

Physics of Earth materials - SIO 225

<http://igppweb.ucsd.edu/~fialko/sio225.html>

An introduction to the mechanics of continua, including theory of elasticity, brittle failure, fluid dynamics, and viscoelasticity, with applications to geodynamic problems.

Prerequisite: some familiarity with (or willingness to learn) partial differential equations and tensor algebra.

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Lecture course, 4-units, letter grade or S/U grade, homework, final exam.

Time: Mon Wed Fri, 10:00-10:50 AM, 303 IGPP - Munk Conference Room

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SYLLABUS

Date	Topic	Reading/Homework	Lecturer
02 OCT	Introduction	Read: <i>Class notes; Segall, Origins (pp xvii-xxi); Malvern, Chapter 1</i>	YF
05 OCT	Vectors and tensors	Read: Notes	YF
07 OCT	Elements of tensor algebra	Read: Notes	YF
09 OCT	Elements of tensor algebra cont'd	Read: <i>Malvern, Chapter 2</i>	YF
12 OCT	Coordinate transformations	Homework 1 Read: Notes	YF
14 OCT	Deformation and rigid body motion	Read: notes ; <i>Malvern, Chapter 2</i>	YF
Stress and strain; Conservation laws			
		Read: class notes; <i>Ranalli</i>	

16 OCT	Strain and rotation	Ch. 1.4-1.6	YF
19 OCT	Conservation of mass and the continuity equation	Read: Notes	YF
21 OCT	Conservation of linear momentum	Read: Notes	YF
23 OCT	Stress; Principal axes and principal values	Read: Notes	YF
26 OCT	Conservation of angular momentum; Equilibrium equations	Homework 2	
28 OCT	Conservation of energy	Read: Ranalli, Ch. 2; Malvern, 3.2-3.3; Class notes	YF
Failure			
30 OCT	Frictional sliding; Mohr-Coulomb failure; Anderson's faulting theory	Read: Suppe, pp. 289-294	YF
02 NOV	Rate and state friction	Read: Class notes Homework 3	YF
Elasticity			
04 NOV	Generalized Hooke's Law	Read: Malvern Ch. 6.1-6.2	YF
06 NOV	Generalized Hooke's Law cont'd Compatibility equations	Read: Notes	YF
09 NOV	Linear elastic solutions for homogeneous deformation	Read: Malvern Ch. 8.1-8.2	YF
11 NOV	No class: Veterans Day Holiday	Read:	
13 NOV	Navier-Cauchy equations of motion	Read: Malvern Ch. 8.3-8.4	YF
16 NOV	Waves in elastic media	Read: Class notes Homework 4	YF

18 NOV	Theory of dislocations	Read: Class notes	YF
20 NOV	Stress concentration; Brittle failure; Elements of fracture mechanics	Read: Class notes	YF
Fluid mechanics			
23 NOV	Navier-Stokes equations	Homework 5 Read: notes; Malvern Ch. 7.1	YF
25 NOV	Some analytic solutions: plane Couette and Poiseuille flows	Read: notes; Malvern Ch. 7.3-7.4	YF
27 NOV	No class: Thanksgiving Holiday	Read:	YF
30 NOV	Some analytic solutions: Stokes flow	Read:Class notes	YF
02 DEC	Geologic applications (mantle convection, magma flow)	Homework 6 Read:Class notes	YF
Viscoelasticity and plasticity			
04 DEC	Constitutive equations for the Maxwell and standard linear solids	Read: Ranalli Ch. 4.6; Class notes	YF
07 DEC	Transient deformation in the Earth's crust and mantle; Post-glacial rebound, post-seismic relaxation	Read: Class notes	YF
09 DEC	Deformation of rocks in the ductile regime; Power- law rheology; Dislocation and diffusion creep	Read: Class notes	YF
11 DEC	Harmonic excitation and Q; Attenuation of travelling waves	Read: Class notes	YF

18 DEC

Final exam

08:00-11:00 am

YF

SIO 225 SUGGESTED BOOKS (some on reserve at SIO Library):

Textbooks:

Earthquake and Volcano Deformation, P. Segall, Princeton University Press, 458 pp., 2010.

Introduction to the mechanics of a continuous medium, L. E. Malvern, Prentice-Hall, Englewood Cliffs, NJ, 1969.

Reference Books:

Rheology of the Earth. Deformation and flow processes in geophysics and geodynamics Ranalli, G., Allen & Unwin, Boston, MA, 1986.

Theory of Elasticity, Landau, L., and E. Lifshitz, Oxford University Press, 1986; (Chapters 1, 3)

Principles of structural geology, J. Suppe, Prentice-Hall, Englewood Cliffs, NJ, 1985.

An introduction to fluid dynamics, Batchelor, G.K., Cambridge University Press

Computer Homework:

Computer homework can be done most easily by using *MATLAB* which runs on most machines. If you do not have a computer account we will set you up.

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