DEPARTMENT OF PHYSICS
UPH122C/UPH222C: ENGINEERING PHYSICS
4 CREDITS (4-0-0)

COURSE OUTCOMES :

1. Student will be able to apply de-Broglie hypothesis and one dimensional Schrodinger wave equation for computing physical parameters of a material.
2. Student will be able to verify conductivity of conductors, semiconductors and superconductors theoretically.
3. Student will be able to identify crystal structure of cubic crystals.
4. Student will be able to analyze the necessity of dielectric materials.
5. Student will be able to analyze suitability of lasers, ultrasonic waves, optical fiber and shockwaves for engineering applications.

UNIT - I

Modern Physics and Quantum Mechanics: 13 Hours

Introduction, Quantization of energy levels, Frank-Hertz experiment. Wave particle dualism, de-Broglie hypothesis, de-Broglie wavelength, de-Broglie wavelength associated with electrons. Davisson and Germer experiment. Matter waves and their characteristic properties. Phase velocity, group velocity, expression for group velocity (superposition of two waves). Relation between phase and group velocity in dispersive medium, relation between group velocity and particle velocity. Relation between phase velocity, group velocity and velocity of light. Expression for de- Broglie wavelength using group velocity. Application of de-Broglie hypothesis.

Heisenberg's uncertainty principle and its physical significance (no derivation). Application of uncertainty principle (non-existence of electron in the nucleus). Wave function, Properties and physical significance of a wave function. Probability density and normalization of a wave function. Setting up of a one dimensional time independent Schrodinger wave equation. Eigen functions and eigen values. Applications of Schrodinger wave equation- eigen function and energy eigen values of a particle in a potential well of infinite height and for a free particle. Finite potential well (qualitative) and tunnel effect (qualitative) and its applications.

UNIT – II

13 Hours

Electrical Properties of Metals and Semiconductors:

Free electron concept (Drude-Lorentz Theory). Classical free electron theory-assumptions. Mean collision time, mean free path, relaxation time and drift velocity. Expression for drift velocity. Expression for electrical conductivity in metals. Effect of impurity and temperature on electrical resistivity of metals (Matthiessen's rule). Failures of classical free electron theory. Quantum free electron theory-assumptions. Fermi-Diarc statistics. Density of states and its derivation (3 dimension). Fermi energy, Fermi factor and variation of Fermi factor with energy for different temperatures. Derivation of Fermi energy for 0K. Merits of quantum free electron theory.

Semiconductors, concentration of electrons and holes in intrinsic and extrinsic semiconductors (qualitative). Fermi level in intrinsic and extrinsic semiconductors (qualitative). Direct and indirect band gap semiconductors. Derivation of electrical conductivity for semiconductors. Hall effect, derivation of Hall voltage and Hall coefficient, experimental measurement of Hall voltage and Hall coefficient. Applications of Hall effect.

Superconductivity:

Temperature dependence of resistance in conductors and superconductors. Meissner effect, critical magnetic field, Type I and Type II superconductors. BCS theory (qualitative). Applications of superconductors.

UNIT – III

13 Hours

Crystal Structure:

Space lattice, unit cell, primitive cell, lattice parameters, crystal systems, Bravais lattices. Directions and planes in a crystal. Miller indices. Expression for inter-planar spacing in terms of Miller indices. Co-ordination number, atomic packing factor for SC, BCC, FCC. Relation between lattice constant and density of material. Crystal structures of CsCl, NaCl, ZnS and Diamond. Bragg's Law and Bragg's X-ray spectrometer-determination of wavelength. Determination of cubic crystal structures using diffractrograms.

Dielectric materials:
Polar and non-polar dielectrics. Dielectric polarization, polarization process in polar and non-polar dielectrics, polarization mechanisms. Dielectric constant, relation between polarization and dielectric constant. Internal field and derivation of internal field in solids and liquids (one dimensional). Clausius - Mossotti relation. Frequency dependence of polarization. Dielectric loss and its derivation. Ferroelectrics and piezoelectrics. Applications of dielectric materials.

UNIT –IV

13 Hours

Lasers:
Introduction, absorption, spontaneous emission and stimulated emission, Einstein's coefficients (expression for energy density). Conditions for laser action, requisites of a laser system, working mechanism. Characteristics of a laser. Classification of Lasers. Construction and working of Nd:YAG, carbon dioxide and semiconductor diode lasers. Applications of lasers- industry, defense, medical and environmental. Holography-construction and reconstruction of a hologram. Applications of holography. Laser Safety.

Optical fibers:
Introduction, propagation mechanism in optical fibers, angle of acceptance, numerical aperture and its derivation. Modes of propagation (qualitative), types of optical fibers and attenuation. Applications-optical fiber communication system, optical fiber as a sensor and fiber laser.

Ultrasonic and Shock Waves:
Ultrasonic Waves: Introduction, generation of ultrasonic waves (magnetostriction and piezoelectric methods) and properties. Measurement of velocity of ultrasonic waves in solids and liquids. Applications of ultrasonic waves- non destructive testing of materials, Medical and elastic constants of solids and liquids.

Shock Waves: Mach number, distinctions between- acoustic, ultrasonic, subsonic and supersonic waves. Shock waves – characteristics. Method of producing shock waves –Reddy shock tube. Applications of shock waves.

Total: 52 Hours

Text Books:

1. M.N.Avadhanulu and P.G.Kshirsagar, "A text book of engineering physics", 8th edition, S. Chand & Company, 2006.
2. S.O.Pillai, "Solid state physics", sixth edition, New Age International, 2007.

Reference:

1. R.K.Puri and V.K.Babbar, "Solid state physics" S.Chand & Company, 2010.
2. Arthur Beiser, "Modern physics", sixth edition, T.M.H, 2002
3. Kenneth Krane ,"Modern physics", second edition, Wiley India Pvt. Ltd, 2006.
4. B. B. Laud, "Lasers and non linear optics", second edition, New Age International, 1991.
5. K.Rajagopal, "Engineering physics", PHI, 2009.
6. V.Rajendran, "Engineering physics", Tata McGraw Hill, 2009.
7. Wiley precise text book series, "Engineering physics", Wiley India Pvt. Ltd., 2014
8. Chintoo S. Kumar, K. Takayana and K. P. J. Reddy, "Shock waves made simple", Wiley India Pvt. Ltd., 2014.

Question Paper Pattern:

1. Total of **eight** Questions with **two** from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than **four** subdivisions.
3. Any **five** full questions are to be answered choosing at least one from each unit.

UPH127L/UPH227L: ENGINEERING PHYSICS LABORATORY
1.5 CREDITS (0-0-3)

COURSE OUTCOMES :

1. Student will be able to develop individual experimental skills.
2. Student will be able to apply measuring tools for precision measurements.
3. Student will be able to experiment with basic electrical components in designing circuits.
4. Student will be able to measure properties of different materials.

LIST OF EXPERIMENTS:

1. Verification of Stefan's law.
2. Planck's constant (determination of Planck's constant using LED or photoelectric effect method).
3. Measurement of wavelength of a laser using diffraction grating.
4. Measurement of velocity of ultrasonic waves in liquids and solids by using Ultrasonic interferometer.
5. Determination of Fermi energy for a conductor.
6. Determination of dielectric constant by charging and discharging method.
7. The study of frequency response in series and parallel LCR circuits.
8. Black box experiment to identify passive components and estimate their values.
9. Determination of rigidity modulus of a wire by Torsional pendulum method.
10. Determination of cubic crystal structures using diffractrograms.
11. Photo diode characteristics.
12. Determination of Young's modulus of a metal strip by single cantilever method.
13. Electric resistivity of a semiconductor by four probe method.
14. Measurement of numerical aperture and attenuation in an Optical Fiber.
15. Determination of Band gap for a semiconductor.

Note:

1. Ten experiments are to be conducted.
2. Candidate has to perform two experiments in the semester end examination.

Reference Book:

1. H Sathya Sheelan, "Laboratory manual in applied physics", Ed3, New Age International, 2008.

Laboratory assessment:

1. Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE).
2. Allocation of 50 Marks for CIE:
   - Performance and journal write-up: Marks for each experiment = 30 marks / No of proposed experiments.
   - One practical test for 20 marks (5 write-up, 10 conduction, calculation results etc.., 5 viva-voce).
3. Allocation of 50 marks for SEE: 25% write-up, 50% conduction, calculations, result etc.., 25% viva-voce.