze, and discuss their findings on an air or water pollution issue in the form of a presentation using concepts that they learnt in lectures as outlined in LTA 2.	✓	✓	✓	✓	10%	
Examination: 40 % (duration: 2 hrs , if applicable)						
					100%	

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:

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 Rubrics.

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. Term Project	Capacity for self-directed learning to investigate air and water pollution issues and their impacts on human health and/or well-being	Demonstrate excellent self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being	Demonstrate good self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being	Demonstrate moderate self-directed learning capacity investigate air and water pollution issues and their impacts on human health and/or well-being	Demonstrate basic self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being	Demonstrate poor self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being
2. Assignments	Ability to explain in detail and with accuracy and apply their knowledge in key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Excellent analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air	Good analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and	Moderate analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and	Basic analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Poor analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems

		and water pollution formation, transport, and dispersion problems	dispersion problems	dispersion problems		
3. Mid-terms	Ability to explain in detail and with accuracy and apply their knowledge in key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Excellent analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Good analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Moderate analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Basic analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Poor analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems

4. Examination	Ability to explain in detail and with accuracy and apply their knowledge in key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Excellent analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Good analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Moderate analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Basic analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Poor analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Term Project	Capacity for self-directed learning to	Demonstrate excellent self-	Demonstrate good self-directed	Demonstrate moderate to basic	Demonstrate poor self-directed learning

	investigate air and water pollution issues and their impacts on human health and/or well-being	directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being	learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being	self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being	capacity to investigate air and water pollution issues and their impacts on human health and/or well-being
2. Assignments	Ability to explain in detail and with accuracy and apply their knowledge in key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Excellent analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Good analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Moderate to basic analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Poor analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems

3. Mid-terms	Ability to explain in detail and with accuracy and apply their knowledge in key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Excellent analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Good analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Moderate to basic analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	Poor analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems
4. Examination	Ability to explain in detail and with accuracy and apply their knowledge in key concepts related to the scale and process of current air and water pollution problems, including the physical and	Excellent analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and	Good analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution	Moderate to basic analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical	Poor analysis and problem-solving skills in demonstrating their understanding of key concepts related to the scale and process of current air and water pollution problems, including the physical and chemical

	chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	water pollution problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	problems, including the physical and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	and chemical principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems	principles related to the process of air and water pollution, mathematical and/or computational models to solve air and water pollution formation, transport, and dispersion problems

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.)

1. Basic concepts of environmental engineering science
    a. Water and the hydrosphere
    b. Air and atmosphere
    c. Impurities in environmental media
    d. Concentrations and other units of measure
    e. Material balance
    f. Factors governing contaminant concentrations
    g. Magnitudes of the scale of air and water pollution
    h. Engineering analysis

2. Transformation processes
    a. Governing concepts of stoichiometry, chemical equilibrium, chemical kinetics
    b. Rate laws: First, second, pseudo-first order and higher order reactions
    c. Temperature dependence of rate constants
    d. Reaction mechanisms: Elementary reactions; Opposing reactions; Parallel reactions; Consecutive reactions and the steady-state approximation; Unimolecular decomposition; Free radical chain and branched reactions
    e. Phase changes and partitioning
    f. Oxidation-reduction reactions

3. Environmental reactor models and transport phenomena
    a. Reactor models: Batch reactor model, completely mixed flow reactor model, plug flow reactor model
    b. Transport mechanisms of gases, liquids, and particles

4. Air and water quality engineering problems
    a. Nature of air quality problems
    b. Air pollutant emissions and controls
    c. Air quality models
    d. Nature of water quality problems
    e. Water pollution treatment methods

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

6. Contaminant measurement
    a. Spectroscopy
    b. Mass spectrometry
    c. Chromatography

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.	McQuarrie and Simon, *Physical Chemistry: A Molecular Approach*, 1st Edition, University Science Books (1997)
2.	Atkins and de Paula, *Physical Chemistry*, 12th Edition, Oxford University Press (2023)
3.	Houston, *Chemical Kinetics and Reaction Dynamics*, 1st Edition, Dover Books (2006)
4.	Skoog, Holler and Crouch, *Principles of Instrumental Analysis*, 7th Edition, Thomas Brooks/Cole (2017)
5.	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.)

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