Quizzes and short questions QUANTUM ELECTRONICS

by K Thyagarajan, Physics Department, IIT Delhi, New Delhi.

Module 1: Quizzes and short questions:

1. Q: A plane wave propagates along a direction given by

$$\hat{\kappa} = \frac{\sqrt{3}}{2}\hat{x} + \frac{1}{2}\hat{z}$$

In a uniaxial medium with n_o = 2.3 and n_e = 2.2. What is the angle made by the $\vec{S}$ of the extraordinary wave with the *z*-axis (optic axis)?

2. Q: Consider a medium with n_x = 1.56, n_y = 1.59 and n_z = 1.60. A circularly polarized plane wave propagates in this medium with its propagation vector in the *x*-*z* plane. At what angle with respect to *x*-axis should the wave propagate so that its polarization state does not change with propagation?

Answers of module 1 *Quizzes and short questions*:

A1: A: From the given value of $\hat{\kappa}$ we know that the propagation vector makes an angle of 60° with the *z*-axis. Since $\vec{D}$ is perpendicular to $\hat{\kappa}$ it makes an angle of 30° with respect to the *z*-axis. Using the following relations

$$D_x = \varepsilon_0 n_o^2 E_x$$

And

$$D_z = \varepsilon_0 n_e^2 E_z$$

We can obtain the ratio of E_z to E_x and hence the angle made by the $\vec{E}$ with the z-axis which comes out to be 27.84°.

A2: From the given value of $\hat{\kappa}$ we know that the propagation vector makes an angle of 60° with the *z*-axis. Since $\vec{D}$ is perpendicular to $\hat{\kappa}$ it makes an angle of 30° with respect to the *z*-The propagation must be in the x-z plane so that the two eigen modes may have the same speed. Thus the angle of propagation with the z-axis must satisfy the following equation:

$$\frac{1}{n^2(\psi)} = \frac{cos^2\psi}{n_x^2} + \frac{sin^2\psi}{n_z^2} = \frac{1}{n_y^2}$$

Solving for ψ we get ψ = 60.47°.