| 21UPHC100/200 | Engineering Physics | (3-0-0) 3Credits |
|---|---|---|

**Contact Hours: 39, CIE: 50 Marks, SEE: 50 Marks, Exam Duration: 3 Hrs.**

**Course Learning Objectives (CLOs):**

Engineering Physics course is designed to deliver optimum knowledge of materials and energy concepts. Content explores the fundamental theories, experimental demonstrations and their applications in various engineering fields. Scope of the curriculum includes the study of special theory of relativity, quantum mechanics, electrical properties of materials and photonics.

**Course Outcomes (COs):**

| Description of the Course Outcome: At the end of the course the student will be able to: | | Mapping to POs (1,12) | | |
|---|---|---|---|---|
| | | Substantial Level (3) | Moderate Level (2) | Slight Level (1) |
| CO-1 | Explore the basics of theory of relativity and their significance in understanding material properties. | 2 | 1 | |
| CO-2 | Demonstrate the concept of dual natures of energy and matter, one-dimensional wave equation and its relevance in understanding quantum structures. | 1 | 2 | |
| CO-3 | Understand the electrical properties of metals and superconductors for engineering applications. | 1 | 2 | |
| CO-4 | Elaborate the behavior of material at nano-size and concept of semiconductors, which supports for their applications. | 1 | 2 | |
| CO-5 | Discuss the optical phenomena *vis a vis* interaction of radiation with matter, lasing action, and the basics of optical fibers and their applications. | 2 | 1 | |

| POs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mapping Level | 2.83 | 1.8 | | | | | | | | | | |

**Prerequisites:** Nil

## Contents:

**Unit I**

## Theory of Relativity

Classical theory of relativity- Frames of reference (Inertial and Non-inertial) and Galilean transformations. Michelson-Morley experiment, Postulates of Special theory of relativity, Lorentz transformations. Consequences of Lorentz transformations-length contraction, time dilation (twin paradox) and addition of velocities. Relativistic mass and mass- energy equivalence (qualitative).Numerical examples. **7 Hrs.**

**Unit II**

## Quantum Mechanics

Introduction to quantum mechanics, de-Broglie hypothesis, Davisson-Germer's experiment (demonstration).Concept of phase velocity, group velocity and particle velocity (qualitative).Relation between group velocity and particle velocity.Application of de-Broglie hypothesis. Heisenberg's uncertainty principle and applications. Wave function, properties and physical significance of a wave function. Probability density and normalization of wave function, setting up of 1-dimensional time independent Schrödinger wave equation. Applications of Schrödinger wave equation – (a) Energy Eigen values and (b) Eigen functions of a particle in a one-dimensional potential well of infinite height and free particle. Numerical examples. **8 Hrs.**

**Unit III**

## Quantum theory of Conductivity

**Conductors:** Review of classical free electron theory- Assumptions and failures. Quantum free electron theory (QFET) – assumptions, Distribution of electrons, Fermi level, Fermi energy, Fermi velocity, Fermi temperature, concept of density of states (in bulk), Fermi-Dirac statistics- Dependence of fermi factor and Occupation of density of states on temperature. Expression for electrical conductivity, success of QFET. Numerical examples.

**Superconductors:** Appearance of residual resistivity in typical metal – Concept of zero resistivity and superconductivity – critical temperature, persistent current, BCS theory. Meissner effect, Critical field, Soft and Hard superconductors, Applications.

**8 Hrs.**

**Unit IV**

## Materials Science

**Semiconductors :** Direct and indirect band gap semiconductors, Fermi level in semiconductor, carrier concentration and electrical conductivity in semiconductors (qualitative). Hall effect – determination of Hall voltage and Hall coefficient. Numerical examples.

**Nanomaterials :** Introduction, size dependent properties of nanomaterials, classification – based on electron confinement, variation of DOS. Syntheses of nanomaterials by top down and bottom up approaches (one example for each). Characterization techniques (qualitative).Carbon nanostructures-Graphene, fullerene and CNTs.Applications of nanomaterials- Super-capacitors, LED and Solarcells. **8 Hrs.**

**Unit V**

## Photonics

**Laser :** Basics of light amplification, Einstein's coefficients (expression for energy density), principle and operation of $CO_2$ and semiconductor diode laser. Applications - LIDAR, laser cooling, laser fusion.

**Optical Fiber :** Principles of optical fiber (total internal reflection), Angle of acceptance, Numerical aperture, Fractional Index change, V-number and Modes of propagation. Types of Optical fibers, Attenuation co-efficient and fiber losses (qualitative).Numerical examples.

**8 Hrs.**

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**Question Paper Pattern**:

1) Each question will carry 20 marks with maximum of four sub divisions.
2) Each unit will consists of two full questions
3) Students have to answer one full question from each unit and total five questions to be answered.
4) The question paper will have built in choice in the unit.

**Reference Books:**


1) Text book of Engineering Physics by Avadhanalu and Kshirasagar - S. Chand Publishers.
2) Modern Physics by Kenneth S. Krane, - 3rd Edition, John Wiley & Sons Publishers
3) Elementary Solid State Physics by M. Ali Omar - Addison-Wesley Publishers
4) Introduction to Nanotechnology by C. P. Poole - John Wiley & Sons Publishers