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 Modelling**
Course Code:	**SEE8213**
Course Duration:	**One semester**
Credit Units:	**3 credits**
Level:	**R8**
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)*	**SEE6212 Environmental Modelling**
Exclusive Courses: *(Course Code and Title)*	**Nil**

Part II Course Details

1. Abstract

This course will introduce students to basic techniques in environmental modelling. Applications to atmospheric chemistry, air quality, water pollution, computational fluid dynamics and atmospheric modelling will be described. The mathematical theory will be reviewed as necessary.

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.	Model and analyse environmental systems using numerical calculus and root finding	25%		✓	
2.	Model and analyse environmental systems using linear systems	25%		✓	
3.	Model and analyse environmental systems using ordinary differential equations	25%		✓	✓
4.	Model and analyse environmental systems using partial differential equations	25%		✓	✓
		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	
Lectures	Cover basic principles and theory	✓	✓	✓	✓	

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: 100%						
Problem sets	✓	✓	✓	✓	30%	
Midterm	✓	✓	✓	✓	35%	
Project	✓	✓	✓	✓	35%	
Examination: 0% (duration: , if applicable)						
					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 Rubrics.

5. Assessment Rubrics

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

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Problem sets	Ability to solve computational problems	High	Significant	Moderate	Basic	Not reaching marginal levels
2. Midterm	Ability to describe theory and formulate computational strategies	High	Significant	Moderate	Basic	Not reaching marginal levels
3. Project	Ability to solve non-trivial computational problems	High	Significant	Moderate	Basic	Not reaching marginal levels

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. Problem sets	Ability to solve computational problems	High	Significant	Moderate	Not reaching marginal levels
2. Midterm	Ability to describe theory and formulate computational strategies	High	Significant	Moderate	Not reaching marginal levels
3. Project	Ability to solve non-trivial computational problems	High	Significant	Moderate	Not 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.)

1. Basic concepts
   - Modelling, simulation
   - Exact versus numerical solutions, floating-point arithmetic
   - Numerical calculus, finite difference, quadrature, root finding

2. Linear systems
   - Linearity, nonlinearity, feedback
   - Direct and indirect methods, Gaussian elimination, convergence, Gauss-Seidel, matrix solution, iteration
   - Applications: network models, mass balance, interpolation, steady constituent transport

3. Ordinary differential equations
   - Timestep, error, accuracy, stability, adaptive methods, explicit and implicit schemes, Euler and Runge-Kutta methods, stiff equations
   - Direct and indirect methods, Gaussian elimination, convergence, Gauss-Seidel
   - Applications: mass balance, chemical kinetics, box models, particle trajectories

4. Partial differential equations
   - CFL condition, upwinding, Damkohler number
   - Applications: pollutant dispersion, reaction-diffusion

5. Complex model simulation
   - Applications: Community Earth System Model simulation on Linux system

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.	P.R. Turner et al., *Applied Scientific Computing with Python*, Springer, 2016.
2.	J. Kiusalaas, *Numerical Methods in Engineering with Python 3*, Cambridge University Press, 2013.

2.2 Additional Readings

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

1.	D. R. Durran, *Numerical Methods for Fluid Dynamics*, Springer, Second Edition, 2010.
2.	W.H. Press et al, *Numerical Recipes: the Art of Scientific Computing*, Cambridge University Press, Third Edition, 2007.