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SIOG 225 - Physics of Earth Materials - Fialko [FA 21]

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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.

Instructor: [Yuri Fialko](#) ; 321 IGPP; yfialko-at-ucsd.edu; Ph. 822-5028

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

SYLLABUS

Date	Topic	Reading/Homework	Lecturer
24 SEP	Introduction	Read: <i>Class notes; Segall, Origins (pp xvii-xxi); Malvern, Chapter 1</i>	YF
27 SEP	Vectors and scalars	Read: Notes	YF
29 SEP	Tensors	Read: Notes	YF
01 OCT	Elements of tensor algebra	Homework 1 Read: Notes	YF
04 OCT	Elements of tensor calculus: Differentiation	Read: Notes	YF
06 OCT	Elements of tensor calculus: Integration	Read: <i>Malvern, Chapter 2</i>	YF
08 OCT	Coordinate transformations	Homework 2 Read: Notes	YF
11 OCT	Deformation and rigid body motion	Read: <i>notes</i> ; <i>Malvern, Chapter 2</i>	YF
Stress and strain; Conservation laws			
13 OCT	Strain and rotation	Read: <i>class notes; Ranalli Ch. 1.4-1.6</i>	YF
15 OCT	Conservation of mass and the continuity equation	Read: Notes	YF
18 OCT	Conservation of linear momentum	Read: Notes	YF
20 OCT	Stress; Principal axes and principal values	Read: Notes	YF
22 OCT	Conservation of angular momentum; Equilibrium equations	Homework 3	
25 OCT	Conservation of energy	Read: <i>Ranalli, Ch. 2; Malvern, 3.2-3.3; Class notes</i>	YF
Failure			
27 OCT	Frictional sliding: Mohr-Coulomb failure; Anderson's faulting theory	Read: <i>Suppe, pp. 289-294</i>	YF
29 OCT	Rate and state friction	Read: <i>Class notes</i> Homework 4	YF
Elasticity			
01 NOV	Generalized Hooke's Law	Read: <i>Malvern Ch. 6.1-6.2</i>	YF
03 NOV	Generalized Hooke's Law cont'd Compatibility equations	Read: Notes	YF
05 NOV	Linear elastic solutions for homogeneous deformation	Read: <i>Malvern Ch. 8.1-8.2</i>	YF
08 NOV	No class: Veterans Day Holiday	Read:	
08 NOV	Navier-Cauchy equations of motion	Read: <i>Malvern Ch. 8.3-8.4</i>	YF
10 NOV	Waves in elastic media	Read: <i>Class notes</i> Homework 5	YF
12 NOV	Theory of dislocations	Read: <i>Class notes</i>	YF
15 NOV	Stress concentration; Brittle failure; Elements of fracture mechanics	Read: <i>Class notes</i>	YF
Fluid mechanics			
17 NOV	Navier-Stokes equations	Homework 6 Read: <i>notes; Malvern Ch. 7.1</i>	YF
19 NOV	Some analytic solutions: plane Couette and Poiseuille flows	Read: <i>notes; Malvern Ch. 7.3-7.4</i>	YF
22 NOV	Some analytic solutions: Stokes flow	Read: <i>Class notes</i>	YF
24 NOV	Geologic applications (mantle convection, magma flow)	Homework 7 Read: <i>Class notes</i>	YF
26 NOV	No class: Thanksgiving Holiday	Read:	YF
Viscoelasticity and plasticity			
29 NOV	Constitutive equations for the Maxwell and standard linear solids	Read: <i>Ranalli Ch. 4.6; Class notes</i>	
01 DEC	Deformation of rocks in the ductile regime; Power-law rheology; Dislocation and diffusion creep	Read: <i>Class notes</i>	YF
03 DEC	Transient deformation in the Earth's crust and mantle; Post-glacial rebound, post-seismic relaxation	Read: <i>Class notes</i>	YF
10 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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Last modified: Sun Sep 27 17:17:39 PDT 2020

Course Summary:

Date	Details	Due
Fri Oct 8, 2021	homework 1	due by 11:59pm
Fri Oct 15, 2021	homework 2	due by 11:59pm
Fri Oct 29, 2021	homework 3	due by 11:59pm
Fri Nov 5, 2021	homework 4	due by 11:59pm

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To Do

- Grade homework 3 20 points • Oct 29 at 11:59pm
- Grade homework 4 20 points • Nov 5 at 11:59pm

November 2021						
<	31	1	2	3	4	5
	6	7	8	9	10	11
	12	13	14	15	16	17
	18	19	20	21	22	23
	24	25	26	27	28	29
	30	1	2	3	4	5
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Course assignments are not weighted.