ES 301
Structural Analysis of Rocks

Classroom: CAS B31 *Time*: MWF 12:00 - 1:00, *Lab:* Mon 9 - 11

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Goals. The goal of this course is to reveal physical processes in the Earth by applying basic mechanical principles to geologic phenomena. It is the Earth's interior engine that produces mountains and oceans, volcanoes and earthquakes, and in general makes the Earth an interesting planet. In order to understand these processes, we have to utilize methods that directly sample structures and processes below the surface. It is the dynamics of the solid Earth, along with these tools needed to explore the planet that form the main subject matter of this course. The course provides a strong foundation for further study in many areas of Earth Sciences as well as field-based studies. We will assume some calculus, some college-level physics, and 100-level exposure to geologic principles.

Textbook: *Earth Structure, an Introduction to Structural Geology and Tectonics*, by B.A. van der Pluijm and S. Marshak, WW Norton & Company (2nd ed. 2004).
where to buy it: up to you – Barnes-Noble or via web retailers.

Requirements
Homework. Most weeks, a short assignment will be given. These will be due within one week, and typically will be an example of a computation that we discussed in class. These are an important part of the class.

Short writing assignments: Expect 1-2 assignments requiring one page summaries and analyses of scientific papers. You will learn to find information in the literature and analyze it.

Exams. There will be two midterms and one final at the end of the course. Both will emphasize basic concepts taught, as opposed to computations, but some quantitative reasoning questions will be present. The 2-hour final is 50% cumulative, 50% on last material.

Field Trip: At least one 1-day field trip is planned for later in the semester, where skills from the labs will be applied towards a mapping project.

Participation. You are expected to ask questions and volunteer information in class, and to participate in in-class projects and discussions.

Computing Skills. Recognizing that you are embarking on a degree in a quantitative science, you have the opportunity in this course to learn basic data manipulation skills. These will be developed as we need them in class and lab.

Grading. Grades are assigned as follows: 15% each of 2 midterms, 20% final, 30% Lab and field report, 10% Homework and 10% class participation.

Collaboration policy. Although you may discuss general approaches to homework, you are required to do all work independently. Points will be deducted for homework that appear substantially identical to others.

Additionally, we stress the importance of your familiarity with, and adherence to, Boston University's College of Arts and Sciences Academic Conduct Code, in particular those portions dealing with cheating and plagiarism.

Other Benefits and Recommendations

Departmental Colloquia. As a budding Earth Sciences major (or even if you are not), the regular ES Colloquium Series provides an excellent opportunity to see what practicing scientists do. While not required for this course, your attendance is strongly urged. These are usually held on Thursdays at 4 pm; schedules will be posted around the department.

Contents:

Review of plate tectonics, brittle deformation definitions and processes, Mohr circle representation of stress, stress in the Earth (Mohr-Coulomb failure criterion, effect of fluids), faults (geometry and mechanics of strike-slip, normal and thrust faults and their tectonic setting), strain history and measurement, foliation and lineation, ductile deformation mechanisms (diffusion and dislocation creep), strain rate/rheology, diapirs and ductile shear zones, regional examples.

Grading Guidelines: Problem Sets

This sheet explains the primary criteria used for grading problem sets.

1. *Is the answer right*? Of course, you only get full credit for a right answer. However being right is usually less important than how you got there. Also, credit will be given if a mistake in an earlier section was the only reason that the wrong answer was obtained.

2. *Was all the work done*? Make sure you double-check the assignment.

3. *Show all your work* -- some credit will **always** be reserved for being able to show how you got results. Getting the right answer is usually less important than showing that you understand why it is correct. Also, this is the only way I can give partial credit for wrong answers (e.g. if a simple typing error was made). Here are 3 specific cases:

- Math: show *intermediate algebra steps*, and make assumptions clear.

4. *Obviously wrong results* should be identified, even if you don't know what went wrong:

- Is your answer *physically reasonable*? If you get an answer that is obviously wrong then say so. Points will be deducted for extremely wrong answers that are given without comment. Some examples: a gravity anomaly is 10000 times larger than the total Earth's attraction, a crustal thickness estimate is 10 m, a negative seismic velocity. If you don't know why the answer is wrong, but you know it is, just say "I don't know why, but this is way too large/small because....."

- Do *units* make sense? Any equation should have the same units on both sides.

5. Are mistakes *simple math errors* attributable to typing in formulas wrong, or do they represent a misunderstanding of the problem? I give lots of partial credit and usually take off minimal points for minor mistakes. However, see #2 - #4 above.

6. Is the problem set *neat and well organized*? This includes writing, algebra, and any graphs.

7. Does the *discussion* show:
   - hard numbers where possible?
   - insight into the importance and significance of the result?
   - few unnecessary words? (babbling rarely helps)

8. Is there any evidence of *duplication and collaboration*? While it is fine to discuss with your peers the general approaches to problems, do your own work unless otherwise indicated on the assignment. Violation of University plagiarism rules is a serious offence.

Grading Guidelines: Written assignments

Below are my general guidelines for grading written assignments in my science classes. Generally these consist of gathering some information and then discussing it.

Grades are based on evaluation in the following areas:
#1. *completeness*: are all questions completely answered?
#2. *content*: is all information correct? is an able effort made to get in-depth information?
#3. *clarity and style*: is the writing easy to understand, or a chore to read?
#4. *insight and analysis*: is some effort made to understand the implications of observations, beyond just presenting the information?

I use one of two approaches to assigning grades, based on these evaluation areas.

Numerical Scores. Most points are assigned to each part of the assignment and each question asked, covering #1 and #2 above. Usually, additional points cover #3 and #4. A score of 0 is assigned to all assignments and parts of assignments that are not handed in. These are turned into letter grades at the end of the semester; there is no strict formula as I will adjust cutoffs based on overall difficulty and participation. As a *very inexact* guide, cutoffs for A/B, B/C, C/D and D/F are near 90%, 80%, 65-70% and 50% but may vary.

Letter Grades.
A. All 4 elements are present and are strong, especially #4.
B. basic information (#1 and #2) is present, but falls short in one area, typically #4 but sometimes #3. Or, one small part of a problem was not done while the rest was done well.
C. A cursory effort was made but generally lacks #4. Often comes up short in #1 or #2.
D. Little effort was made. Generally missing much of #1 and #2.
F. Nothing was submitted, or submission has no bearing on the assignment.

Summaries. Some assignments ask that you just summarize, and not critique a paper. In such instances relatively little weight is given to #4. Assume this is NOT the case unless explicitly stated; for example, I sometimes assign a summary as the first part of a multi-part assignment.

Lateness.
I deduct 10% from the score of an assignment for every day it is late. Any exceptions are rare, and *must* be agreed to *before* the assignment is due by both you and me.

Collaboration and plagiarism
Many projects are collaborative, and some part of those reports will be collaborative.
BUT all writing and homework must be done by you -- duplicated answers are easy to spot.
Also, copying text directly off published sources is plagiarism unless you make it clear it is a quotation.