SEMESTER-III

PHYDSC201T

WAVES AND OPTICS

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *The course aims at reviewing the concepts of waves and oscillations from a more advanced perspective and goes on to build new concepts. It begins with superposition of harmonic motion leading to physics of damped and forced oscillations. The course will also introduce students to the broad idea of wave optics including various interferometers.*

Unit 1:

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Wave Motion: Plane Progressive (Travelling) Waves. Wave Equation. Differential Equation. Pressure of a Longitudinal Wave. Energy and Intensity of progressive wave. **(12 Lectures)**

Unit 2:

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends (analytical treatment). Phase and group velocities and relations between them. Energy of vibrating string. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. **(12 Lectures)**

Unit 3:

Wave Optics: Definition and properties of wave front. Huygens Principle.

Interference: Division of amplitude and wavefront. Methods for production of interference fringe by Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin films: Parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **(12 Lectures)**

Unit 4:

Interferometer: Michelson Interferometer - (1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes.

Diffraction: Types of diffraction, differences between Fresnel and Fraunhofer diffraction. Kirchhoff's Integral Theorem (statement only), Fresnel-Kirchhoff's Integral formula (Qualitative discussion only).

Fraunhofer diffraction: Single slit, double slit and transmission diffraction grating, resolving power of grating, Resolving Power of a telescope. **(12 Lectures)**

Unit 5:

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms. **(12 Lectures)**

Expected learning outcomes: *On successful completion of this course, the students will have the skill and knowledge to, understand simple harmonic motion, superposition of collinear harmonic oscillations, phenomena of interference, diffraction, various interferometers, zone plates and holography as manifestation of interference.*

Reference Books:

i. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
ii. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
iii. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
iv. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill.
v. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
vi. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
vii. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.
viii. A text book on Light – B. Ghosh and K. G. Mazumdar (Shreedhar Publishers).
ix. Advanced Practical Physics Vol II – B. Ghosh (Shreedhar Publishers).