SEE6212: ENVIRONMENTAL MODELLING

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Environmental Modelling

Subject Code
SEE - School of Energy and Environment

Course Number
6212

Academic Unit
School of Energy and Environment (E2)

College/School
School of Energy and Environment (E2)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
SEE8213 Environmental Modelling

Exclusive Courses
Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Model and analyse environmental systems using numerical calculus and root finding	25		x	
2	Model and analyse environmental systems using linear systems	25		x	
3	Model and analyse environmental systems using ordinary differential equations	25		x	x
4	Model and analyse environmental systems using partial differential equations	25		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	Lectures	Cover basic principles and theory	1, 2, 3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Problem sets	1, 2, 3, 4	30	-	No
2	Midterm	1, 2, 3, 4	35	-	No
3	Project	1, 2, 3, 4	35	-	Yes

Continuous Assessment (%)

100

Examination (%)

0

Minimum Continuous Assessment Passing Requirement (%)

30

Additional Information for ATs

To pass a course, a student must do ALL of the following:
1) should not miss more than 3 lectures;
2) 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);
3) obtain at least 30% of the total marks allocated towards final examination (if applicable); and 4) meet the criteria listed in the section on Assessment Rubrics.

Assessment Rubrics (AR)

Assessment Task
Problem sets (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to solve computational problems

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not reaching marginal levels

Assessment Task
Midterm (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to describe theory and formulate computational strategies

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not reaching marginal levels

Assessment Task
Project (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to solve non-trivial computational problems

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not reaching marginal levels

Assessment Task
Problem sets (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to solve computational problems

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not reaching marginal levels

Assessment Task
Midterm (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to describe theory and formulate computational strategies

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not reaching marginal levels

Assessment Task
Project (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to solve non-trivial computational problems

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not reaching marginal levels

Part III Other Information

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

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

Reading List

Compulsory Readings

	Title
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.

Additional Readings

	Title
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.