OE Devices Hw 8 2019 spring

1. linear polarized plane wave : $\vec{E} = E_o e^{jkz} \hat{a}_x$

RCP polarized wave: $A_R e^{-jkz}(\hat{a}_x - e^{j\frac{\pi}{2}} \hat{a}_y)$

LCP 〃 : $A_L e^{-jkz}(\hat{a}_x + e^{j\frac{\pi}{2}} \hat{a}_y)$

$$\vec{E}_R + \vec{E}_L = (A_R + A_L) e^{-jkz} \hat{a}_x + (A_L - A_R) e^{-jkz} \cdot e^{j\frac{\pi}{2}} \hat{a}_y$$

$A_R + A_L = E_o$, $A_L - A_R = 0$; $A_L = A_R = \frac{1}{2} E_o$

2. $\vec{F}_1 = 3\hat{a}_x \cos wt - 4\hat{a}_z \cos wt$

$\begin{cases} \gamma_x = 3 , \phi_x = 0 \\ \gamma_z = -4 , \phi_z = 0 \end{cases} \Rightarrow \gamma = \frac{-4}{3} , \Delta\phi = 0 \Rightarrow$ linearly polarization ※

$\vec{F}_2 = 5\hat{a}_y \cos wt \Rightarrow \gamma = 0$ or ∞ $\Delta\phi = 0 \Rightarrow$ linearly polarization ※

$\vec{F}_1 + \vec{F}_2 = 3\hat{a}_x \cos wt - 4\hat{a}_z \cos wt + 5\hat{a}_y \cos wt$

$\begin{cases} \gamma_x = 3 , \phi_x = 0 \\ \gamma_y = 5 , \phi_y = 0 \\ \gamma_z = -4 , \phi_z = 0 \end{cases} \Rightarrow \begin{cases} \gamma_{xz} = 5 & \phi_{xz} = 0 \\ \gamma_y = 5 & \phi_y = 0 \end{cases} \Rightarrow \gamma = 1 , \Delta\phi = 0$ linearly polarization.

3. $\vec{F} = \cos(wt + 60°)\hat{a}_x + \cos(wt + \alpha)\hat{a}_y$

$\Rightarrow \begin{cases} \gamma_x = 1 , \phi_x = 60° \\ \gamma_y = 1 \quad \phi_y = \alpha° \end{cases} \Rightarrow \gamma = 1 \quad \Delta\phi = (\alpha - 60)°$

(a) For linearly polarization and lying in second and forth quadrants:

$\Delta\phi = 180° \Rightarrow \alpha = 240°$ #

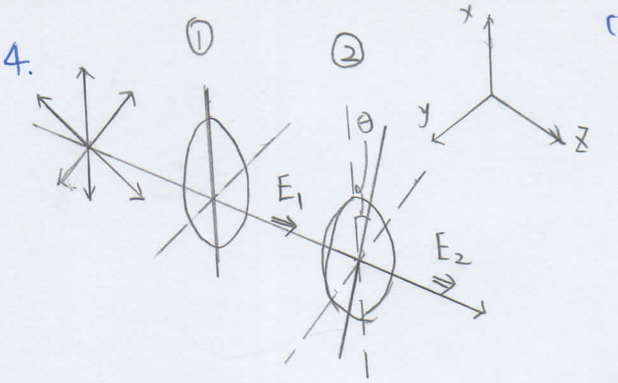
(b) For circular polarization $\Delta\phi = \pm 90°$

For $+X$ direction toward $+y$ direction

$\Rightarrow$ cos should lie in the first and forth quadrants.

$\Delta\phi = -90° = 270° \Rightarrow \alpha = 330°$

4.



(a)

①

$$E_1 = E_0 e^{j(\omega t - kz)} \hat{a}_x$$

②

$$E_2 = E_1 \cos\theta = E_0 e^{j(\omega t - kz)} \times \cos\theta \ \hat{a}_x$$

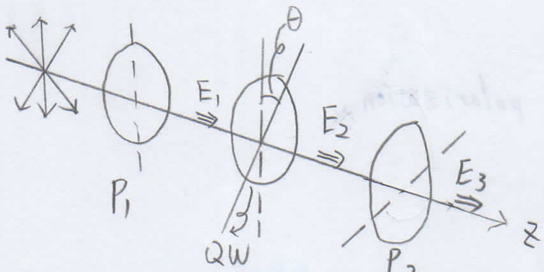
$$\therefore T = \left|\frac{E_2}{E_0}\right|^2 = \left(\frac{E_0 \cos\theta}{E_0}\right)^2 = \cos^2\theta$$

(b) For $T = 70\% = 0.7 \Rightarrow \cos^2\theta = 0.7 \Rightarrow \theta = 33.21$ ※

$T = 0.2 \Rightarrow \cos^2\theta = 0.2 \Rightarrow \theta = 63.435$ ※

5.

For quater-wave plate



Assume the angle between the polarization of E_1 and the fast axis is θ

$\theta = 0 \Rightarrow E_2$ remains linear polarization $\Rightarrow I_3 = 0$

$0 < \theta < 45 \Rightarrow E_2$ is an elliptical $\Rightarrow I_{3,\theta=0} < I_{3,0<\theta<45°} < I_{3,\theta=45°}$

$\theta = 45° \Rightarrow E_2$ is circular polarization $\Rightarrow I_{3,\theta=45}$ is maximum $= \frac{1}{2} I_1$

For half-wave plate

Polarization of E_1 will rotate 2θ after passing through half-wave plate

$\Rightarrow I_3 = I_1 \cos^2(90° - 2\theta)$

I_3 reacher maximum when $\theta = 45°$ ※