Planetary Global Tectonics
PtyS 512 Fall 2018

Wednesday and Friday from 11:00 a.m. – 12:15 p.m.

Space Sciences 312

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Office hours: After class or by appointment

Course Objectives: This course will provide an overview of the fundamental physical processes that govern deformation and tectonics of planets. The target audience is beginning graduate students in the planetary science department at the University of Arizona, although graduate students and advanced undergraduates from across the University are also welcome.

Approximate Outline:

Introduction [2 lectures]: Overview of tectonic deformation styles that exist on planets; overview of rheology.

Continuum mechanics [4 lectures]: Strain; stress; equilibrium equations; constitutive equations; elasticity; viscosity; viscoelasticity; plasticity.

Rock rheology [3 lectures]: dislocations and deformation of solids; diffusion creep; dislocation climb; pressure solution creep; fractures. The microphysical view.

Applications of Continuum mechanics [4 lectures]: Flexure of thin plates; support of topographic loads. Topographic relaxation. Simple mantle flow problems.

Gravity and Isostasy [5 lectures]: density and gravity anomalies in planetary crusts; modes of isostatic compensation (Airy vs Pratt); gravity anomalies on Earth, planets, and moons and implications for crustal and mantle structure.

Heat Transfer [6 lectures]: Conduction; convection of viscous fluids; mantle convection on Earth and planets; parameterized convection models; magma genesis and transport; shear and tidal heating.

Seismology [3 lectures]: Elastic wave equations; P and S waves; propagation of seismic waves through planets; determination of planetary structure from seismic waves; physics of earthquakes.

Planetary Magnetic Fields [3 lectures]: Ways that magnetic fields can be produced; survey of types of planetary magnetic fields that exist in the solar system; necessary conditions for dynamo activity and core convection; basic physics of how dynamos work.

Textbook: *Geodynamics, 3rd Edition* by D.L. Turcotte and G. Schubert is the primary (required) text. Much of the course material will be drawn from the text, but I will not follow the text in detail.

Some additional books that you should be aware of include:

> *Planetary Surface Processes* by Melosh
> *The Solid Earth: An Introduction to Global Geophysics* by Fowler
> *Physics of the Earth* by Stacey
> *Principles of Geophysics* by Sleep and Fujita
> *Introduction to the Physics of the Earth's Interior* by Poirer
> *Rheology of the Earth* by Ranalli
> *Creep of Crystals* by Poirer
> *Fundamentals of Rock Mechanics* by Jaeger and Cook
> *Mantle Convection in the Earth and Planets* by Schubert, Turcotte, and Olson
> *Theory of Elasticity* by Landau and Lifshitz
> *Elasticity and Geomechanics* by Davis and Selvadurai
> *Planetary Tectonics* edited by Watters and Schultz

Prerequisite: The course is intended for first- and second-year planetary science graduate students. To succeed in this course, you will need a familiarity with vector calculus, differential equations, and basic physics. If you are lacking any of this background, you should talk to me about whether this course is appropriate for you.

Grades: Grades are assigned on the A, B, C, D, E system. The grade will be based on several components, weighted as follows:

> 35% Homework
> 25% Midterm
> 40% Final

Course policies:

Homework: There will be approximately 8 homework assignments in the course. You are encouraged to work together on the homeworks, but you must each turn in a unique homework written by you alone.

Feedback: Please let me know how you think the course is going. Suggestions for improvements and ideas for things to try (e.g., topics or activities you'd like to see) are both welcome.

Late work: If an assignment is due, you are responsible for turning it in, even if you are absent. All assignments are due at the beginning of class on the due date. Any assignments turned in after that time will be considered late. I will try to be understanding, but I reserve the right to enforce the following policy: Late assignments turned in within one week of the due date will receive one-half credit, after which they will receive zero credit. Please talk to me if you think you can't finish an assignment on time.

Special needs: Students with disabilities who require reasonable accommodations to fully participate in course activities or meet course requirements must register with the Disability Resource Center. If you qualify for services through DRC, bring your letter of accommodations to me as soon as possible.

Academic Integrity: It is strongly recommended that all students read the *University of Arizona's Code of Academic Integrity.* All students in this course are expected to abide by this code, which will be strictly enforced. Cheating will not be tolerated in any form. Submission of any written work that partially or fully duplicates material from the web, your fellow students, or any other source constitutes plagiarism. Students are encouraged to work together on the homework sets, but unique written responses must be handed in by each student. Instances of plagiarism will lead to a zero on that assignment, with harsher penalties for repeat offenses or extreme cases. Plagiarism on the midterm or final exam will lead to a failing grade for the course.

Significant Dates:
Wednesday August 22: First class
October 10, 12 – possible midterm dates (negotiable)
Friday November 23 – Thanksgiving holiday, no class
Wednesday December 5 – last class
Wednesday December 12, 10:30 a.m. – 12:30 p.m.: Final exam

Additionally, I will be traveling a lot this semester; specifically, I will be out of town the weeks of September 10-14, October 1-5, October 15-19, and possibly November 12-16 (the latter to be confirmed). What I would like to do is cancel class those weeks and, for the entire semester, arrange an additional weekly class slot that everyone is able to attend, such that during weeks that I'm in town, we'll have 3 classes per week instead of two. This will allow us to achieve approximately the same amount of class time. The half-way point of the semester (the 15th class) will still occur at approximately the same time in this scenario.