VIT
Vellore Institute of Technology

Final Assessment Test – April 2019

Course: PHY1701 - Engineering Physics

Class NBR(s): 4287 / 4289 / 4300 / 4301 / 4303 / 4309 /5948

Slot: C2+TC2

Time: Three Hours

Max. Marks: 100

General Instructions :

1. Graph sheet may be provided.
2. Draw diagrams wherever necessary.
3. Be precise in answering the questions.

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. Explain Compton scattering (do not derive Compton shift formula) with a schematic. How does Compton shift vary with the scattering angle of photon? Explain. In Compton scattering experiment, how much would be the maximum Compton shift, if the electron is replaced with a neutron (neutron is ≈2000 times heavier than electron)? **[10]**

2. a) Find the de Broglie wavelength of a ball of mass 0.20 kg just before it strikes the earth after being dropped from a building 50 m tall. **[5]**

   b) Set up steady state form of Schrodinger's equation from time dependent form without using classical wave equation. **[5]**

3. a) A bead of mass 5.00 g slides freely on a wire 20.0 cm long. Treating this system as a particle in one-dimensional box, calculate the value of '*n*' corresponding to the state of the bead if it is moving at a speed of 0.100 nm per year (that is apparently at rest). **[5]**

   b) Using wave aspect of the moving material particle, prove that the energy of a particle (say electron) trapped in one dimensional box is quantized. **[5]**

4. Classify nano materials based on geometrical dimensions with examples. Draw schematic for each class. Plot to show, how density of states varies with energy in each class. **[10]**

5. Explain with a diagram, how does light amplification occur in a laser? What is threshold gain? Derive expression for gain coefficient for a longitudinal cavity of length, L and attenuation, α. Use R_1 and R_2 as the reflection coefficients of the two mirrors. **[10]**

6. Establish a relation between Einstein's A and B coefficients and explain, when can stimulated emission predominate over spontaneous emission and vice-versa? **[10]**

7. a) Write down the Maxwell's equations in both integral and differential forms for a lossy dielectric medium. **[4]**

   b) Derive the electromagnetic wave equation (in terms of electric field, E) for a good conductor of conductivity, σ, permittivity, ε and permeability, μ. **[6]**

8. The electric field in free space is given by $E = 50\cos(10^8 t + \beta x)\hat{y}$ V/m **[10]**

   (i) Find the directions of wave propagation and the magnetic field.

   (ii) Calculate β and the time it takes to travel a distance of $\lambda/2$.

   (iii) Sketch the wave at $t = 0$, $T/4$, and $T/2$ (use a graph paper).

9. a) How does endoscopy employ optical fibers? Explain with a schematic. **[4]**

   b) List different kinds of losses occurring in optical fibers. Explain modal dispersion in multimode step index fibers in detail. **[6]**

10. With neat, well- labelled schematic and energy band diagram, explain construction, principle and working of a diode laser. **[10]**

11. State Einstein's postulates of special theory of relativity and hence derive Lorentz transformation equations. In which condition, Lorentz transformation equations reduce to Galilean transformation equations? **[10]**

12. In an inertial frame S, a red light and a blue light are separated by a distance $\Delta x = 2.45$ km. First, the blue light flashes and after 5.35μs, the red light flashes. The frame S′ is moving with a uniform velocity $u = 0.855c$ along x-axis with respect to frame S. What is the separation between the two flashes and the time elapsed between them as measured in frame S′. **[10]**

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