Geological Sciences GLY5466, Seismology and Earth Structure

Time: MW 11:45 pm - 1:40 pm

Place: Williamson Hall 210, online

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Course Description: Ever wonder how we know that the Earth has distinct layers – the crust, mantle, core? Or why earthquakes happen or what they mean? Find out how wave phemonena in the earth allow us to determine earth structure, active tectonic motions, and basic rheology (physical state) of the Earth, from surface to center. In this course we will outline the basic physics of seismology in some detail, including: stress and strain; propagation of seismic waves; Snell's law, Fermat's principle, Huygens' principle; wave transmission, reflection, and refraction at boundaries; surface waves; wave dispersion; Earth's normal modes. We will examine how seismology defines Earth structure, and how modern seismology characterizes earthquake sources, giving some idea of seismic generation. Finally, we will outline the important relationship between plate tectonic theory and observational seismology.

Prerequisites: Math MAP2302 – Linear differential equations or Physics PHY2048 or PHY2060 – Mechanics; or equivalents; or consent of instructor.

Grading Method: Homework (70%) and term paper (30%).

Textbook: *An Introduction to Seismology, Earthquakes, and Earth Structure*, by Stein & Wysession, Blackwell Publishing.

Week 1 – Basic theory, Stein & Wysession Chapter 2.3: Intro seismology and plate tectonics; waves in continuous media, Newton's Second Law of motion, stress tensor, principal stress, max shear stress and faulting.

Week 2 – Basic theory, Stein & Wysession Chapter 2.3 to 2.4: deviatoric stress, strain, elasticity; seismic waves, plane waves, spherical waves.

Week 3 – Basic theory, Stein & Wysession Chapter 2.4 to 2-5: energy of plane waves, layered media, angle of incidence, Snell's law, critical angle.

Week 4 – Basic theory, Stein & Wysession Chapter 2.5 to 2-6: ray parameter and slowness, Fermat's principle, Huygens' principle; transmission and reflection of plane waves.

Week 5 – Basic theory, Stein & Wysession Chapter 2.6 to 2-9: transmission and reflection of plane waves; surface waves, dispersion.

Week 6 – Basic theory, Stein & Wysession Chapter 3-1 to 3-2: refraction seismology, flat and dipping layers, crustal structure.

Week 7 – Earth structure, Stein & Wysession Chapter 3-2 to 3-4: reflection seismology, common mid-point stacking, migration; body wave seismology.

Week 8 – Earth structure, Stein & Wysession Chapter 3-4 to 3-5: body wave seismology, rays and travel times, velocity structure and travel time inversion, structure of the Earth.

Week 9 – Earth structure, Stein & Wysession Chapter 3-6 to 3-8: anisotropy; attenuation; composition of the Earth.

Week 10 – Earth structure, Stein & Wysession Chapter 4-1 to 4-3: focal mechanisms, body wave radiation patterns, sterographic display; waveform modeling.

Week 11 – Earthquakes, Stein & Wysession Chapter 4-4 to 4-6: moment tensors; coseismic deformation, seismic cycle, source parameters, energy and stress drop; earthquake statistics, aftershocks, probabilities.

Week 12 – Earthquakes, Stein & Wysession Chapter 4-6 to 4-7: source parameters, energy and stress drop; earthquake statistics, aftershocks, probabilities.

Week 13 – Earthquakes, Stein & Wysession Chapter 5-1 to 5-6: plate boundaries and seismicity; plate kinematics; spreading ridges; subduction zones, great trench earthquakes; continental tectonics and earthquakes.

Week 14 – catch up