Dynamics of Planetary Interiors 01:460:442
01:460:442 should be cross-listed with 16:460:507
3 credits

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Draft syllabus for a revised course

This course will review applications of continuum mechanics, thermodynamics and fluid dynamics to the processes within the Earth and other rocky planets of the solar system. Work in the course will combine fundamental theory with hand-on computer-based data manipulation, giving students a way to connect theoretical expectations of simple models with reality of current knowledge about the planets.

1 period lecture
2 periods lab

Topics:

Week 1: Review of what is needed as background (460:506 in one week)

Week 2: Plate tectonics for the XXIst century
Practical Tasks: find an Euler pole from fracture zone shapes
use magnetic stripes to measure plate motion rate

Week 3: Mantle convection
Practical: heat flow from the surface and likely temperature in the center of the Earth

Week 4: Lithosphere is elastic
Practical: measure elastic thickness from the profile of seafloor

Week 5: Plate cooling model
Practical : ocean seafloor depth as an indicator of plate age

Week 6: Lithosphere is viscous – delamination
Practical: Venusian topography as evidence for stagnant lid tectonics

Week 7: Plumes in the mantle
Practical: plume flux from the width of the plume uplift

Week 8: Glacial rebound and the value of mantle viscosity
Practical: evaluate viscosity given topography and elevation of the Canadian Shield.

Week 9: Driving forces of plate tectonics
Practical: estimate plate driving forces for a ridge-trench pair

Week 10: Stokes flow
Practical: estimate rate of magma ascent through lithosphere

Week 11: Dynamo generation
Practical : lunar dynamo: yes or no given the size of the body and its core

Week 12: True polar wander
Practical: how did Mars achieve its current tilt orientation?

Week 13: Reserved for an emerging topic and/or guest speaker

Week 14: Student reports/presentations

Learning Goals:

Students will learn the basic physical principles used to represent planetary processes such as behavior of the lithosphere, convection within planetary interiors, origins of the geodynamo, etc. In practical exercises, students will develop a working knowledge of 21st century data resources available for understanding terrestrial planets, and how to utilize them to solve first-order problems in planetary dynamics.

Assessment: Students will be evaluated based on a series of weekly laboratory exercises and an end-of-term presentation. In their presentations, students will describe a newly proposed, data-driven exercise illustrating a concept or process in planetary dynamics.