City University of Hong Kong
Course Syllabus

offered by School of Energy and Environment
with effect from Semester A 2017 / 18

Part I Course Overview

Course Title:	Climate Modeling
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)*	SEE8213 Climate Modeling
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

Numerical modelling lies at the heart of atmospheric science in general and climate science in particular. This course reviews the governing equations, the numerical methods used to solve them, and their implementation in weather and climate models. Applications to mesoscale meteorology and oceanography will also be discussed.

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.	Describe the historical development of and need for numerical models	10%	✓		
2.	Describe the governing equations for the atmosphere and ocean	20%	✓		
3.	Describe standard numerical techniques employed in dynamical cores	20%	✓		
4.	Describe common physical parameterisations	20%	✓		
5.	Describe modelling strategies adopted in numerical weather prediction, climate prediction and oceanography	30%	✓	✓	
		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	5		
Lectures		✓	✓	✓	✓	✓	✓	3

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	5			
Continuous Assessment: 60%								
Homework	✓	✓	✓	✓	✓		10%	
Quizzes	✓	✓	✓	✓	✓		5%	
Midterm	✓	✓	✓				25%	
Term project	✓	✓	✓	✓	✓		20%	
Examination: 40% (duration: 2 hours, 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. Homework	Ability to solve problems related to lecture material	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Quizzes	Ability to describe key concepts	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Midterm	Ability to explain key concepts and solve problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Term paper	Ability to apply lecture material to the analysis and/or solution of a current research topic	High	Significant	Moderate	Basic	Not even reaching marginal levels
5. Final exam	Ability to explain key concepts and solve problems	High	Significant	Moderate	Basic	Not even 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.)

CILO1

i) Basic concepts: weather, climate, numerical weather prediction, climate prediction, predictability, initial-value problem, ensemble

CILO2

i) Governing equations: Navier-Stokes, hydrostatic approximation, primitive equations, geostrophy, quasi-geostrophy, balance, vertical coordinate
ii) Parameterisation: need for parameterisations, Reynolds decomposition, closure, turbulence

CILO3

i) Basic concepts: ordinary differential equation, partial differential equation, discretisation, error, stability, CFL condition
ii) Types of models: finite difference, spectral, finite element, finite volume
iii) Important schemes: semi-Lagrangian, spectral transform

CILO4

i) Standard parameterisations: gravity-wave drag, large-scale cloud, microphysics, convection, boundary-layer, land surface.

CILO5

i) Numerical weather prediction: analysis, observations, data assimilation, cycling
ii) Mesoscale meteorology: lateral boundary conditions, nesting
iii) Oceanography: differences between atmospheric and oceanic models
iv) Climate: general circulation models, coupled models, energy balance models, linear stochastic models

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.)

Nil

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.	*Climate System Modeling,* K. E. Trenberth (ed.) (Cambridge University Press, 1992)
3.	D.J., Stensrud, *Parameterization schemes : keys to understanding numerical weather prediction models*, Cambridge U.P., 2007.
4.	D. R. Durran, *Numerical Methods for Fluid Dynamics*, Springer, Second Edition, 2010