| Semester: I/II | | | |
|---|---|---|---|
| **Course Title** | Applied Physics for Electrical & Electronics Engineeering stream | **CIE Marks** | 50 |
| **Course Code** | BEEPHY102/202 | **SEE Marks** | 50 |
| **Course Type** | Integrated | **Total Marks** | 100 |
| **Course Category** | ASC | **SEE Duration** | 03 hrs |
| **Hours Per Week** | 2L: 2 T: 2P | **SEE Type** | Written |
| **Total Hours** | 40 hrs of theory + 18-20 hrs of practical sessions | **Credits** | 04 |

| **Course Learning Objectives** |
|---|
| This course will enable the students to |
| ● Understand the principles of Quantum Mechanics and electrical properties of solids. |
| ● Study the essentials of Laser and Optical Fiber for Engineering Applications. |
| ● Understand the fundamentals of Vector calculus and EM waves and Semiconductors devices. |
| ● Understand the Practical importance, precise measurements and analysis of the experimental results. |
| **Pre-Requisites** |
| • Properties of Light, Wave-Particle dualism, Classical Free Electron Theory, Characteristics of LASER, Basics of electrical conductivity, Total Internal Reflection, Electricity & Magnetism, Basics of Semiconductors. |

| **Module-1: Quantum Mechanics** | **(8 hrs)** |
|---|---|
| Introduction, de Broglie hypothesis, matter waves and their properties, de Broglie wavelength and derivation of expression by analogy. Heisenberg's Uncertainty Principle and its application (Non-existence of an electron inside the nucleus- non-relativistic). Wave Function, Physical Significance of a wave function and Born Interpretation. Time Independent Schrödinger wave equation (Derivation). Eigen functions and Eigen Values, Particle inside one-dimensional infinite potential well, Waveforms and Probabilities. Numerical Problems.<br>**Self-learning:** de Broglie Hypothesis | |
| **Module-2: Electrical Properties of Solids** | **(8 hrs)** |
| Introduction, Quantum Free Electron Theory of Metals: Assumptions, Fermi-energy, Fermi factor, Variation of Fermi Factor with Temperature and Energy. Mention of expression for Electrical Conductivity.<br>**Dielectric Properties:** Polar and non-polar dielectrics, Polarization and its mechanisms, Internal Fields in solids (Qualitative), Clausius-Mossotti equation (Derivation), Solid, Liquid and Gaseous dielectrics. Application of dielectrics (Qualitative) in Transformers, Capacitors, Electrical Insulation. Numerical Problems.<br>**Superconductivity:** Introduction, Matthiessen's rule, temperature dependence of Resistivity, Meissner Effect, Critical Field, Temperature dependence of Critical field, Types of Super Conductors, BCS theory (Qualitative), High Temperature superconductivity (Qualitative), Applications: MAGLEV vehicles, Numerical problems.<br>**Self-learning:** Dielectrics Basics | |
| **Module-3: Lasers and Optical Fibers** | **(8hrs)** |
| **Lasers:** Interaction of Radiation with Matter, Expression for Energy Density of radiation. Requisites of a Laser System. Conditions for Laser action. Construction and Working of He-Ne Laser. Applications: Laser range finder and Laser Printer. Numerical Problems. | |

**Optical Fiber**: Principle and Structure, Propagation of Light, Acceptance angle and Numerical Aperture (Derivation). V-number, Modes of Propagation, fractional index change, Classification of Optical Fibers, Attenuation and its mechanisms. Applications: Point to Point communication - merits and demerits, Intensity-based Fiber Optic displacement Sensor, Numerical Problems.
**Self-learning:** Total Internal Reflection

| **Module-4: Maxwell's Equations and EM Waves** | **(8 hrs)** |
|---|---|

**Fundamentals of Vector Calculus:** Divergence and Curl of Electric field and Magnetic field (static), Gauss' divergence theorem and Stoke's theorem. Description of laws of Electrostatics, Magnetism, Faraday's laws of EMI, Current Density, Equation of Continuity, Displacement Current (with derivation), Maxwell's equations in Vacuum. EM Waves and its properties, wave equation in differential form in Free Space (Derivation of the equation using Maxwell's equations) Numerical Problems.
**Self-learning:** Fundamentals of vector calculus.

| **Module-5: Semiconductors and Devices** | **(8 hrs)** |
|---|---|

Introduction, Expression for the concentration of electrons in Conduction Band & Holes concentration in Valance band (mention the expression). Relation between Fermi Energy & Energy Gap in intrinsic Semiconductors (Qualitative). Fermi level in Intrinsic & Extrinsic Semiconductor, Law of Mass action, Electrical Conductivity of a Intrinsic Semiconductor (derivation), Hall Effect, Expression for Hall Coefficient (derivation) and its application. Construction and working of semiconductor laser and Photo diode-Power Responsivity, Numerical problems.
**Self-learning:** Fermi level in Intrinsic & Extrinsic Semiconductor

**Practical Components**

**Experiments are categorized into 1. Exercise 2. Open ended 3. Demonstration.**

Any ***Ten*** Experiments to be conducted by selecting ***six*** experiments from ***Exercise***, ***two*** from ***Open ended*** & ***two*** from ***Demonstration***

| **Sl. No.** | **Experiments for Conduction/Exercise** |
|---|---|
| 1. | Determination of wavelength of LASER using Diffraction Grating. |
| 2. | Determination of acceptance angle and numerical aperture of the given Optical Fiber. |
| 3. | Determination of Magnetic Flux Density at any point along the axis of a circular coil. |
| 4. | Determination of Fermi Energy of Copper. |
| 5. | Determination of dielectric constant of the material of capacitor by Charging and Discharging method. |
| 6. | Study the Characteristics of a Photo-Diode and to determine the power responsivity / Verification of Inverse Square Law of Intensity of Light |
| 7. | Determination of Energy gap of the given Semiconductor. |
| 8. | Determination of Planck's constant |
| | **Open Ended Experiments** |
| 9. | Identification of circuit elements in a Black Box and determination of values of the components. |
| 10. | Study of motion using spread Sheets |
| 11. | Study the I-V Characteristics of the Given Bipolar Junction Transistor. |
| 12. | Step Interactive Physical Simulations |
| | **Demonstration Experiments** |
| 13. | Study the frequency response of Series & Parallel LCR circuits |
| 14. | Study of Application of Statistics using spread sheets |
| 15. | Determination of resistivity of a semiconductor by Four Probe Method |
| 16. | PHET Interactive |

| Text Books: | |
|---|---|
| 1. | "Engineering Physics" by S.P. Basavaraj Edition, Subhash Stores, 2005. |
| 2. | "A Textbook of Engineering Physics" by M N Avadhanulu and P G Kshirsagar, 10th revised Edition, S. Chand. & Company Ltd, New Delhi. |
| 3. | "Engineering Physics" by R K Gaur and S. L Gupta, Dhanpat Rai Publications, 2017. |
| 4. | "Solid State Physics" by S O Pillai, New Age International Private Limited, 8th Edition, 2018 |
| **Reference Books:** | |
| 1. | "Concepts of Modern Physics" by Arthur Beiser, 6th Edition, Tata McGraw Hill Edu Pvt Ltd-New Delhi, 2006 |
| 2. | "An Introduction to Quantum Physics" by French, A. P. and Taylor, Edwin, W. W. Norton & Company, 1978. |
| 3. | "Lasers and Non-Linear Optics" by B. B. Laud, 3rd Edition, New Age International Publishers, 2011. |
| 4. | "Fundamentals of Fibre Optics in Telecommunication & Sensor Systems" by B. P. Pal, 2nd Edition, New Age International Publishers |
| 5. | "Introduction to Electrodynamics", by D. Griffith, 4th Edition, Cambridge University Press, 2017 |

| **Course Outcome Statements:** After the successful completion of the course, the student will be able to | |
|---|---|
| **CO1** | Describe the Quantum Mechanics, Electrical Properties of materials, Laser, Optical Fibers, Maxwell Equations, EM waves, semiconductor and devices. |
| **CO2** | Apply the concepts of Quantum Mechanics, Electrical Properties of materials, Laser, Optical Fibers, Maxwell Equations, EM waves, semiconductor and devices in Engineering applications. |
| **CO3** | Analyze the optical, Electrical Properties of materials, Maxwell Equations, EM waves, semiconductors and devices in Engineering applications by Solving Numerical. |
| **CO4** | Determine and interpret the physical properties of the materials & devices by conducting the experiments. |

**Course Articulation Matrix**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | - | - | - | - | - | - | - | - | - | 1 |
| **CO2** | - | 2 | - | - | - | - | - | - | - | - | - | 1 |
| **CO3** | - | 2 | - | - | - | - | - | - | - | - | - | 1 |
| **CO4** | - | 2 | 1 | - | 1 | - | - | 1 | 1 | - | - | 1 |
| **Avg.** | 3 | 2 | 1 | - | 1 | - | - | 1 | 1 | - | - | 1 |

**3: High, 2: Medium, 1: Low**