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. 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) $\lambda_1 >> \lambda_2$

(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, $\boldsymbol{B(x,y,z,t) = B_0 \sin(\omega t - kz)\hat{x}}$

(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 side 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)*