VIT
Vellore Institute of Technology

Final Assessment Test – November/December 2023

Course: BPHY101L - Engineering Physics

Time: Three Hours | Max. Marks: 100

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

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. With a suitable diagram and proper assumptions, derive the expression for the wave equation of a one-dimensional mechanical wave propagating on a string under constant tension T. Obtain the expression for velocity of the wave. [10]

2. a) Write the transmission and reflection coefficient of the wave at the boundary of two strings of different linear mass densities. Show that a transverse wave on a string suffers a phase shift of 180° after reflection from a rigid wall. [5]

   b) A string of length 400 cm vibrates with a 240 Hz standing wave. If there are nodes at every 50 cm of the string, then what is the eight harmonic of vibration and the string's fundamental frequency? [5]

3. Describe briefly the differential forms of four Maxwell's equations of electromagnetic waves in free space. Using the same, obtain magnetic field wave equation and show that electromagnetic waves travel at the speed of light in vacuum. [10]

4. What is a well-behaved wave function? Discuss the physical significance of wave function. Obtain the steady state form of wave equation for a particle in quantum mechanics. [10]

5. a) Briefly explain ultraviolet (UV) catastrophe and discuss how Planck's hypothesis resolved the UV catastrophe? [5]

   b) A bowler delivers a 0.1 kg cricket ball at 40 m/s. Suppose the momentum is measured with an accuracy of 1 percent. Find the uncertainty associated with the measured position. [5]

6. a) Mention briefly about quantum confinement. Classify the materials based on the same with proper diagrams. [5]

   b) For an electron confined to a one-dimensional infinite potential well of width 3 Å, calculate the energy (in eV) required for it to jump from its ground state to its second excited state. [5]

7. Obtain the expression for eigen function of a particle confined to a potential well of length L. Show that the particle has wider energy levels towards higher quantum states. Draw the probability distribution of the particle in the first three energy levels. [10]

8. Obtain Einstein's relations and show that the ratio of spontaneous emission rate to stimulated emission rate in a laser at temperature T is given by $e^{\frac{h\nu}{k_B T}} - 1$. [10]

9. a) With a neat diagram, explain the role of optical resonator in a laser. [5]

   b) Compute the relative population with respect to ground state at 250 K and 1000 K. Assume the wavelength of light as 632.8 nm. Comment on the population inversion mechanism related to temperature. [5]

10. Briefly discuss the different types of dispersion in an optical fiber. Calculate the pulse spreading due to intermodal dispersion in the case of a step index multi-mode fiber. [10]

11. a) List out the advantages of fiber optic cable over conventional cables. What is the reason for a high bandwidth of the signals carried through the optical fiber? [5]

    b) For a step index fibre having core index 1.43 and cladding index 1.4, calculate critical angle, acceptance angle and numerical aperture. [5]

12. Differentiate direct and indirect bandgap semiconductors with E-k diagram. Explain the construction and working principle of an LED. Justify why we need a direct band gap semiconductor for making LEDs. [10]

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