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Date: October 28, 2023

Thermodynamics, Wave Motion and Optics (PHYS201)
Participation 2

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1. Find the output intensity of an optical system of a polarizer followed by two analyzers with transmission axes at 45° to the next one, interns of the initial intensity in case the incident light is:

   (a) Unpolarized

$$I_1 = \frac{1}{2} I_0 \tag{1}$$
$$I_2 = I_1 \cos^2(45°) = \frac{1}{4} I_0 \tag{2}$$
$$I_3 = I_2 \cos^2(45°) = \frac{1}{8} I_0. \tag{3}$$

   (b) Right Circularly Polarized

$$I_1 = \frac{1}{2} I_0 \tag{4}$$
$$I_2 = I_1 \cos^2(45°) = \frac{1}{4} I_0 \tag{5}$$
$$I_3 = I_2 \cos^2(45°) = \frac{1}{8} I_0. \tag{6}$$

   (c) Linearly Polarized at 30 degree with the first polarizer

$$I_1 = I_0 \cos^2(30°) = \frac{3}{4} I_0 \tag{7}$$
$$I_2 = I_1 \cos^2(45°) = \frac{3}{8} I_0 \tag{8}$$
$$I_3 = I_2 \cos^2(45°) = \frac{3}{16} I_0. \tag{9}$$

2. Find the output intensity of a system of a polarizer followed by 99 analyzers each of which with transmission axes making angles 1° to the previous one, interns of the initial intensity in case the incident light is:

   (a) Unpolarized

$$I_1 = \frac{1}{2} I_0 \tag{10}$$
$$I_{99} = I_1 \left(\cos^2(1°)\right)^{99} \tag{11}$$
$$= \frac{\cos^{198}(1°)}{2} I_0 \tag{12}$$
$$\approx 0.4851 I_0. \tag{13}$$

(b) Linearly Polarized at 30 degree with the first polarizer

$$I_1 = I_0 \cos^2(30^\circ) = \frac{3}{4} I_0 \tag{14}$$

$$I_{99} = I_1 \left(\cos^2(1^\circ)\right)^{99} \tag{15}$$

$$= \frac{3\cos^{198}(1^\circ)}{4} I_0 \tag{16}$$

$$\approx 0.7277 I_0. \tag{17}$$

(c) In part (a), find the relative change in intensity in case of 1 polarizer and in case 1 polarizer followed by 99 analysers.

$$\Delta I = \left| \frac{I_1 - I_{99}}{I_0} \right| \tag{18}$$

$$= \left| \frac{0.5 I_0 - 0.4851 I_0}{I_0} \right| \tag{19}$$

$$\approx 0.0149. \tag{20}$$