Syllabus for *Fluid Physics for Geologists* (GEOL 382G)
University of Texas at Austin, Spring 2012

Instructor: Bayani Cardenas, cardenas@jsg.utexas.edu, 471-6897, EPS 3.160

The **goals** of this course are:
1) To develop a quantitative process-based understanding of flow and transport phenomena in hydrologic and geologic systems
2) To develop learning, problem-solving, critical thinking, and communication skills

By the end of the class, the student should be able to think critically in terms of first principles (governing equations of mass/energy/momentum balance, flow fields, entropy, etc.) so you can always go back to them. The class focuses on principles of flow and transport in geologic systems: including rivers, lakes, aquifers, glaciers, magma, oceans, and the atmosphere. The course more-or-less follows a standard outline for a fluid mechanics class, but with special emphasis on topics of geologic, especially hydrologic, interest.

Course Philosophy: *Learning by doing!*

Course expectation: Everyone is to have a positive, fun and mature attitude towards learning and applying hydrologic concepts. Students should demand a lot from the instructor and I will strive to meet these expectations. But in return, I expect the same from you.

Other skills to be developed: Students will use mathematical software (eg MATLAB, Maple) throughout the class. There will also be extensive use of the finite-element software COMSOL, in addition to some experimentation.

Required Reading:
The primary textbook is by Furbish, D. J., *Fluid Physics in Geology* (1997, Oxford University Press). Other books on fluid mechanics/dynamics can be used to complement the primary textbook.

Grading:

Two in-class exams	= 25%	(3/8 and 5/3)
Weekly (or bi-weekly) homework/problem sets and exercises	= 50%	
Participation and attitude	= 25%	
Total	**= 100%**	

Course structure

Lecture hours: T-Th, 2:00-3:30 PM in EPS 2.104
Office hours: Monday 9-10 AM, 1-2 PM or by appointment
Computer room hours: TBD

The teaching method will follow the Socratic method (more on this later). Therefore, attendance is important. The quality of your interaction during the lecture meetings will be

assessed, and a significant percentage of your grade is based on your level of preparation and participation at each class meeting.

There will be no separate final exam during finals week. The philosophy behind this is that if you did most of the homework and studied hard for the two in-class exams, you have learned the material and there is no need for a final assessment.

- Each Tuesday we start with student presentations, where you explain your approach and results for an exercise distributed the previous week. The exercise will be aimed at new material not yet covered in class.
- Each Tuesday we will review assigned readings, with demos, example problems, supplementary lecture, questions and discussion. READ AHEAD. It will be assumed you will have read the material, and are prepared to discuss it and work on related problems.
- Each Thursday, we will continue to work on example problems and discussion, with supplementary lecture material from time to time.
- You are responsible for ALL material in the book, whether or not it is covered in class or homework. We will go deeper into a few topics and review relevant mathematics concepts.
- The first exam will cover chapters 1-8 (or 9) and the second exam will cover chapters 1-15. And remember, if it is in the book you are responsible for it.

Homework, Exercises and Exams:

Homework problems are assigned on Thursdays and are typically due on the following Thursday before class. Late homework loses 20% per day of tardiness. **All work (i.e. calculations, programs, and sketches) should be submitted to get full credit.** This will also allow us to give you appropriate credit even if you messed up some calculations.

On the Socratic approach

Prof. Elizabeth Garret of the U. of Chicago School of Law:

A teaching strategy that includes calling on students without giving them prior notice is the best way I have found to foster critical thinking for all members of such a group. No student is certain before class whether she will be called on to discuss difficult issues or to respond to answers provided by one of her colleagues. She must therefore pay close attention to my discussions with other students so she will be ready to play a meaningful role. Furthermore, the Socratic Method places some responsibility on students to think about the questions silently and participate actively on their own; the element of surprise provides a powerful incentive for them to meet that responsibility. It also encourages students to prepare for class, which will enable them to learn more from the Socratic dialogue that takes place. The objective is to inculcate in students the habit of rigorous and critical analysis of the arguments they hear, as well as the practice of assessing and revising their own ideas and approaches in light of new information or different reasoning.

For a more technical and historical description, go to:
http://en.wikipedia.org/wiki/Socratic_method

The Socratic method seems unconventional for a physics/mechanics class, but then who wants to be *conventional*.

Course schedule (subject to revision)

Class No.	Date	Topic	Reading from Furbish
1	Jan 17 (Tue)	Introduction, Structural Homology	Ch 1
2	Jan 19 (Thu)	Time constants	
3	Jan 24 (Tue)	Continuum concept	Ch 2
4	Jan 26 (Thu)	Mechanical properties	Ch 3
5	Jan 31 (Tue)	Mechanical properties	
6	Feb 2 (Thu)	Thermodynamical properties	Ch 4
7	Feb 7 (Tue)	Thermodynamical properties	
8	Feb 9 (Thu)	Dimensional analysis	Ch 5
9	Feb 14 (Tue)	Dimensional analysis	
10	Feb 16 (Thu)	Statics	Ch 6
11	Feb 21 (Tue)	Kinematics and advective transport	Ch 7
12	Feb 23 (Thu)	Conservation of mass	Ch 8
13	Feb 28 (Tue)	Conservation of mass	
14	Mar 1 (Thu)	Conservation of energy	Ch 9
15	Mar 6 (Tue)	Inviscid Flow (Conservation of momentum)	Ch 10
16	Mar 8 (Thu)	**First Exam**	
	Mar 13 (Tue)	*Spring break*	
	Mar 15 (Thu)	*Spring break*	
18	Mar 20 (Tue)	Inviscid Flow (Conservation of momentum)	
19	Mar 22 (Thu)	Vorticity and strain	Ch 11
20	Mar 27 (Tue)	Vorticity and strain	
21	Mar 29 (Thu)	Viscous flow (Conservation of momentum)	Ch 12
22	Apr 3 (Tue)	Viscous flow (Conservation of momentum)	
23	Apr 5 (Thu)	Viscous flow (Conservation of momentum)	
24	Apr 10 (Tue)	Viscous flow (Conservation of momentum)	
25	Apr 12 (Thu)	Porous media flow and transport	Ch 13
26	Apr 17 (Tue)	Porous media flow and transport	
27	Apr 19 (Thu)	Porous media flow and transport	
28	Apr 24 (Tue)	Porous media flow and transport	
29	Apr 26 (Thu)	Turbulent flow and transport	Ch 14
30	May 1 (Tue)	Boundary layers	Ch 15
31	May 3 (Thu)	**Second Exam**	

All students, staff and faculty are bound by the honor code of the University of Texas:

"The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community."

The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-6441 TTY.