City University of Hong Kong
Course Syllabus

offered by School of Energy and Environment
with effect from Semester A 2022/23

Part I Course Overview

Course Title:	**Environmental Modelling**
Course Code:	**SEE8213**
Course Duration:	**One semester**
Credit Units:	**3**
Level:	**R8**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites:	**Nil**
Precursors:	**Nil**
Equivalent Courses:	**Nil**
Exclusive Courses:	**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)

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 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)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4			
Lectures	Cover basic principles and theory	✓	✓	✓	✓			

4. Assessment Tasks/Activities (ATs)

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

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. 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

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. 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

III Other Information

1. Keyword Syllabus

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

2. Reading List

2.1 Compulsory Readings

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

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.