City University of Hong Kong
Course Syllabus

offered by School of Energy and Environment
with effect from Semester A 2019 / 20

Part I Course Overview

Course Title:	Environmental Modelling
Course Code:	SEE6212
Course Duration:	One semester
Credit Units:	3
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)*	Nil
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 ordinary differential equations	25		✓	
2.	Model and analyse environmental systems using stochastic differential equations	25		✓	✓
3.	Model and analyse environmental systems using partial differential equations	25		✓	✓
4.	Model and analyse environmental systems using interpolation and optimisation	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)

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

TLA	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.)

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

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
   - Integrability, dimensionality, modelling, simulation
   - Exact versus numerical solutions, floating-point arithmetic

2. Ordinary differential equations
   - Timestep, error, accuracy, adaptive methods, explicit and implicit schemes, Euler and Runge-Kutta methods, stiff equations
   - Applications: chemical kinetics, box models, particle trajectories

3. Stochastic differential equations
   - Ito calculus, stochastic Taylor approximation
   - Diffusion, random walk, Langevin equation, Wiener increment, Ornstein-Uhlenbeck process, Fokker-Planck equation
   - Applications: turbulent dispersion of pollutants

4. Partial differential equations
   - Types of differential equations, convergence, finite difference, stability, CFL condition, solver, matrix solution, iteration, upwinding
   - Finite element, finite volume, spectral and pseudospectral methods
   - Applications: heat transfer, flow in a box, phytoplankton dynamics, computational fluid dynamics

5. Interpolation and optimisation
   - Interpolation, splines, krieging
   - Gradient descent, Monte Carlo methods, ensemble, MCMC, Metropolis algorithm, importance sampling
   - Applications: data re-gridding, parameter estimation

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.	W.H. Press et al, *Numerical Recipes: the art of scientific computing*, Cambridge University Press, Third Edition, 2007.
2.	H.P. Langtangen, *A primer on scientific programming with Python*, Springer, 2012.

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.	P.E. Kloeden and E. Platen, *Numerical solution of stochastic differential equations*, Springer, 1999.