GEOFLUIDS

Instructor: Joe Dufek
Office ES&T 2248
Phone: 404-894-9472
Email: dufek@gatech.edu

Office Hours: 3-4 on Tuesdays or by appointment

Recommended Text: Pijush Kundu, *Fluid Mechanics (Any edition should suffice)*.

Overview
Fluid dynamics approaches with applications to Earth and Planetary Sciences.

Description
Fluids play a central role in almost all Earth and planetary processes. Core convection deep in the Earth, porous flows of magma and fluids in the crust, surface flows from rivers to ocean currents and gas dynamics in the atmosphere, all shape landscape and influence the thermal budget of Earth and other planets. This course focuses on the fundamental concepts of fluid dynamics merged with geophysical applications. We will explore the physics of pure fluids and multiphase flow through class demonstrations, fluid experiments, and a review of current literature.

Goal
This course will cover the basic fluid dynamics needed to describe fluids as they related to Earth and Planetary science, and students leaving this course will have an understanding of the fundamental assumptions and derivation of the conservation equations.

Learning Objectives
Upon completion of this class students will be able to:

1. Understand the assumptions necessary to treat fluids as a continuum.
2. Describe the physical properties of fluids and be able to describe how momentum is transmitted by fluids.
3. Understand the kinematic description of fluids.
4. Be able to derive fluid equations for the conservation of mass, momentum and energy.
5. Describe the application to non-inertial reference frames and understand fluids on rotational bodies.
6. Describe mathematically the initiation of convection, and scale conservation equations.
7. Use scaling to describe the major momentum transfer mechanisms for different physical systems and describe the onset of turbulence.
8. Mathematically describe lagrangian motion of particles in a fluid.

Grading:
25% Assignments (approximately 8), 35% 2 Exams (equally weighted), 20% Team Project, 20% Final Paper

Undergraduate vs. Graduate Expectations: On the assignments and exams, questions marked 'Graduate' are required by the graduate students and not undergraduates. The grade for undergraduates does not reflect those questions, i.e. the total possible points in determining the undergraduate grade does not include these questions. For the final paper, graduate students are expected to use data, perform a new calculations, or data analysis. Undergraduates can do this as well, or may opt to write a review paper.

Background on Grading: You are welcome to work with each other on the assignments, but make sure you understand the material as it has a way of making its way on to exams. Separate sheets describing the team project and final paper are also being distributed and can also be found on the website. For the Final Paper graduate students will be expected to perform a calculation, data analysis, or experiment and write in Geophysical Review Letters style. Undergraduates may elect to write a review paper in its place.

Absences: See the Institute Absence policy is available at: www.catalog.gatech.edu/rules/4/

Academic Integrity:
Academic dishonesty will not be tolerated. This includes cheating, lying about course matters, plagiarism, or helping others commit a violation of the Honor Code. Some exams (when specifically announced in class) allow the use of self-prepared supporting information (one sheet of paper, either typed or handwritten, could be double-sided); no other support materials are allowed at tests. Plagiarism includes reproducing the words of others without both the use of quotation marks and citation. Students are reminded of the obligations and expectations associated with the Georgia Tech Academic Honor Code and Student Code of Conduct, available online at www.honor.gatech.edu.

Learning Accommodations:
If needed, we will make classroom accommodations for students with documented disabilities. These accommodations must be arranged in advance and in accordance with the Office of Disability Services (http://disabilityservices.gatech.edu).

Course Outline:

Week 1:
- Introductions/Basis of Fluid Mechanics
- Microscopic View of Fluids

Week 2:
- Viscosity and Momentum Diffusion

Week 3:
- Flow Kinematics: Streamline, Streak Line, Path Line and Streamfunctions

Week 4:
- Vorticity and Crocco's Theorem
- In Class Lab on Rotational Flows and Vorticity

Week 5:

Conservation of Mass and the vagaries of compressible/incompressible flows

Week 6:

Conservation of Energy and Heat Transport in Fluids

Week 7

Conservation of Momentum and Navier Stokes

Scaling of the Navier Stokes and Drag Determination by Momentum Conservation

Week 8

Exam 1

Non-inertial Reference Frames

Week 9

Fluid Mixing in Rotating Reference Frames

Potential Flows

Week 10

Low Reynolds Number Flows, Fluid Memory, and Porous Flows

Convection and Boundary Layers

Week 11

Spring Break

Week 12

Turbulent Flow

Turbulent Boundary Layers

Week 13

Turbulence

Convection

Week 14

Particle Transport in Turbulent Flows

Week 15

Lagrangian Equation of Motion in Fluids

Week 16

Gravity Currents and Granular Flows

Exam 2