FOUNDATIONS OF GEOPHYSICS
FALL 2012 GEOS F431/631 Syllabus
4 Credits

INSTRUCTORS:

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COURSE LOGISTICS:

We will meet Tuesdays 1-4pm in Seminar Room (TBD) and Thursdays 1-4pm in Geology Computer Lab.

COURSE CATALOG TEXT:

GEOS F431 Foundations of Geophysics

4 Credits
O ered Fall

Applications of conservation of mass momentum and energy to geophysical, geologic and glaciological problems. Introduction to mathematical approaches such as continuum mechanbe placed on methods and tools for solving a variety of problems in global and regional geophysics, and the geophysical interpretation of solutions. Stacked with F431. Prerequisites: GEOS F418, MATH 302 and 314 or permission of instructor.

COURSE GOALS:

1. The primary goal of GEOS 631 is to train new graduate students in the fundamental problem solving methods (including computational skills) used in a variety of geophysics problems. The foci are on the applications of the Conservation Laws for Mass, Momentum, and Energy to geophysical problems and to introduce modern views of plate tectonics and potential theory.
2. The primary goal of GEOS 431 is to o er a solid foundation in the problem solving

In order to succeed in this course, you will need to have an understanding and be able to apply

1. basic linear algebra, such as a basis transformation (for vector or matrix), orthogonality
2. vector calculus: grad, div, and all that (Cartesian global coordinates, x-y-z)
3. vector calculus: grad, div, and all that (spherical local coordinates, r-theta-phi)

If you do not have these skills, please discuss this with the instructors and with your graduate advisor.

We will meet once per week for a 3 hour discussion and problem solving session and once a week for a 3 hr computing lab session. Most homework is to be done *before* attending class, not after. This will include coming to class prepared by reading course material, outlining the key concepts, and answering short practice questions and problems. During class, we will discuss the material you have read (guided by your questions from the reading) and we will use team problem solving, small group discussions, and other in class activities to probe the material more deeply.

After class each week you will complete the problem-based assignment you began as a group during the class { either through matlab computational methods as part of the computing lab or through a paper/pencil solution.

Assessment in this class will take the form of ungraded formative assessments such as preparing your notes and questions for class or graded formative assessments such as problem sets or the equation dictionary. Summative assessment will include two exams.

STUDENT LEARNING OUTCOMES:

The speci c learning outcomes on which the assessments will be based include:

Problem Solving Methods

1. De ne a Continuum and provide examples for geodynamic problems
2. De ne a vector, de ne a tensor
3. Read and interpret equations written in index notation (in comparison with vector/matrix notation)
4. Describe and visualize the 6 components of stress and strain
5. Identify several special states of stress and provide multiple examples of each
6. Explain the Conservations of Momentum, Mass, and Energy and describe the physical process underlying each of the terms within the equations
7. Explain what an equation of state (constitutive eqn) is and provide examples related to geodynamic problems
8. List the steps toward solving a general geodynamics problem (de ne geometry, list assumptions and boundary conditions, write conservation equations using appropriate terms, choose and write eqns of state and constitutive laws to build a solvable system of X eqns and X unknowns, solve the system of eqns)
9. Apply the general process for solving geodynamics problems to speci c problems (de ning assumptions, boundary conditions, conservation laws, etc)

10. Recognize and evaluate other scientists' approaches to geodynamics problems (using the general process)
11. Classify geodynamics example problems according to which conservation laws are most important and which solution techniques might be useful.
12. Apply concepts of Fourier Series
13. Explain the concept behind spherical harmonics and how it is useful for describing gravity and magnetic fields of the earth
14. Understand relationship between vector and potential fields
15. Set up and solve differential equations for potential field problems

Geodynamics Content

1. Draw the 1D Earth and label the core, mantle, crust, important distances, and basic properties of each layer
2. Draw the 1D Earth and label the core, mantle, crust, important distances, and basic properties of each layer
3. Explain the fundamental concept behind plate tectonics
4. Understand the mathematical description of (plate) motion on a sphere (key: euler vectors)
5. Explain the factors that affect the gravity field on Earth and how it varies in time
6. Describe the variability in the Earth's magnetic field through time and space
7. Discuss the sources of heat with the earth and the effect of these sources on processes in the mantle and crust such as radioactive heating, solidification of the outer core, etc.
8. Show familiarity with different processes involved with local and global sea-level changes (e.g., isostatic rebound, changes in dynamic topography due to internal mass redistributions, orbital fluctuations, etc, etc)

COURSE MATERIALS:

Book:

1. Required: Geodynamics by Turcotte and Schubert (2002)
2. Recommended: Geophysical Continua by Kennett and Bunge (2008)
3. Additional books will be on reserve at the library.

Notes: We will supply instructor-written notes and outlines of key concepts to supplement the reading and guide your preparations for class. These will be handed out early in the semester, so that you can plan and read ahead as necessary (i.e. being in the field is not an excuse for being unprepared for class).

Access to Computer with Matlab License: UAF provides networked Matlab licenses for all university computers, if you do not have a computer with Matlab, ask your graduate advisor or course instructors for the best solution. The Geology and Geophysics Computer Lab has computers with Matlab for your use. You will need a login for the Computer Lab, please see Chris Wyatt for this login before the first computing lab begins.

Journal Articles and Supplemental Readings: These will be supplied as .pdfs on Blackboard as available.

COMMUNICATION: We will use *Blackboard* to post all materials related to the course. You will receive regular emails when things are updated on blackboard or for other updates or changes to activities related to the course. You are responsible for being aware of due dates or updated material on blackboard.

ASSESSMENT: Students registered for 431 are expected to achieve essentially all of the primary learning outcomes for geophysical problem solving and content. The speci c di erences between 631 and 431 include

1. On all computing assignments, 631 students will receive one or two additional more challenging questions that go farther in depth on the topic.
2. 431 students do not have to complete the nal computing assignment.
3. 431 students will receive double points for the equation dictionary.
4. On homework assignments, all problems (typically 6 per assignment) will be divided into two groups. Three problems will be *introductory problems*, which are intended to reinforce the basic concepts covered in class, and three will be *advanced problems*, which extend that knowledge and challenge the students. In grading, for example, if all problems are worth 4 points, 431 students will earn 12 out of 20 possible points on the three introductory problems and we will assign two of the advanced problems for the nal 8 points; while 631 students will be assigned two of the introductory problems for 8 points total and earn 12 points total for completing all three of the advanced problems.
5. For the problem design part of the exams, the 431 students will have to create and solve a problem more similar to the introductory problems on their homework assignments; 631 students will have to create and solve a problem more similar to the advanced problems.
6. In-class exams will be assessed similarly to the homework assignments.

Computational Problems: Over the course of the semester, you will begin 7 longer computational problems (approximately one every other week) dur7(the)eweeTtatssessOv10.9091 Tf2

Exams: There will be two exams, one mid-way through the course and one at the end. The exams will each have two parts:

1. You will design a question similar to those in our problem sets that extend the learning of the concepts to a new application. You will supply the question and the solution (431 students only need to describe the method for solution). You may share your questions with each other, but you may not share your solutions. You will have some practice designing questions earlier in the semester and you will receive a rubric for how we will assess your question and your solution.
2. We will choose several of the questions from all those submitted by students (possibly slightly edited) as a two-hour timed exam during the three-hour class period (or the nals period).

Class Participation: This will be assessed by whether you have done the reading and prepared for class su ciently to contribute to class activities (as part of this we may make random checks that you have taken notes or written questions as part of preparation for class). We will include both instructor and peer feedback in assessment of your contributions to group work and class discussions.

		431	631
	Biweekly Computational Problem Sets (6 or 7@20pts each)	=120	=140
	Biweekly Written Problem Sets (6@20pts each)	=120	=120
	Equation Dictionary	= 40	=20
Grading:	Exam 1 Problem Design	=50	=50
	Exam 1 In Class	=50	=50
	Exam 2 Problem Design	=50	=50
	Exam 2 In Class	=50	=50
	Contributions during class activities (1pt per class)	=28	=28
	Total	= 508	= 508

Your nal grade will be determined by the total points you earn. Because of the small di erences in the degree of di culty in various problems from year to year and to ensure consistency of expectations from year to year, we adjust the minimum points required for

o ce of Student Support Services. We will collaborate with the O ce of Disabilities and/or the O ce of Student Support Services to make your educational experience in our class as positive as possible. Check the following website for further information: `http://www.uaf.edu/advising/learningresources/`