Engineering Optics

Lecture 20

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Problem-1

If E_x and E_y represent the x and y components of the resultant field $\mathbf{E}\,(=\mathbf{E}_1+\mathbf{E}_2)$, then

$$E_x = a_1 \cos \omega t$$

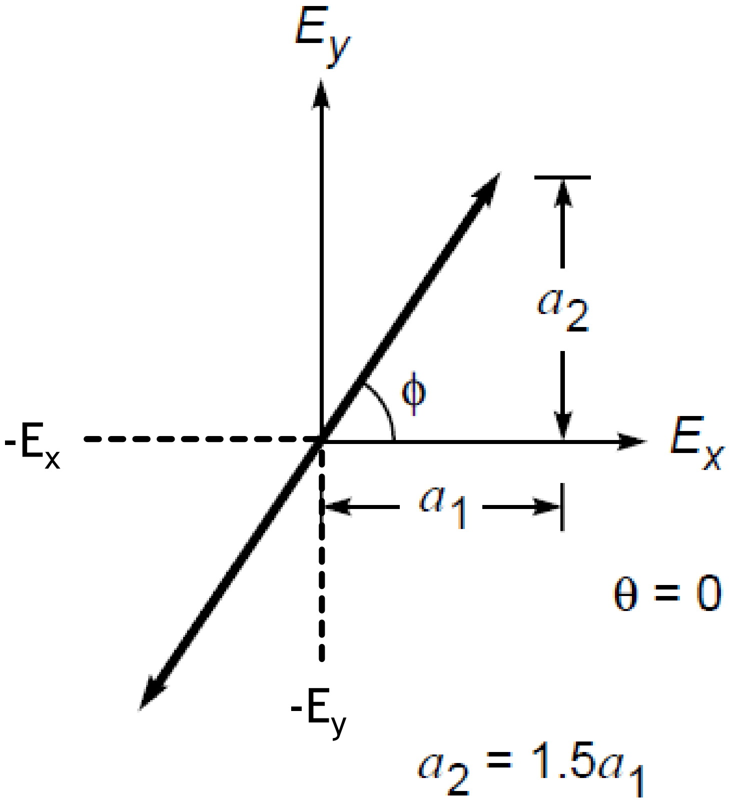
and $$E_y = a_2 \cos(\omega t - \theta)$$

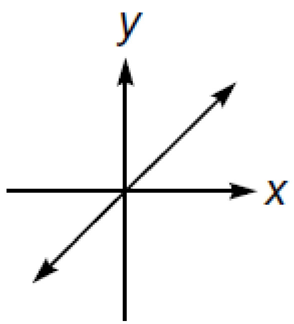
$$\theta = n\pi$$

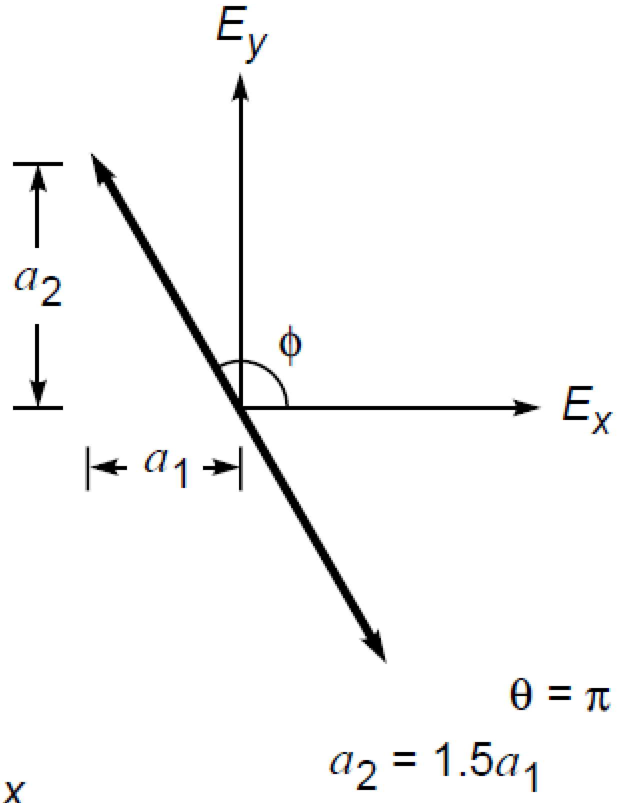
State of polarization for (i) $\theta = 0$ and $a_2 = 1.5\ a_1$ (ii) $\theta = \pi$ and $a_2 = 1.5\ a_1$

Case – 2: Examples

$\theta = n\pi$







Optics, Ghatak

What if θ = π/2 ?

Now θ = π/2

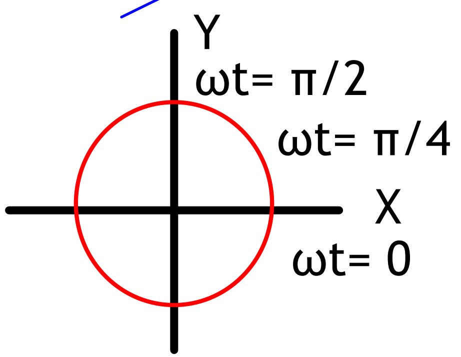
$$\boxed{\begin{aligned} E_x &= a_1 \cos \omega t \\ E_y &= a_2 \cos(\omega t - \theta) \end{aligned}}$$

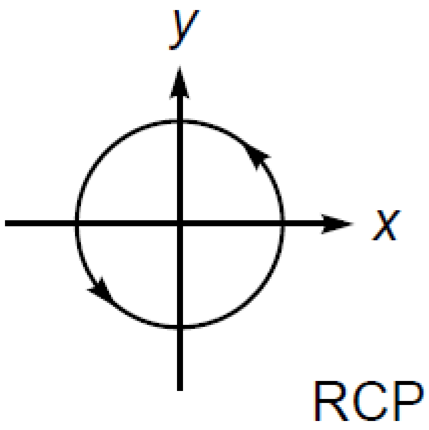
Q: Condition to get LCP light?

$$E_x = a_1 \cos \omega t$$

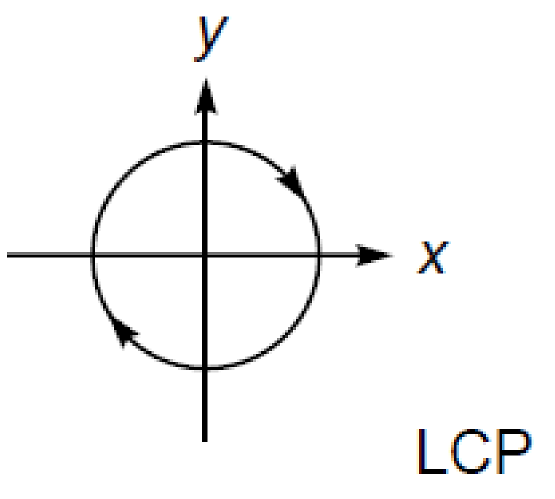
$$E_y = a_1 \sin \omega t$$

tip of the electric vector rotates on the circumference of a circle (of radius a_1) in the counterclockwise direction





θ = π/2



Q: What if a1 ≠ a2 ??

Optics, Ghatak

Problem:2

Discuss the state of polarization when the *x* and *y* components
of the electric field are given by the following equations:

(a) $E_x = E_0 \cos(\omega t + kz)$

$$E_y = \frac{1}{\sqrt{2}} E_0 \cos(\omega t + kz + \pi)$$

(b) $E_x = E_0 \sin(\omega t + kz)$

$$E_y = E_0 \cos(\omega t + kz)$$

(c) $E_x = E_0 \sin\left(kz - \omega t + \frac{\pi}{3}\right)$

$$E_y = E_0 \sin\left(kz - \omega t - \frac{\pi}{6}\right)$$

(d) $E_x = E_0 \sin\left(kz - \omega t + \frac{\pi}{4}\right)$

$$E_y = \frac{1}{\sqrt{2}} E_0 \sin(kz - \omega t)$$

(a) $E_x = E_0 \cos(\omega t + kz)$

$$E_y = \frac{1}{\sqrt{2}} E_0 \cos(\omega t + kz + \pi)$$

$\Rightarrow$Linearly polarized

(b) $E_x = E_0 \sin(\omega t + kz)$

$$E_y = E_0 \cos(\omega t + kz)$$

$$\Rightarrow \theta = \frac{\pi}{2}, a_1 = a_2$$

Left (?) circular polarization

(c) $E_x = E_0 \sin\left(kz - \omega t + \frac{\pi}{3}\right)$

$$E_y = E_0 \sin\left(kz - \omega t - \frac{\pi}{6}\right)$$

$$\Rightarrow d\theta = \frac{\pi}{2}, a_1 = a_2$$

Right(?) circular polarization

(d) $E_x = E_0 \sin\left(kz - \omega t + \frac{\pi}{4}\right)$

$$E_y = \frac{1}{\sqrt{2}} E_0 \sin(kz - \omega t)$$

$$\Rightarrow \theta = \frac{\pi}{4}, a_1 \neq a_2$$

Right (?) elliptically polarized light

Problem-3

$$E_x = a_1 \cos \omega t$$

$$E_y = a_2 \cos (\omega t - \theta)$$

θ takes the values 0,π/3, π/2, 2π/3 and π. Determine the state of polarization

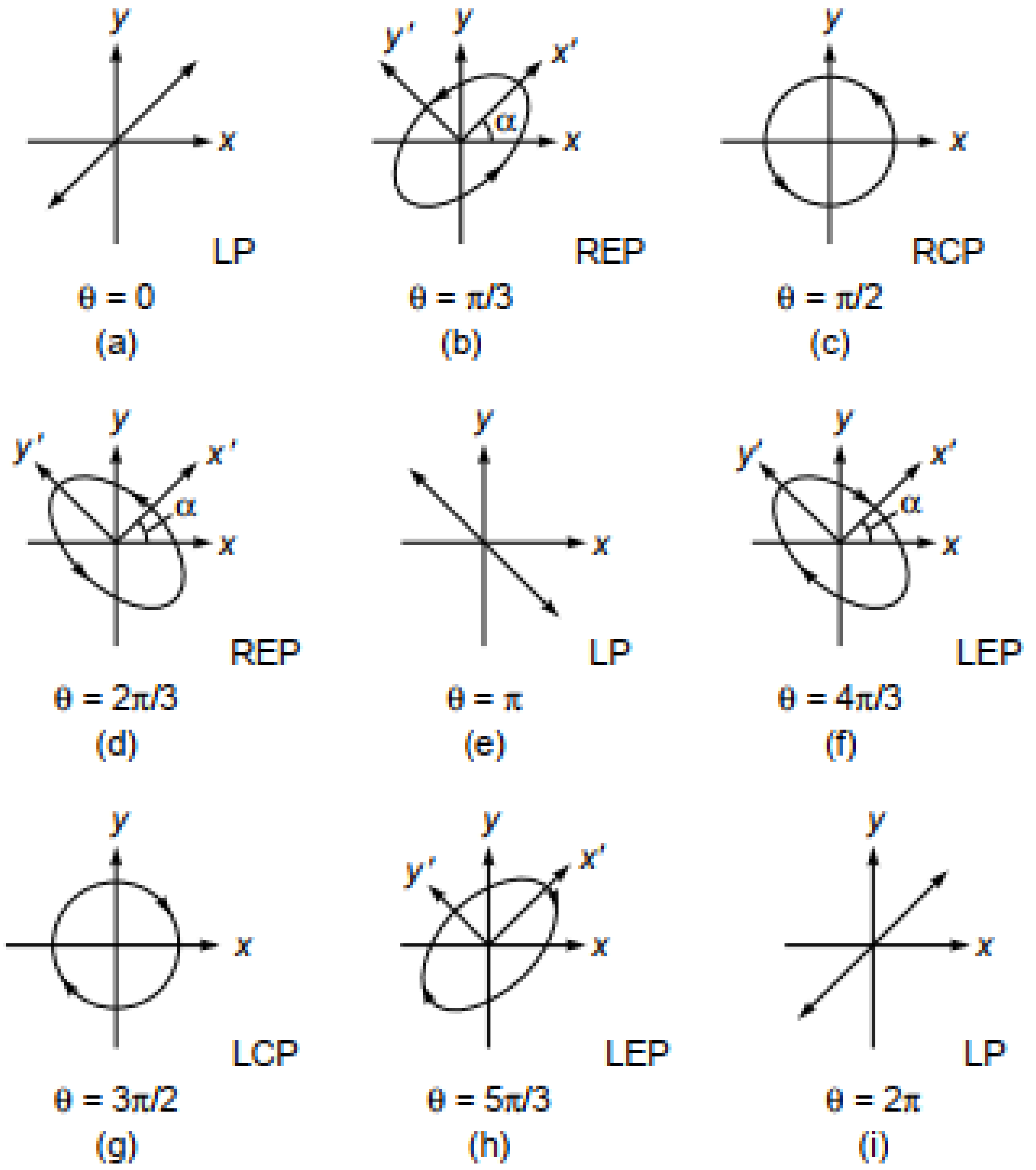
Answer:

Let:

$$E_x = a_1 \cos \omega t$$
$$E_y = a_2 \cos (\omega t - \theta)$$

If $a_1 = a_2 \Rightarrow$

If $a_1 \neq a_2$ one obtains an elliptically polarized wave which degenerates into a straight line for $\theta = 0, \pi, 2\pi, \ldots$.



z ⊙ Propagation is along z-axis–coming out of the paper.

Thank You