Engineering Optics

Lecture 24

12/05/2023

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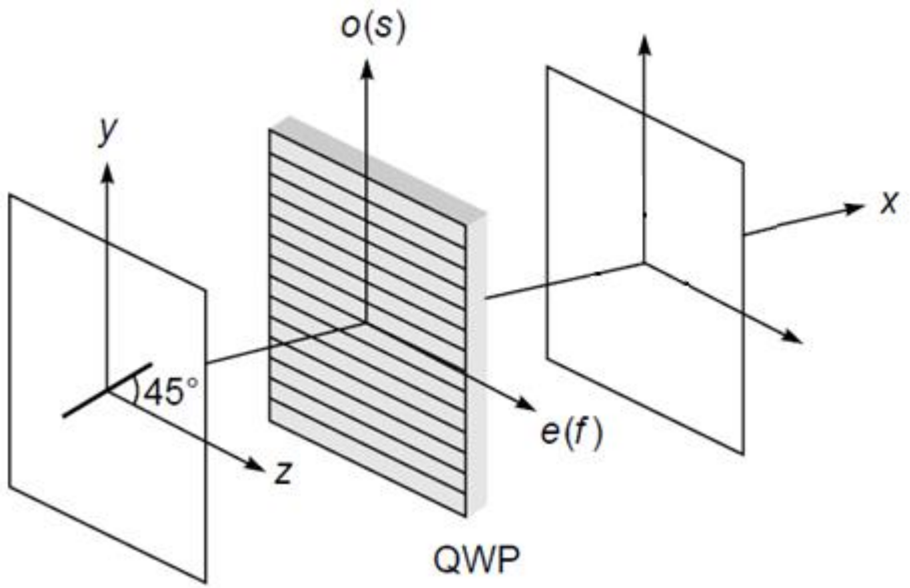
QWP and HWP

Wave plate→ Retarder→ alters the polarization state of a light wave travelling through it.

Two common types : Quarter wave plate (QWP) and half-wave plate (HWP)

QWP and HWP

What is the state of polarization of the out coming beam of light?



QWP and HWP

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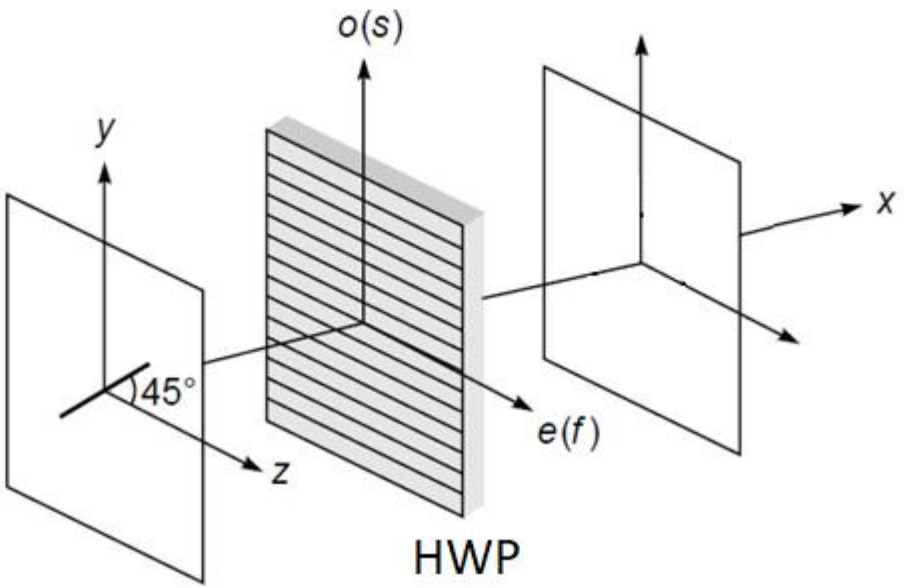

QWP and HWP

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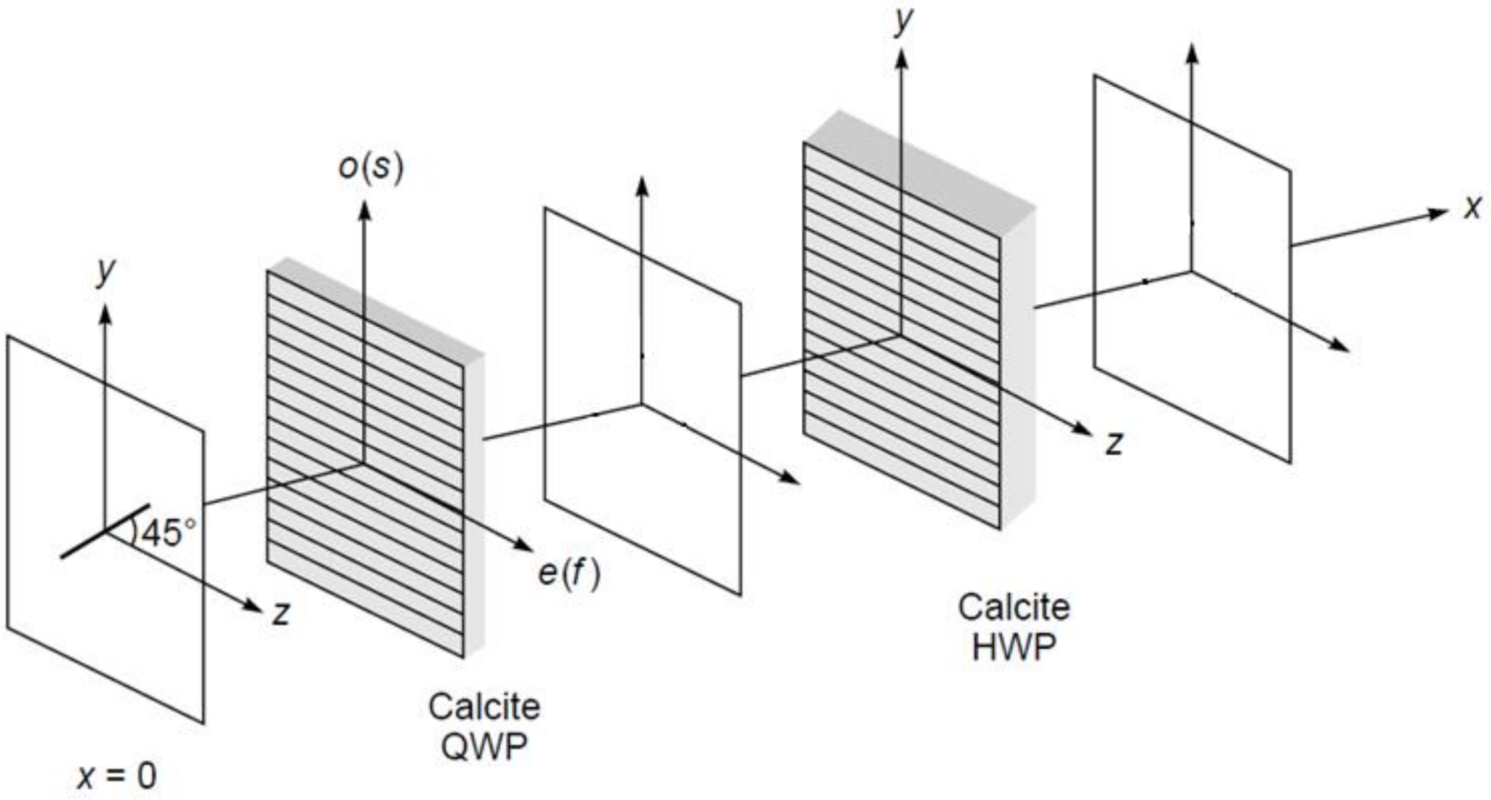
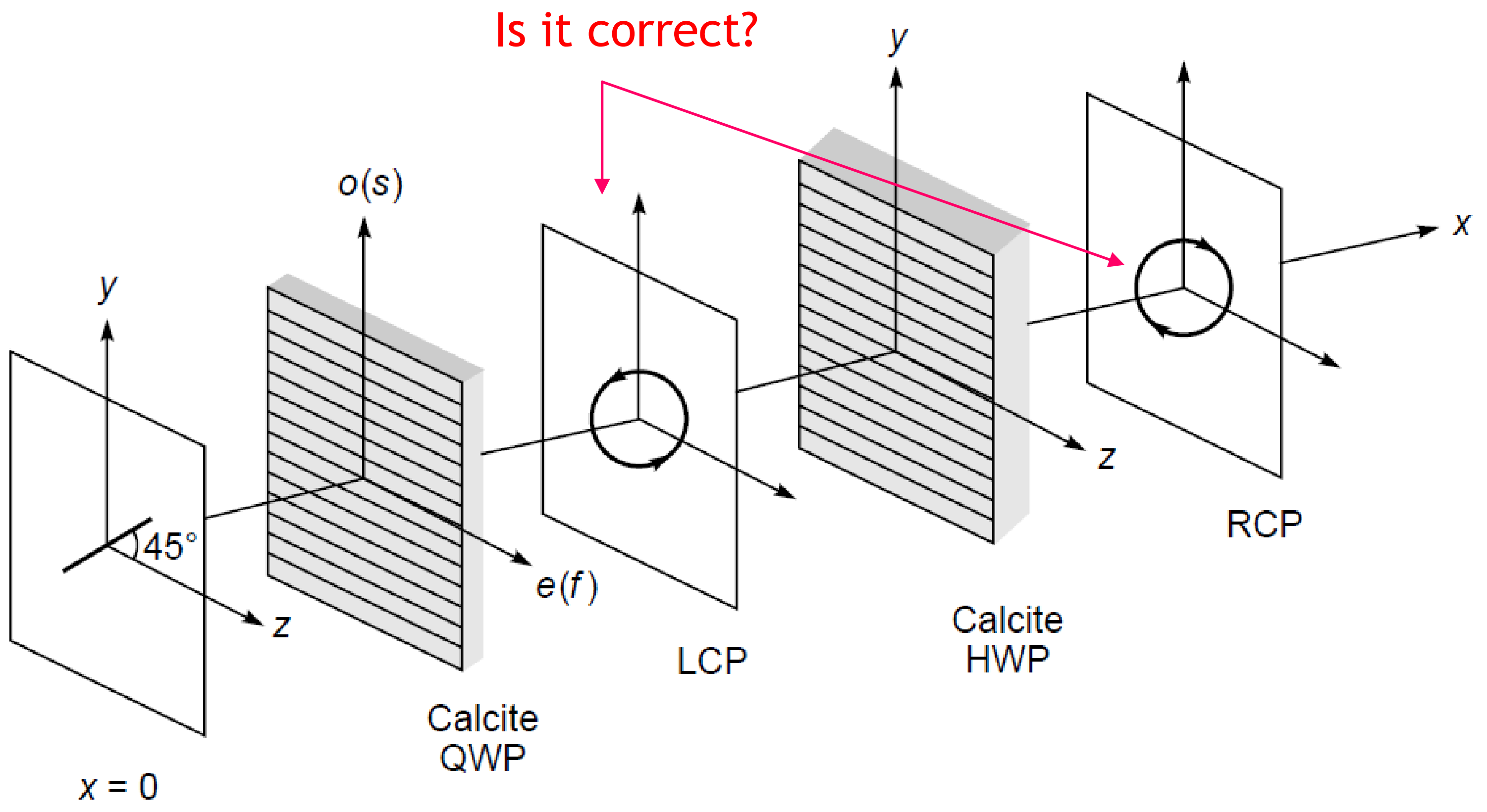


Optics, Ghatak

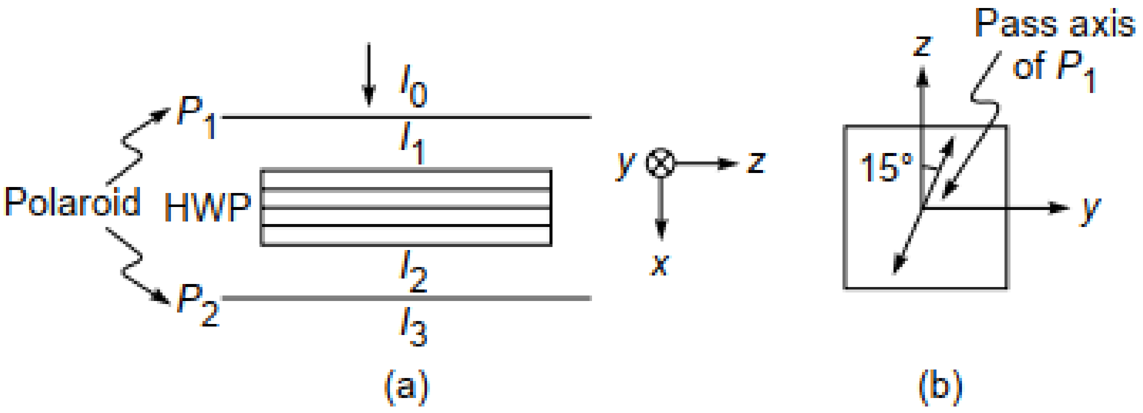
QWP and HWP



A linearly polarized beam making an angle 45° with the z axis gets converted to a LCP after propagating through a calcite QWP; further, a LCP gets converted to a RCP after propagating through a calcite HWP. The optic axis in the QWP and HWP is along the z direction as shown by lines parallel to the z axis.

Problem:1

A HWP is introduced between two crossed Polaroids P_1 and P_2. The optic axis makes an angle of 15° with the pass axis of P_1 as shown in Figure. If an unpolarized beam of intensity I_0 is normally incident on P_1 and if I_1, I_2 and I_3 are the intensities after P_1, after HWP, and after P_2, respectively, then calculate I_1 / I_0, I_2 / I_0, and I_3 / I_0



Problem-2

- A left circularly polarized beam (λ_0 = 5893 Å) is incident normally on a calcite crystal of thickness 0.005141 mm. What will be the state of polarization of the emergent beam?
- (n_0 = 1.65836 and n_e = 1.48641)

Soltion-2

Solution: The electric field for the incident beam at $x = 0$ is

$$E_y = \frac{E_0}{\sqrt{2}} \sin \omega t \qquad E_z = \frac{E_0}{\sqrt{2}} \cos \omega t$$

Is it correct?

Now

$$\theta = \frac{(n_o - n_e)d \times 2\pi}{\lambda_0}$$

$$= \frac{0.17195 \times 0.005141 \times 2\pi}{5893 \times 10^{-7}} \approx 3\pi$$

Thus the emergent wave will be [cf. Eq. (49)]

$$E_y = \frac{E_0}{\sqrt{2}} \sin(\omega t - 3\pi)$$

$$= -\frac{E_0}{\sqrt{2}} \sin \omega t \qquad E_z = \frac{E_0}{\sqrt{2}} \cos \omega t$$

which represents a right circularly polarized beam.

Problem-3

- A left circularly polarized beam (λ_0 = 5893 Å) is incident on a quartz crystal of thickness 0.025 mm. Determine the state of polarization of the emergent beam. Assume n_o and n_e to be 1.54425 and 1.55336, respectively.

Solution-3

Solution: As in Example 22.1, the electric field for the incident beam at $x = 0$ is given by $E_y = \frac{E_0}{\sqrt{2}} \sin \omega t \qquad E_z = \frac{E_0}{\sqrt{2}} \cos \omega t$

$$\theta' = (n_e - n_o)\frac{2\pi}{\lambda_0} d = 2\pi \frac{0.00911 \times 0.025}{5893 \times 10^{-7}} \approx 0.77\pi$$

Thus the emergent beam will be

$$E_y = \frac{E_0}{\sqrt{2}} \cos(\omega t + 0.77\pi) \qquad E_z = \frac{E_0}{\sqrt{2}} \cos(\omega t)$$

which will represent a right elliptically polarized light beam.

Thank You