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Spring 2-1-2016

PHSX 491.01: Fluid Dynamics

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Recommended Citation

Ware, Andrew, "PHSX 491.01: Fluid Dynamics" (2016). *Syllabi*. 7291.
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Course Information

- Instructor Name: Andrew Ware
- Office: CHCB 130
- Email: andrew.ware@umontana.edu
- Lectures MWF 1:10 – 2:00 p in CHCB 34 and occasionally MW 8:10 – 9:00 am
- Text: *Fluid Mechanics* Kundu, Cohen & Dowling, 6th Edition (required)
- Office Hours: M 2 – PM, TR 1 – 1 AM by appointment
- Website: umonline.umn.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	4 % (20 % each)
Homework	3 %
Final exam	3 %

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 basic 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 mode 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](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. Beginning 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 155 or call 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

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