SEE8224: ENVIRONMENTAL ENGINEERING SCIENCE

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Environmental Engineering Science

Subject Code
SEE - School of Energy and Environment
Course Number
8224

Academic Unit
School of Energy and Environment (E2)

College/School
School of Energy and Environment (E2)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
SEE6224 Environmental Engineering Science

Exclusive Courses
Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the scale and process of current air and water pollution problems using fundamental chemistry and physics principles	10	x		x
2	Relate fundamental chemistry and physics principles to different air and water pollution problems	35		x	x
3	Apply mathematical and/or computational models to solve air and water pollution formation, transport and dispersion problems	35		x	x
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	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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
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.	1, 2, 3, 4	
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.	2, 3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Mid-terms There will be two midterm exams for instructor to assess students' learning progress on the concepts as outlined in LTA 1.	1, 2, 3, 4	30	

2	Assignments Students will complete the assignments to demonstrate their ability to explain and apply their knowledge in key concepts as outlined in LTA 1.	2, 3, 4	20	
3	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.	1, 2, 3, 4	10	

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

0

Minimum Examination Passing Requirement (%)

0

Additional Information for ATs

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

a. 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);
b. obtain at least 30% of the total marks allocated towards final examination (if applicable); and
c. meet the criteria listed in the section on Assessment Rubrics.

Assessment Rubrics (AR)

Assessment Task

Term Project

Criterion

Capacity for self-directed learning to investigate air and water pollution issues and their impacts on human health and/or well-being

Excellent

(A+, A, A-) Demonstrate excellent self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

Good

(B+, B, B-) Demonstrate good self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

Fair

(C+, C, C-) Demonstrate moderate self-directed learning capacity investigate air and water pollution issues and their impacts on human health and/or well-being

Marginal

(D) Demonstrate basic self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

Failure

(F) Demonstrate poor self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

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Assessment Task

Assignments

Criterion

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

(A+, A, A-) 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

(B+, B, B-) 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

Fair

(C+, C, C-) 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

Marginal

(D) 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

Failure

(F) 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

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Assessment Task

Mid-terms

Criterion

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

(A+, A, A-) 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

(B+, B, B-) 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

Fair

(C+, C, C-) 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

Marginal

(D) 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

Failure

(F) 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

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Assessment Task

Examination

Criterion

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

(A+, A, A-) 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

(B+, B, B-) 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

Fair

(C+, C, C-) 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

Marginal

(D) 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

Failure

(F) 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

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Assessment Task

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

Criterion

Capacity for self-directed learning to investigate air and water pollution issues and their impacts on human health and/or well-being

Excellent

(A+, A, A-) Demonstrate excellent self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

Good

(B+, B) Demonstrate good self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

Marginal

(B-, C+,C) Demonstrate moderate to basic self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

Failure

(F) Demonstrate poor self-directed learning capacity to investigate air and water pollution issues and their impacts on human health and/or well-being

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Assessment Task

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

Criterion

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

(A+, A, A-) 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

(B+, B) 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

Marginal

(B-, C+, C) 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

Failure

(F) 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

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Assessment Task

Mid-terms (Applicable to students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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

(A+, A, A-) 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

(B+, B) 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

Marginal

(B-, C+, C) 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

Failure

(F) 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

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Assessment Task

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

Criterion

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

(A+, A, A-) 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

(B+, B) 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

Marginal

(B-, C, C+) 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

Failure

(F) 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

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Part III Other Information

Keyword Syllabus

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

Reading List

Compulsory Readings

	Title
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)

Additional Readings

	Title
1	NIL