Course Outline

Numerical Methods and Laboratory

General Information

Course #	ATOC 558
Section #	1
Term	Fall
Year	2020
Course pre-requisite(s)	ATOC 412 or ATOC 512, or permission of instructor
Course co-requisite(s)	None
Course schedule (day and time of class)	Tuesday, Thursday: 0835-0955 am
Number of credits	3

Instructor Information

Name and Title	(Peter) M.K. Yau, professor
E-mail	Peter.yau@mcgill.ca
Virtual office hours	Appointment by email
Communication plan	Email or Zoom

TA Information (**if applicable**) TBA

Course Overview

Numerical simulation of atmospheric and oceanic processes. Finite difference, finite element, and spectral modelling techniques. Term project including computer modelling of convection or large-scale flows in the atmosphere or ocean.

Instructor Message Regarding Remote Delivery

The remote learning context presents new challenges. The instructor will do his best to provide a supportive learning environment. There will be links posted in myCourses to Student-specific Guidelines for Remote Teaching and Learning and Remote Learning Resources to support the student's learning.

Learning Outcomes

By the end of this course students will learn the basics of numerical techniques for atmospheric and oceanic modeling and be able to evaluate different numerical schemes at the advanced undergraduate and beginning graduate level.

Instructional Method

The method of instruction is as follows:

a) Lectures will be posted on myCourses at least a day before the scheduled hours on Tuesdays and Thursdays. The lectures will contain exercises for you to discover some of the material yourself.

b) The scheduled hours on Tuesdays and on Thursdays will be devoted to Q&A sessions, discussion of more difficult concepts, and homework problems. If possible, these sessions will make use of Zoom online meetings; otherwise email discussion will be utilized.

Expectations for Student Participation

Although not mandatory, participation in the online Zoom sessions and/or email discussion sessions will help the student to learn the course material.

Recordings of Sessions

There will be no recording of sessions.

Required Course Materials

None required, course material covered in power point lecture presentation posted on myCourses.

Course Content

1 Introduction

2 Finite-difference approximations (FDA) to derivatives

3 FDA in time for oscillatory equation –accuracy and stability

4 Computational model –Leap frog time differencing

5 Treatment of friction/dissipation equation; Lax Equivalent theorem

6 Linear Stability analysis of FD schemes I

7 Linear Stability analysis of FD schemes II –Von Neumann analysis; computational dispersion

8 Linear Stability analysis for advection equation

9 Linear Stability analysis for diffusion equation

10 Spatial and time filters

11 Non-linear stability analysis and aliasing –energy method

12 Fourier analysis of aliasing and non-linear instability

13 Staggered grids and energy conserving schemes

14 Boundary conditions

15 Semi-Lagrangian advection

16 Cubic spline interpolation; implicit and semi-implicit FD schemes

17 Elliptic solvers

18 Galerkin methods –spectral and finite element methods

A description of the means of evaluation to be used in the course:

a) Homework and small projects: (4-5 for a total of 60%)
b) Two 1.5-hour tests (20% each). Each test covers the material since the previous test. The last test will be during the final exam period.

McGill Policy Statements

Language of Submission

"In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded. This does not apply to courses in which acquiring proficiency in a language is one of the objectives."

Academic Integrity

"McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures" (see McGill's guide to academic honesty for more information).