PHY-202 Waves and Oscillations

Credit Hours: 3-0

Pre-requisite: None

Course Objectives: It is undergraduate core course and aims to make students understand Simple harmonic oscillators with/without driving force and resonance. Fourier analysis and normal modes of continuous systems. Interference, reflection, refraction, and diffraction phenomena. Geometrical optics and wave properties of light.

Course Contents: Simple harmonic motion, superposition principle, Lissajous figures, spring-mass system, and pendulums, forced oscillators, damped oscillators, power in driven oscillators, coupled oscillators, normal modes, Fourier analysis, Huygens' principle, Doppler effect, interference, reflection and refraction, diffraction, Fourier transform, general solution of one-dimensional wave equation.

Detailed Course Contents: Introduction to simple harmonic motion, the complex representation. Superposition principle, beats, Lissajous figures, spring-mass systems and pendulums, stress, strain, shear, oscillations in water, oscillations in air, massive springs, decay of free vibrations, forced oscillators, transient phenomena, damped oscillators, power in driven oscillators, resonance with examples, anharmonic oscillators, coupled oscillators, normal modes, resonance in coupled oscillators, N coupled oscillators and normal modes, longitudinal oscillations, coupled oscillators with very large N, continuous system, free and forced vibrations of a stretched string, vibrations of a rod, air columns, the elasticity of a gas, Fourier analysis, progressive waves, superposition, wave pulses, motion of wave pulses, dispersion, waves at boundaries, Huygens' principle, Doppler effect, interference, reflection and refraction, diffraction, Fourier transform, general solution of one dimensional wave equation, bandwidth, pulse propagation, two and multi-slit interference, thin films, Fourier optics, single and multi-slit diffraction, two dimensional Fourier optics.

Course Outcomes:

At the end of the course, students will be able to:

- Acquire knowledge of waves for several physical phenomena

- Apply the knowledge of wave concept to other fields of physics
- Understand the mathematical aspects of waves and oscillations

Textbooks:

A. P. French, Vibrations and Waves, W. W. Norton & Company, 1971. (Referred as Fh)

Richard Fitzpatrick, Oscillations and Waves: An Introduction, CRC press, 2013. (Referred as Rk)

Reference Book: George C. King, Vibrations and waves, John Wiley & sons, 2013.

Weekly Breakdown		
Week	Section	Topics
1	Fh Ch. 1, pp. 3-16	Introduction to simple harmonic motion, the complex representation.
2	Fh Ch. 2, pp. 19-38	Superposition principle, beats, Lissajous figures.
3	Fh Ch. 3, pp. 41-60	Spring-mass systems and pendulums, stress, strain, shear, oscillations in water and air.
4	Fh Ch. 3, pp. 60-83	Massive springs, decay of free vibrations, forced oscillator and complex number method.
5	Fh Ch. 4, pp. 83-101	Damping and resistive forces, transient phenomena, damped oscillators, power in driven oscillators.
6	Fh Ch. 4, pp. 101-112 Ch. 5, pp. 121-127	Resonance with examples, anharmonic oscillators, coupled oscillators, normal modes.
7	Fh Ch. 5, pp. 128-151	Resonance in coupled oscillators, N coupled oscillators and normal modes, longitudinal oscillations, coupled oscillators with very large N.
8	Fh Ch. 6, pp. 161-178	Continuous system, free and forced vibrations of a stretched string, vibrations of a rod, air columns, the elasticity of a gas.
		Midterm Exam
9	Fh Ch. 6, pp. 189-196 Ch.	Fourier analysis, progressive waves, superposition.

	7, pp. 201-209, 213-216	
10	Fh Ch. 7, pp. 216-219, 223-234 Fh Ch. 8, pp. 253-259, 264-267	Wave pulses, motion of wave pulses, dispersion, waves at boundaries.
11	Fh Ch. 8, pp. 267-280 Ch. 8, pp. 284-294	Huygens' principle, doppler effect, interference, reflection and refraction, diffraction.
12	Rk. 8.1-8.3	Fourier transform, general solution of one dimensional wave equation, bandwidth.
13	Rk. 9.1, 10.1-10.5	Pulse propagation, two and multi-slit interference, thin films.
14	Rk. 10.6-10.9	Fourier optics, single and multi-slit diffraction, two-dimensional Fourier optics.
15		Revision