Department of Geophysics

Ilya Tsvankin

COURSE NUMBER AND NAME

GPGN553: Introduction to Seismology (second half of a two-semester course that includes GPGN552 and GPGN553).

COURSE OBJECTIVES

To introduce students to basic problems and methods of seismology, discuss the physics of wave propagation.

CATALOG DESCRIPTION

The course is focused on the physics of wave phenomena and the importance of wave-theory results in exploration and earthquake seismology. Includes reflection and transmission problems for spherical waves, methods of steepest descent and stationary phase, point-source radiation in layered isotropic media, surface and nongeometrical waves. Discussion of seismic modeling methods, fundamentals of wave propagation in anisotropic and attenuative media.

Prerequisites: GPGN552 or consent of instructor.

3 hours lecture; 3 semester hours.

Texts: Seismic Wavefields in Layered Isotropic Media (online at Samizdat Press), Tsvankin, I.; Quantitative Seismology, Aki, K. and Richards, P.G.; Waves in Layered Media, Brekhovskikh L.M.; Crystal Acoustics, Musgrave M.J.P.

SEMESTER TO BE OFFERED

Spring

COURSE SYLLABUS

Reflection/transmission problem for an acoustic spherical wave – 3 weeks

- Plane-wave decomposition of point-source radiation

- Integral solutions for the scattered wavefields
- Stationary-phase method, zero-order and first-order approximations
- The method of steepest descent for the reflected wavefield

Analysis of the reflected and transmitted acoustic wavefields – 3 weeks

- Reflection from low-velocity and high-velocity media, generation and properties of head waves
- Asymptotic description of the transmitted wavefield, ray-theory solution
- Analytic and numerical analysis of nongeometrical waves

Point-source radiation in elastic media – 3 weeks

- Solution of the reflection/transmission problem for a spherical wave at a solid/solid boundary
- Analysis of the reflected and transmitted wavefields
- Surface waves at fluid/solid and solid/solid boundaries
- Nongeometrical waves in elastic media, examples of nongeometrical phenomena from cross-hole and marine surveys
- Wave phenomena due to additional terms of the ray series, example of the PS-wave generated at normal incidence

Seismic modeling methods for 1-D and 2-D isotropic media – 2.5 weeks

- Ray theory and ray series expansion, advantages and limitations of ray tracing algorithms
- Reflectivity method and its applications for buried sources and receivers, extension to "quasi-2-D" models
- Finite-difference and finite-element algorithms, Cagniard-de-Hoop method

Introduction to wave propagation in anisotropic and attenuative media – 3.5 weeks

- Wave equation in anisotropic media, symmetries of the stiffness tensor
- Plane waves in anisotropic models, Green-Christoffel equation, polarization vectors
- Phase and group velocities in transversely isotropic media, conventional and Thomsen notation
- Theory for plane-wave propagation in attenuative media
- Velocity dispersion in attenuative media, reflection/transmission in the presence of attenuation

INSTRUCTOR

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IMPACT ON OTHER PROGRAMS

None

OVERLAP/DUPLICATION

None