

ICTP DIPLOMA PROGRAMME IN EARTH SYSTEM PHYSICS 2013-14

SYLLABUS

WAVE PHYSICS - [12 lectures: 18 hours], F. Romanelli

Part I Fundamentals of vibrations and waves

1. Introduction to the course: what is a wave?

2. 1-Degree of Freedom (DOF) Systems

Harmonic oscillator, Natural frequency. Damping, Damping regimes, Q factor. Forcing, Transients and stationary regime. Resonance.

3. 2&N DOF systems

Coupled oscillators. Discrete propagating systems. Acoustical phonons, Optical phonons, Dispersion. "Free" modes.

4. The wave equation

Transverse waves on a string. Sound waves.

The wave function

The wave function. Harmonic waves. Energy, Power & Intensity.

5. Wave phenomena

Superposition principle. Interference. Beats. Heterogeneous string, Reflection and transmission. Boundary conditions & modes. String with fixed and free ends. Air columns with fixed and free ends.

6. Vibration in lattices

Brillouin zone. Modes of monoatomic lattices. Phonons

Wave propagation

Huygens and Fermat principles. Reflection and refraction, Snell's law..

Part II Waves in solids

7. Elasticity

Theory of elasticity. Deformation, Strain tensor. Stress tensor.

Body waves

Generalized Hooke's law. Navier equations. Body waves (P and S).

8. Rays and body waves

Harmonic and spherical body waves. Body waves at interfaces. Free surface, Apparent velocity. Traveltimes in layered media. Direct, reflected and head waves. Ray Parameter. Traveltimes in layered spherical media.

9. Surface waves and Dispersion

Surface waves. Rayleigh waves in a halfspace. Phase velocity.
Group and phase velocity

10. Surface waves and Dispersion

SH waves in plates. Plates & rods (extensional and torsional waves).

11. Surface waves in layered media

Surface waves in layered halfspaces. Love waves. Rayleigh waves.

12. Free modes of the Earth

2D: wave equation in cylindrical coordinates; Bessel functions. Free modes of a membrane. 3D: wave equation in spherical coordinates; Spherical harmonics. Torsional modes; Spheroidal modes.

Tutorial: Fourier

Complex sound waves; Fourier synthesis & analysis; Vibrating string

Tutorial: Wave propagation and resonant cavities

Huygens and Fourier principles; Doppler effect; Waveguides and sound in a box