J/L/TX

Reg. No: 24BEE0230.

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: **BPHY101L - Engineering Physics**

Time: **Three Hours** Max. Marks: **100**

- **KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Derive the wave equation by considering the motion of transverse waves on a string with linear mass density, ρ, and uniform tension, T.

2. Starting from the appropriate Maxwell's equations, derive the electromagnetic wave equations both for the electric and magnetic fields and compare them with the classical wave equation. What is the important information that stems of this comparison?

3. What is Schroedinger's equation and what is its importance? Obtain Schroedinger's time dependent and independent equations.

4. Obtain the expressions for the eigenvalue as well as eigenfunction for a particle that is confined in a one-dimensional box of finite width and infinite height. Sketch the wave function as well as probability density for the first three energy levels and interpret the results.

5. Explain the construction of a CO_2 laser and with the help of energy level diagram, explain the lasing action. What is the role of nitrogen in the CO_2 laser?

6. What does 'dispersion' mean in optical fibers? Classify various types of dispersion and explain each of them. Compute intermodal dispersion in a step-index fiber.

7. Is the principle behind light emission in an LED similar to that of a laser diode? Comment. Discuss the construction and working of a laser diode with its energy band diagrams.

8. a) It is known that He-Ne lasers lase at 632.8 nm. If one wishes to increase the population of the upper level by raising the temperature, at what temperature will the ratio be ½? **[5]**

   b) How does the spectral width of a laser light compare to that of a conventional light source? Which of the characteristics of laser light is related to spectral width? Calculate the intensity of a laser beam of diameter, 1 mm, with an output power of 10 mW. **[5]**

9.a) i) A free electron has a wavefunction, $\psi(x) = A\,sin\,(5 \times 10^{10}x)$, where x is measured in meters. Find the electron's (a) de Broglie wavelength, (b) momentum, and (c) energy in electron volts. **[5]**

ii) A 100-gram tennis ball moving at 10 m/s along the x-axis is confined to a room 15 m on a side. Show that the spread of velocities caused by the uncertainty principle does not have measurable consequences. **[5]**

[OR]

9.b) i) In a semiconductor device, electrons that are accelerated through a potential of 5 V attempt to tunnel through a barrier of width 0.8 nm and height, 10 V. Compute the transmission probability. [5]

ii) What is your understanding about *quantum-size effect*? Compute surface to volume ratio for a spherical particle of diameter, 1 mm as well as for a nanoparticle of diameter, 1nm. What is your inference upon the comparison? [5]

10.a) i) An input optical power of 10 mW is propagating through an optical fiber of length, 500 m. The output light power is measured to be 2 mW. Compute the attenuation of the fiber in dB/km. [5]

ii) Calculate the critical angle, numerical aperture and the acceptance angle of a fiber with a core refractive index of 1.5 and cladding refractive index of 1.45. [5]

[OR]

10.b) i) The radius of an active light receiving region of a photodiode is specified as 0.02 cm. When a light of intensity, 0.1 mW/cm^2, is incident on it, the photocurrent generated is 56.6 nA. Calculate the responsivity. [5]

ii) A silicon photodiode has a quantum efficiency of 65 percent at a wavelength of 900 nm. Calculate the photocurrent produced if the input optical power is $0.5\ \mu W$. What would be quantum efficiency of an ideal photodiode? [5]

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