Physics for CSE- Stream - SIMP 2025 TIE

Module 1: Lasers and Optical Fibers

1. Define LASER and discuss the interaction of radiation with matter.
2. Derive an expression for Energy density in terms of Einstein's coefficients.
3. Illustrate the construction and working of a Semiconductor LASER with a neat sketch and energy level diagram. Also, mention its applications.
4. Discuss the applications of LASER in bar-code scanners and LASER Cooling.
5. Define Acceptance angle and Numerical Aperture and hence derive an expression for NA in terms of RI of core, cladding, and surrounding.
6. Discuss the types of optical fibers based on Modes of Propagation and RI profile.
7. Describe attenuation and explain the various fiber losses.
8. Discuss Point to Point communication using optical fibers.

Module 2: Quantum Mechanics

1. Set up the Schrödinger time-independent wave equation in one dimension.
2. Discuss the motion of a quantum particle in a one-dimensional infinite potential well of width 'a' and also obtain the eigenfunctions and energy eigenstates.
3. State and Explain Heisenberg's Uncertainty principle and hence show that electrons do not exist inside the nucleus using Heisenberg's uncertainty principle.
4. Derive an expression for the de Broglie wavelength by analogy and hence discuss the significance of de Broglie waves.
5. State and Explain Heisenberg's Uncertainty principle and the Principle of Complementarity.
6. Explain the Wave function with mathematical form and discuss the physical significance of a wave function.
7. Define Wave packet and Group Velocity.
8. Discuss the physical significance of a wave function.

Module 3: Quantum Computing

1. Define a bit, qubit and explain the properties of qubit. Also, explain the representation of qubit using the Bloch Sphere.
2. Discuss the CNOT gate and its operation on four different input states.
3. State the Pauli matrices and apply Pauli matrices on the states $|0\rangle$ and $|1\rangle$.
4. Elucidate the differences between classical and quantum computing.
5. Describe the working of the controlled-Z gate mentioning its matrix representation and truth-table.
6. Discuss the working of the phase gate mentioning its matrix representation and truth table.
7. Explain Orthogonality and Orthonormality with an example for each.
8. Explain Single qubit gate and multiple qubit gates with an example for each.

Module 4: Electrical Properties of Materials and Applications

1. Define Fermi Factor and discuss the variation of the Fermi factor with temperature and energy.
2. Enumerate the failures of classical free electron theory and assumptions of the quantum free electron theory of metals.
3. Describe Meissner's Effect with variation of critical field with temperature and hence classify superconductors into Soft (Type-1) and Hard (Type-2) superconductors using M-H graphs.
4. Explain the phenomenon of superconductivity and discuss qualitatively the BCS theory of

superconductivity for negligible resistance of metal at temperatures close to absolute zero.

5. Explain DC and AC Josephson effects and mention the applications of superconductivity in quantum computing.
6. Give the qualitative explanation of RF Squid with the help of a neat sketch.
7. Discuss the effect of temperature and impurity on the electrical resistivity of conductors and hence explain for superconductors.
8. Explain the difference between Type-I and Type-II superconductors.

Module 5: Physics of Animation and Statistical Physics

1. Discuss timing in linear motion, Uniform motion, slow in and slow out. OR Sketch and explain the motion graphs for linear, easy ease, easy ease in and easy ease out cases of animation.
2. Elucidate the importance of size and scale, weight and strength in animations.
3. Illustrate the odd rule and odd rule multipliers with a suitable example.
4. Describe Jumping and parts of the jump.
5. Describe the calculation of Push time and stop time with examples.
6. Discuss modeling the probability for proton decay.
7. Discuss the salient features of Normal distribution using bell curves.
8. Distinguish between descriptive and inferential statistics.