ICTP DIPLOMA PROGRAMME IN EARTH SYSTEM PHYSICS 2015-16

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.

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 and other wave phenomena

Complex sound waves; Fourier synthesis & analysis; Vibrating string
Waveguides