EESC W3201y Syllabus: Solid Earth Dynamics

Prof. Göran Ekström

Spring 2015

Tuesday and Thursday

11:40 – 12:55 a.m.

Schermerhorn 555

Preliminary Lecture Schedule

1. Jan 20 Introduction, review of principles of plate tectonics
2. Jan 22 Heat flow: the Earth's heat engine, relation to dynamic processes, conduction
3. Jan 27 Heat flow: conduction and depth of heating/cooling, cooking an ostrich egg, cooling a dike, value of insulation!
4. Jan 29 Heat flow: convection, mantle circulation, viscosity
5. Feb 3 Heat flow: convection, Kelvin and the age of the Earth
6. Feb 5 Heat flow: thermal structure of the Earth (geotherm), seafloor spreading and cooling of the lithosphere
7. Feb 10 Gravity: potential fields, Newton, field of a point mass
8. Feb 12 Gravity: perturbations to the gravity field, gravity anomalies
9. Feb 17 Gravity: perturbations to the gravity field, exploration/remediation applications
10. Feb 19 Gravity: gravity field of the Earth, the geoid
11. Feb 24 Isostasy: Archimedes' principle and icebergs
12. Feb 26 Isostasy: mountains, sediment loading, saltwater/freshwater distribution
13. Mar 3 Isostasy/Rheology: viscosity and flow
14. Mar 5 Isostasy/Rheology: glacial rebound, Earth's viscosity structure
15. Mar 10 Deformation: stress and strain, modes of deformation
16. Mar 12 Midterm Exam

— Spring Break —

17. Mar 24 Seismology: wave equation, seismic waves, wave propagation (Snell's law)
18. Mar 26 Seismology/Earthquakes: locating earthquakes, fault geometry
19. Mar 31 Seismology/Earthquakes: fault geometry and seismotectonics
20. Apr 2 Seismology/Structure: active-source imaging techniques, exploration/remediation example, Earth's crust
21. Apr 7 Seismology/Structure: passive imaging techniques, structure of the mantle and core
22. Apr 9 Geomagnetism: the magnetic dipole, inclination and declination, description of more complicated fields
23. Apr 11 Geomagnetism: Earth's magnetic field, the geodynamo, variations and reversals of the field
24. Apr 16 Geomagnetism: remanent magnetism, seafloor spreading and magnetic stripes
25. Apr 21 Glaciers: gravity-driven piles of ice
26. Apr 23 Glaciers: flow and fracture, strain
27. Apr 28 Glaciers: heat flow in ice sheets, imaging within ice sheets
28. Apr 30 Glaciers: floatation, isostasy, controls on short-time-scale flow variations

Course website:
http://www.ldeo.columbia.edu/~ekstrom/Courses/W3201/
Lecture slides, homework assignments, and handouts will be posted here. The site can also be reached from a link on the course page in CourseWorks.

Textbooks:
All textbooks are available on reserve in the Geology/Geoscience Library.
The main text for the course will be
Whole Earth Geophysics: An introductory textbook for geologists and geophysicists, R. J. Lillie, Prentice–Hall, available from Book Culture.
Recommended texts (no need to purchase unless you are especially interested):
The Solid Earth, C. M. R. Fowler, Cambridge Univ. Press;
The Physics of Glaciers, Fourth Edition, K. M. Cuffey and W. S. B. Paterson, Butterworth–Heinemann.

Discussion section:
There will be a one-hour discussion section / recitation each week, at a time to be arranged, led by the course TA. The discussion section will focus on topics relevant to the problem sets. The discussion section is not required, but you are very, very strongly encouraged to attend.

Problem sets:
Several problem sets will be assigned, approximately one per major course topic.

> *Problem-set policy:*
> You are welcome, and encouraged, to discuss the problem sets with each other. However, problem sets should always be solved and written up individually. All calculations, graphs, etc., should be completed individually.
> *Show all work.* This means that in order to get full credit for a correct answer, you need to explain in sufficient detail how you arrived at the answer. Some questions will be easy to answer, and you may be able to do them in your head. You must still explain how you arrived at your answer.
> *Credit for late work.* We will deduct 10% of the total available points for each day a problem set is late, up to the third day, after which the problem set will receive no credit. (Please just turn them in on time!)

Grading:
30% Problem Sets
30% Midterm Exam
40% Final Exam

Instructor contact information:
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Academic Integrity and the Honor Code:

Students are expected to do their own work on all tests and assignments for this class and act in accordance with the Faculty Statement on Academic Integrity (`http://www.college.columbia.edu/academics/integrity-statement`) and the Honor Code (`http://www.college.columbia.edu/ccschonorcode`) established by the students of Columbia College and the School of General Studies. Because any academic integrity violation undermines our intellectual community, students found to have cheated, plagiarized, or committed any other act of academic dishonesty can expect to receive zero credit for the work in question and may be referred to the Dean's Discipline process.

It is your responsibility to ensure that your work maintains the standards expected. If you have any questions concerning this academic-integrity policy and your work, please
(1) consult the Columbia University Undergraduate Guide to Academic Integrity (`http://www.college.columbia.edu/academics/academicintegrity`); and/or
(2) speak with Professor Ekström.