Homework Problems VII

1. A parallel beam (diameter d = 1 mm) from a 50 W laser of wavelength $\lambda = 550$ nm is incident perpendicularly on the plane-parallel plate of transparent isotropic material with a refractive index $n = 1.88$.

   (a) What is the pressure exerted by the beam on the front surface of the material, considering separately the reflected and transmitted part of the light?

   (b) Following the transmitted part of the light into the plate: what pressure does it exert on the material when it is reflected and transmitted at the second surface?

   (c) What is the total pressure effect on the material by all processes in (a) and (b)?

2. (a) Find the thickness of a particular birefringent crystal (with indices of refraction $n_1 = 1.4737$ and $n_2 = 1.4714$) needed to produce $\lambda/4$, $\lambda/2$, and $\lambda$ retardation plates, respectively, for the argon laser line $\lambda = 488$ nm.

   (b) Explain, including a sketch of the polarization states, how you can use these retarders, in combination with a linear polarizer, to produce: (i) right circularly polarized light, (ii) left circularly polarized light, (iii) a 90° rotation of plane-polarized light.

   (c) Using the above mentioned optical elements, how do you produce elliptically polarized light? Explain and provide a sketch.

3. You want to distinguish, experimentally, unpolarized light from circularly polarized light of the same wavelength. Describe the procedures in words and sketches.

   (a) Which optical elements will you need to determine this, and how do you have to arrange and use them?

   (b) How can you determine if circularly polarized light is left-circular or right-circular polarized?

4. A transparent isotropic material of thickness $d = 12$ mm changes under uniaxial compression of 100 atm its isotropic refractive index $n$ in the following way:

   (a) $\Delta n (100 \text{ atm}) = 7 \times 10^{-5}$ for light polarized parallel to the compression direction,

   (b) $\Delta n (100 \text{ atm}) = -2 \times 10^{-5}$ for light polarized perpendicularly to the compression direction.

   How much uniaxial pressure do you have to apply so that your stressed material becomes a circular polarizer for linearly polarized light of $\lambda = 6500$ Å? Make a sketch of the arrangement and show what you would do (with the same elements) to change between right and left circularly polarized light.