

Mid-Sem Exam-2 (PHY201)

Date: 10-10-18, Duration: 1Hr, Maximum Marks: 20

Q-1: Write down the wave equation for E-field of light. What determines the speed of light in vacuum.

- (a) For an amplitude of the electric field, E_0 & angular frequency, ω , construct a solution of the wave equation describing Right Circularly Polarized (RCP) light.
- (b) Sketch how \vec{E} vector propagates in space & time for RCP. Indicate time period & wavelength.
- (c) Show that mixing Left and Right circularly polarized light of equal amplitudes and frequency generates a Linearly polarized light. (1+1+2+1)

Q-2: Write down two solutions of transverse waves on a string having wavelengths λ_1 and λ_2 travelling in the +z direction with the same speed v . The transverse oscillations are along y direction and both have equal amplitudes A_0 .

- (a) Show that a linear superposition of these two waves would produce beats in space and in time. Calculate beat period in space and in time. How are these two beat periods related?
- (b) Plot the snapshot of the beat-wave in space at a given time. What would happen to spatial beat period if:
(i) $\lambda_1 = \lambda_2$ and (ii) $\lambda_1 \gg \lambda_2$
- (c) What would happen to the beat phenomenon, if the transverse oscillations for λ_1 is along x-direction and for λ_2 is along y-direction. Argue briefly. (1+1+2+1)

Q-3: A string with tension T and mass per unit length μ is clamped down at $x=0$ and $x=L$. At $t=0$, the string is at rest and its displacement in the y-direction is given by:

$$y(x, 0) = 9 \sin\left(\frac{3\pi x}{L}\right) + 4 \sin\left(\frac{2\pi x}{L}\right) + \sin\left(\frac{\pi x}{L}\right)$$

- (a) What is the total energy at $t=0$? (The string is released at $t=0$ and it starts to oscillate.)
- (b) What is the displacement at a later time t ?
- (c) At what time t will the string, for the first time, have exactly the same shape as at $t=0$? Or, will this never happen. Give brief reason. (2+2+1)

Q-4: The B field of a certain electromagnetic wave is given by, $B(x, y, z, t) = B_0 \sin(\omega t - kz) \hat{x}$

- (a) Plot the directions of \vec{E} , \vec{B} , and \vec{k} vectors for this wave in a right handed coordinate system.
- (b) A single-turn rectangular wire-loop having two sides of lengths λ and $\lambda/2$ is used to pick up signals from the wave by detecting the induced voltage V appearing between two ends. What is the maximum possible value of amplitude V_0 ?
- (c) How the loop should be oriented to obtain the maximum induced voltage? (1+2+2)