Physics 491: Fluid Dynamics Spring 2016

Course Information

- Instructor Name: Andrew Ware
- Office: CHCB 130
- Email: andrew.ware@umontana.edu
- Lectures: MWF 1:10 – 2:00 pm in CHCB 348 and occasionally MW 8:10 – 9:00 am
- Text: *Fluid Mechanics*, Kundu, Cohen & Dowling, 6th Edition (required)
- Office Hours: MW 2 – 3 PM, TR 10 – 11 AM & by appointment
- Website: umonline.umt.edu

Overview

To develop a basic framework to describe fluid dynamics, including introductions to geophysical fluid dynamics and computational fluid dynamics.

Homework

I'll assign reading, which is **strongly** recommended to be read **before** you come to class. I'll assign problem sets about once a week that will be collected and graded. Feel free to ask questions about the homework. You are welcome to work together on the homework.

Exams

Two in-class exams around Fr 3/11 and Fr 4/29. One comprehensive final, Tu 5/10, 3:20 – 5:20 PM. Exams will be closed book, closed notes but I will provide a list of equations.

Grading

In-class exams	40 % (20 % each)
Homework	30 %
Final exam	30 %

Learning Objectives

After completing this course, you should:

Gain an understanding of fluid dynamics…

- Develop an understanding of tensor notation and its application in fluid dynamics
- Understand the importance of conservation laws in fluid dynamics
- Be able to understand and analyze the Navier-Stokes equation
- Understand vorticity and its role in rotational flows

Gain an understanding of the basics of geophysical and computational fluid dynamics…

- Understand why the Coriolis force dominates large scale motion in the atmosphere
- Be able to calculate the frequency and dispersion relation of atmospheric waves such as Rossby waves and gravity waves
- Understand the limitations of finite difference methods applied to model fluids
- Be able to apply finite difference methods to an advection-diffusion equation

Class Topics

Topics include, but are not limited to:

Preliminaries: fluid basics, closure of fluid equations, dimensional analysis, vectors & tensors
Kinematics: fluid particles, strain & rotation, advection & diffusion equation
Conservation laws: continuity equation, Navier-Stokes equation, energy conservation
Vorticity: rotation, Kelvin's theorem, Helmholtz's theorem, rotational vs. irrotational flow
Ideal flow: inviscid flow, two-dimensional flow, axisymmetric flow
Gravity waves: linearizing the Navier-Stokes equation, wave phenomena
Instability: Normal ode analysis, Kelvin-Helmholtz instability, thermal instability
Computational fluid dynamics: finite-difference methods, advection-diffusion equation
Geophysical fluid dynamics: fluid on a rotating sphere, geostrophic flow, gravity & Rossby waves
Turbulence (time permitting): turbulent flow, averaged equations of motion, energy cascades

Course Guidelines and Policies

Student Conduct Code

The Student Conduct Code at the University of Montana embodies and promotes honesty, integrity, accountability, rights, and responsibilities associated with constructive citizenship in our academic community. This Code describes expected standards of behavior for all students, including academic conduct and general conduct, and it outlines students' rights, responsibilities, and the campus processes for adjudicating alleged violations. Full student conduct code: http://www.umt.edu/vpsa/policies/student_conduct.php

Course Withdrawal

Students may use Cyberbear to drop courses through the first 15 instructional days of the semester. Beginng the 16th instructional day of the semester through the 45th instructional day, students use paper forms to drop, add and make changes of section, grading option or credit. PHSX 101 can only be taken as credit/no-credit.

Disability Modifications

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or call 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

[This course can be taken for a traditional letter-grade only]