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:	SEE8213
Course Duration:	One semester
Credit Units:	3
Level:	R8
Proposed Area: *(for GE courses only)*	☐ Arts and Humanities ☐ Study of Societies, Social and Business Organisations ☐ Science and Technology
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 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)

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%			

** If weighting is assigned to CILOs, they should add up to 100%.*

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

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	5		
Lectures		✓	✓	✓	✓	✓	✓	3

4. Assessment Tasks/Activities (ATs)

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)								
** The weightings should add up to 100%.*							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

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. Midterm	Ability to explain key concepts and solve problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. 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
4. 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

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

Nil

2.2 Additional Readings

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