PH104	**Physics II**	**L-T-P-CR-CH: 2-0-0-2-2**

Course Objectives

CO1. To introduce and elaborate the fundamental physical principles of basic quantum mechanics, waves, solid-state physics, and their engineering applications.

CO2. To elaborate technologically relevant solved problems on quantum mechanics, waves and solid-state physics, highlighting the significance of underlying basic physical principles.

CO3. To demonstrate an interdisciplinary perspective to the students by showing how a few physical laws are at the core of various apparently different engineering problems.

CO4. To explain basic principles of quantum mechanics which is later used to understand solid state devices.

CO5. To demonstrate - how the electronic band theory evolved and why quantum mechanics is essential for understanding modern electronic devices.

CO6. To elaborate the most general aspects of waves and oscillations which are ubiquitous in engineering and technological problems.

Learning Outcomes

Upon the completion of this course, the student will be able to:

LO1. Apply the most basic principles of quantum mechanics, waves and solid-state physics and solid-state devices.

LO2. Solve one dimensional quantum mechanical problems and have the ability to see how quantum mechanics is at the heart of solid-state devices.

LO3. Determine why some materials are metals, some are insulators, and some are semiconductors, based on their electronic band structure.

LO4. Analyze problems of carrier generation and transport phenomena in intrinsic and extrinsic semiconductors – which is essential to understand all electronic devices.

LO5. Solve engineering problems dealing with simple, damped or forced harmonic oscillation and perform Fourier analysis of wave phenomenon.

SYLLABUS

Unit 4: Quantum Mechanics (11 lectures)

Wave nature of particles and the Schrodinger equation; Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle; Application of Schrodinger equation: particle in a box.

Unit 5: Waves and oscillations (7 lectures)

Simple harmonic motion, damped and forced simple harmonic oscillator, quality factor, Applications in mechanical and electrical systems, power absorbed by oscillator; superposition of waves and Fourier method, wave groups and group velocity;

Unit 6: Solid state, semiconductor physics and Lasers (11 lectures)

Free electron theory of metals, Fermi level, density of states, Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, LED, photodetector, Solar cells, Laser-device structure, materials, working principle and characteristics.

Total **(29 lectures)**

Text Books:

1. Quantum Physics. R. Eisberg and R. Resnick, John Wiley and Sons, 2nd Edition, 1985.
2. Semiconductor Optoelectronics: Physics and Technology. J. Singh, McGraw-Hill Inc., New York, 1995.
3. Introduction to solid state physics. C. Kittel, Wiley, 8th Edition, 2012.
4. Oscillations and waves in physics, I. G. Main, Cambridge University Press, 3rd Edition, 1995.

Reference Books:

1. Fundamentals of Physics. D. Halliday, R. Resnick and J. Walker, Wiley India (Delhi), 6th Edition, 2010.
2. Introduction to Quantum Mechanics. D. J. Griffiths, Cambridge India, 2nd Edition, 2016.
3. The physics of vibrations and waves. H. J. Pain, John Wiley and Sons, 6th Edition, 2005.
4. Principles of Lasers. O. Svelto, Springer, 5th Edition, 2010.
5. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL
6. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL
7. All relevant courses available on NPTEL