



KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS TREATED AS EXAM MALPRACTICE

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. Derive one dimensional transverse wave equation in a string. Show that the ratio of tension and linear mass density is dimensionally equivalent to square of the velocity.
2. a) What is a harmonic wave? Prove that the displacement $y = Ae^{i(kx-wt)}$ is a solution to wave equation. [5]
b) A uniform string of length 2.5 m and mass of 0.01 kg is placed under a tension of 10 N. What is the fundamental mode of frequency? If the string is plucked transversely and touched at a point 0.5 m from one end, what frequency will survive? [5]
3. Derive wave equations of electric and magnetic fields of a plane EM wave. Show that in free space, the velocity of these fields is equal to the velocity of light.
4. State the initial considerations of Schrodinger in the formulation of the celebrated wave-mechanics of matter waves. From these, derive the time-dependent Schrodinger's wave equation.
5. a) List down the properties of a wavefunction that is associated with a subatomic particle. [5]
b) The wavefunction for a quantum particle of mass 'm' confined to move in the domain $0 \leq x \leq L$ is given by: [5]
$$\psi(x) = N \sin\left(\frac{4\pi x}{L}\right)$$

where N is the normalization factor. Normalize the given wavefunction.
6. Explain the concept of quantum tunnelling. Further, describe in detail one application of this phenomena to study topography of materials.
7. Derive the expressions for energy eigen function and eigen value of an electron confined in an infinite potential box. Draw the relevant diagrams of energy levels, wavefunctions and probabilities of this electron.
8. Why two-level energy system is not suitable for laser? Write down the basic properties of the Nd: YAG laser with proper energy level diagram. Further, explain the lasing mechanism of it. [2+8]
9. a) Define and establish the relationships between Einsteins A and B coefficients. [5]
b) A 3-level laser emits laser light 5500 Å. In the absence of pumping, what will be the equilibrium ratio of the population of the upper level to that of lower level at 300K? [5]
10. With the help of geometrical optics, draw and describe the light propagation in an optical fiber and obtain a relation for the light gathering capacity and acceptance angle of an optical fiber.

11. a) With the help of a diagram, state the differences between a step-index fiber and graded index fiber. [5]
- b) An optical fiber with a diameter of $70\ \mu\text{m}$ with core refractive index of 1.46 is used for communication. If the relative refractive index difference is 1.5%, find the V-number of the fiber; and state which kind of fiber is it? It operates at the wavelength of 850nm. [5]
12. Differentiate between direct and indirect bandgap semiconductor with appropriate figures. Furthermore, with proper schematic, discuss the working principle of a light emitting diode (LED).

