GEOL 4305/5304: Solid Earth Geomechanics **Fall 2013**

Basic Course Information:

- **Time:** lecture, TTH 9:30 - 10.50 AM
- **Location:** Lecture: Geoscience Building, Rm. 109
- **Primary Text:** Pollard and Fletcher, *Fundamentals of Structural Geology*, 2005

Instructor Information:

- **Instructor:** Dr. W. Ashley Griffith
- **Office:** Geoscience Building, Rm 233A
- **Office hours:** TTH 11:00AM-1:00PM
- **Phone:** (817) 272-9666
- **email:** wagriff@uta.edu
- **Faculty Profile:** https://www.uta.edu/mentis/profile/?wagriff

Course Description:

This course focuses on quantitative approaches to structural geology, introducing students to the basics of classical and continuum mechanics and their applications to solving problems of deformation in the earth. Class examples, examples from recent scientific literature, and laboratory exercises/problem sets illustrate mechanical analysis of natural geologic structures such as faults, folds, lava flows, and dikes, as well as practical problems including basic analysis of the stability of well-bores and underground excavations. Students will review examples from the literature that apply mechanical methods to geologic problems and complete their own analysis as a term project. Laboratory exercises will utilize MATLAB as a tool to quantitatively analyze spatial data and solve elastic and viscous boundary-value problems.

Student Learning Outcomes:

After successful completion of this course, students will be able to:

- Use Matlab organize and visualize quantitative field and model data
- Understand and manipulate field quantities and scalar, vector, and tensor data
- Idealize complicated geological problems by reducing them to essential, constrainable elements
- Apply principals of continuum mechanics and elasticity theory to construct and solve boundary value problems
- Communicate the results of quantitative analysis via technical writing

Grading Policy:

The grade breakdown in this course is described in the bullets below. Each component of the course is described briefly in subsequent sections.

- **Final Exam: 15%**
- **Problem Sets: 50% (Can drop lowest lab grade)**
- **Final Project: 30%**
- **Participation: 5%**

Late Policy: For problem sets, one letter grade off for each academic day late

Exams

There will be one (final) exam in this class. The final exam will focus on conceptual questions, intended for you to show that you understand how to go about solving problems rather than testing your ability to "do the math". You will be given a list of exam questions in advance to facilitate studying, and the final exam questions will be chosen from this list of questions. Given that the final exam accounts for only 15% of the class grade, it is not worth enough to completely dominate your final grade, but it is certainly enough to determine whether you get a B or an A if you are on the fringe.

Lab exercises/Problem Sets

These constitute the meat of the course, as indicated by the fact that they make up 50% of your grade. Projected problem set assignment and due dates are given in the course schedule. I will try to hold fast to these dates, but depending on the pace with which we proceed in the class, the dates may be subject to change, so pay attention to announcements in class. NOTE: These problem sets will also be the portion of the course that differs between the students taking the course for undergraduate and graduate credit. Graduate students will frequently be assigned an additional problem or two.

Final Project

If the problem sets are the meat, the Final Project is the potato: cheap (in terms of my time) but filling (for you). As it says in the course description, each student will "complete their own [structural] analysis as a term project". I strongly encourage you to choose a project that complements your own research or interests. I will consider it a true success if it becomes part of your thesis: I don't want to waste your time any more than I want to waste my own. In order to ensure that everyone uses time wisely, there are several due dates for the Final Project listed on the course schedule, starting with the third week of the semester. Descriptions of what is to be done and turned in for each of these due dates are given below:

1. Preliminary Topics (Due Sept 3)
2. Final Topic (Due Sept 17)
3. Working Bibliography (Due Sept 24)
4. Deadline for Discussion of Initial Results & Outline with Instructor (Due Oct 22)
5. Rough Draft Due (Nov 5)
6. Final Paper Due (Dec 3)

   The final project will consist of a paper no longer than **five pages**, single spaced, with figures. Data, m-files, or other relevant stuff may be included as appendices. Part of the grade will go for presentation, so please make sure you take care not to turn in sloppy work.

Note that, given the length of the paper, writing is not expected to constitute the majority of your time… the analysis is. Grading will be based on the quality of your analysis, the quality of your final paper, and your ability to meet each of the deadlines above with quality work.

Participation

Participation will be the only "qualitative" aspect of your grade, determined by me based on your contribution to class discussions and ability to ask insightful questions. One way to ensure that you get a full participation grade is to READ THE BOOK. I have tried to keep the readings << 10 pages per class, with a few minor exceptions, so please do this.

GEOL 4305/5304: Solid Earth Geomechanics Fall 2013

Course Schedule:

Date	Chapter	Topic	Reading	Problem Sets	Final Project Due Dates
22-Aug	1	Logistics & Mountain Building on the Colorado Plateau	Chp. 1	Prob Set 1 Assigned	
27-Aug	No Class	Explore Research Paper Topics			
29-Aug	No Class	Explore Research Paper Topics			
3-Sep	2	Geographic Coordinates & Map Projections	p. 25-34		Preliminary List of Topics Due
5-Sep		Transformationion of base & position vectors: Rotations, Cylindrical & Elliptical Coordinate Systems	p. 34-48		
10-Sep		Indicial Notation and Orientation of Structural Elements	p. 49-69		
12-Sep	4	Fundamental & Derived Physical Quantities, the Continuum, Field Quantities	p. 121-132	Prob Set 1 Due/Prob Set 2 Assigned	
17-Sep		Dimensional Analysis; Dimensionless Groups and Scaling Processes and Experiments	p. 133-150		Final Topic Due
19-Sep	5	Basics of Deformation, Displacement, and Velocity Fields	p. 153-160		
24-Sep		Kinematic & Mechanical Models for Viscous Deformation n Plutons	p. 161-168	Prob Set 2 Due/Prob Set 3 Assigned	Working Bibliography Due
26-Sep		Deformation in the Neighborhood of a Particle	p. 183-189		
1-Oct		3D Deformation and Small vs. Large Strains	p. 189-193		
3-Oct	6	Force and the traction vector	p. 195-207	Prob Set3 Due/Prob Set 4 Assigned	
8-Oct		The stress tensor and Cauchy's Formula	p. 207-216		
10-Oct		Principal Values and Stress Transformations	p. 217-227		
15-Oct		Analysis of Stress in the Earth	p. 228-242	Prob Set 4 Due/Prob Set 5 Assigned	
17-Oct	7	Particle & Rigid Body Dynamics	p. 244-260		

22-Oct		Conservation of Mass & Momentum	p. 260-276		Deadline for Discussion of Initial Results & Outline with Instructor
24-Oct		Field Equations for the Linear Isotropic Elastic Solid	p. 276-282, p. 292-299	Prob Set 5 Due/Prob Set 6 Assigned	
29-Oct		No Class: GSA Meeting in Denver			
31-Oct	8	Quasi-static displacement boundary value problems	p. 299-307		
5-Nov		Quasi-static traction boundary value problems	p. 308-318		Rough Draft Due
7-Nov		Elastic boundary value problems continued	"		
12-Nov		Elastic properties in the lab & Elastic anisotropy	p. 319-332	Prob Set 6 Due/Prob Set 7 Assigned	
14-Nov	9	Rock Strength in the Lab	p. 334-350		
19-Nov		Friction, fracture toughness, and Coulomb Failure	p. 350-364		
21-Nov		Griffith Cracks & Fracture Propagation	p. 364-383		
26-Nov	10	Constitutive Equations & Applications for the Isotropic Linear Viscous Fluid	p. 385-393	Prob Set 7 Due	
28-Nov		No Class: Thanksgiving Holiday			
3-Dec	12	General Approach to Solving Geomechanical Problems	Chp. 12		Final Paper Due
9-Dec - 13-Dec		Final Exam Week			

Other Useful References:

Basic Structural Geology

- Fossen, *Structural Geology*
- Davis, G. H. and Reynolds, S. J., 1996. *Structural Geology of Rocks and Regions*
- Twiss and Moores, *Structural Geology*
- Van der Pluijm and Marshak, *Earth Structure*
- Park, R. G., *Foundations of Structural Geology*
- Passchier and Trouw, *Microtectonics*
-

Rock Mechanics & Related Math Stuff

- Jaeger, J., Cook, N., and Zimmerman, *Fundamentals of Rock Mechanics*
- Means, W.D., *Stress and Strain, Basic Concepts of Continuum Mechanics for Geologists*
- Middleton and Wilcock, *Mechanics in the earth and environmental science*

MATLAB *(more for if you want to use it in your own research, or for the final project)*
Trauth, MATLAB Recipes for Earth Sciences

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It

is the student's responsibility to officially withdraw if they do not plan to attend after registering. Students will not be automatically dropped for non-attendance. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (http://wweb.uta.edu/ses/fao). **The last day to drop is October 30 2013**.

Americans with Disabilities Act: The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the Americans with Disabilities Act (ADA). All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

Academic Integrity: At UT Arlington, academic dishonesty is completely unacceptable and will not be tolerated in any form, including (but not limited to) "cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts" (UT System Regents' Rule 50101, §2.2). Suspected violations of academic integrity standards will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

Student Support Services: UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may contact the Maverick Resource Hotline by calling 817-272-6107, sending a message to resources@uta.edu, or visiting www.uta.edu/resources.

Electronic Communication: UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

Student Feedback Survey: At the end of each term, students enrolled in classes categorized as lecture, seminar, or laboratory will be asked to complete an online Student Feedback Survey (SFS) about the course and how it was taught. Instructions on how to access the SFS system will be sent directly to students through MavMail approximately 10 days before the end of the term. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback data is required by state law; student participation in the SFS program is voluntary.

Final Review Week: A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabus. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.