VIT
Vellore Institute of Technology

Final Assessment Test – Jan/Feb 20

Course: BPHY101L - Engineering Physics

Class NBR(s): 5663 / 5675 / 5683 / 5707

Time: Three Hours

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

General Instructions : Only basic scientific calculator is allowed.

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. Consider a string having mass (m) and tension (T), making oscillations with displacement y(x,t) normal to the direction of propagation. Derive a wave equation that represents the velocity of the wave depending on the tension in the string.

2. a) Are standing waves always quantized? Explain with the help of proper formulation. [5]

   b) An Ethernet cable is 4.00 m long. The cable has a mass of 0.200 kg. A transverse pulse is produced by plucking one end of the cable. The pulse makes four round trips back and forth along the cable in 0.800 s. What is the tension in the cable? [5]

3. Derive the differential form of Maxwell's equations from its integral form for Faraday's law. Then prove that the Electromagnetic waves travel with the speed of light in free space. [4+6]

4. Discuss the conditions for a valid wave function of a matter wave and it's significance. With proper reasoning comment if the given wave functions are valid or not as a matter wave. [5+1+2+2]

   (i) $\Psi(x) = tan\,(x), -\pi/2 \leq x \leq \pi/2$, and

   (ii) $\Psi(x) = \sqrt{1/2}\, e^{-x}$, $-\infty \leq x \leq \infty$.

5. a) Discuss the drawbacks of the classical wave theory explaining the results observed in black body radiation and Compton scattering. [5]

   b) The wave function of certain particle is $\Psi(x) = Acos^2(x)$, for $-\pi/2 \leq x \leq \pi/2$. Determine the value of A which normalizes $\Psi(x)$. [5]

6. With the help of suitable diagrams explain the working principle of scanning tunneling microscope. Furthermore, considering quantum size effect, explain in detail how materials are classified. [5+5]

7. Derive the energy eigen values and eigen functions for a particle in a one-dimensional infinite potential well using appropriate Schrodinger equations. Plot the neat energy level diagrams for first two levels.

8. Discuss the construction and working principle of solid-state laser with suitable energy diagram and its applications.

9. a) From the Einstein's theory, find out the ratio between the rates of stimulated emission to spontaneous emission. Why is it easier to obtain lasing action in the infra-red (IR) region than in the ultraviolet (UV) region? [3+2]

   b) Calculate the value of threshold gain coefficient for a laser with the following data: Cavity length = 100 μm, loss coefficient = 40/cm, reflectivity of the mirrors is 0.5 and 0.35, respectively. [5]

10. What do you mean by dispersion? Derive a relation how much intermodal dispersion occurs when the light propagates through an optical fibre. With the necessary diagrams state how these problems can be eliminated. [2+6+2]

11. a) Give the classification of optical fibers based on the refractive index profiles. [5]

b) A fibre has the following characteristics: core index 1.35 and fractional change 2%. Find the NA and the acceptance angle. If the fibre is kept into the liquid with refractive index 1.5, what will be the NA and acceptance angle? [2+3]

12. Describe the construction and explain the working principal of PIN diode using band energy diagram. Why is it different from normal photo diodes? [6+4]

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