Menoufia University
Faculty of Electronic Engineering
Electronics and Electrical Communications Eng. Dept.
Third Year – Spring 2019

ECE 325 - Optoelectronics
Problem Set #4

Polarization of light

Textbook: S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, international ed., Prentice Hall, 2012.

Chapter 6:

[P1] Give the polarization state of the following wave:

a- $E(z,t) = \hat{x}\,\frac{E_o}{\sqrt{2}}\cos(\omega t - kz) + \hat{y}\,E_o\sin(\omega t - kz + \pi)$

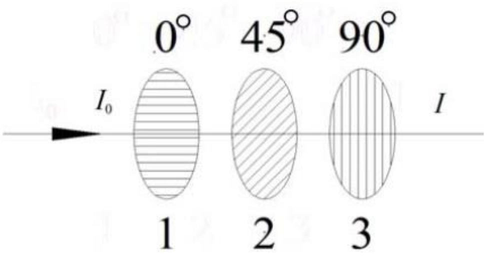
b- $E(z,t) = \hat{x}\,E_o\sin(\omega t - kz + \frac{\pi}{6}) + \hat{y}\,E_o\sin(\omega t - kz - \frac{\pi}{3})$

c- $E(z,t) = \hat{x}\,E_o\sin(\omega t - kz + \frac{3\pi}{4}) + \hat{y}\,E_o\sin(\omega t - kz - \frac{\pi}{4})$

[P2] 6.2 - Show that a linearly polarized light wave can be represented by two circularly polarized light waves with opposite rotations. Consider the simplest case of a wave linearly polarized along the y-axis. What is your conclusion?

[P3] 6.5 - Find the angle between the transmission axes of two polarizers for the transmitted light intensity through both polarizers to be 60%, and 30%.

[P4] Three polarizers are placed after each other. The first is illuminated by unpolarized light with the intensity I_o. The transmission direction for the second and the third polarizer is rotated 45° and 90° in relation to the first respectively.



a- Give the intensity between polarizer 1 and 2 in relation to I_o.
b- Give the intensity between polarizer 2 and 3 in relation to I_o.
c- Give the intensity after polarizer 3 in relation to I_o.

[P5] **6.7** - Consider a negative uniaxial crystal such as calcite ($n_e < n_o$) plate that has the optic axis (taken along z) parallel to the plate face. Suppose that a linearly polarized wave is incident at normal incidence on a plate face. If the optical field is at an angle 45° to the optic axis, sketch the rays through the calcite plate.

[P6] Calculate and compare the thickness of quarter-wave plates made from calcite, quartz and LiNbO3 crystals all operating at a wavelength of $\lambda \approx 590$ nm. What is your conclusion? Assuming little relative change in the indices, what are the thicknesses at double the wavelength?

[P7] Show that two cascaded quarter-wave retarders with parallel fast axes are equivalent to a half-wave retarder. What is the result if the fast axes are orthogonal?

[P8] **6.9** - Consider a Soleil compensator as shown in Figure 6.15 that uses a quartz crystal. Given a light wave with a wavelength $\lambda \approx 633$ nm, a lower plate thickness of 6 mm, calculate the range of d values in Figure 6.15 that provide a retardation from 0 to $\pi/2$ (quarter-wavelength).

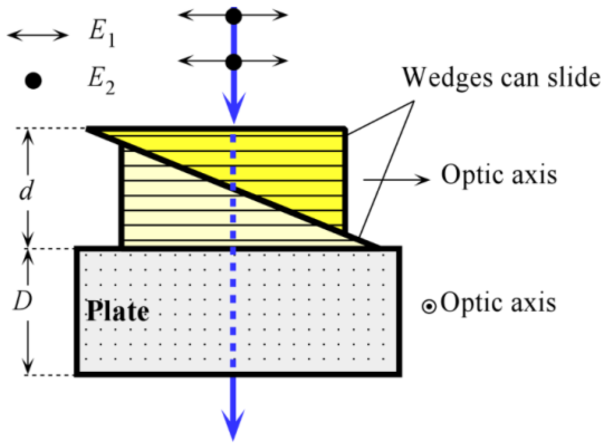


Figure 6.15 Soleil-Babinet compensator