Homework #11
OPTI 370
4/20/2022
(due date: 4/27/2022)

Problem 1:
Determine the thickness of a half-wave plate of order 21 for light at $\lambda_0 = 1.18\mu\text{m}$ using $LiTaO_3$ (lithium tantalate) as an appropriate uniaxial crystal with $n_o = 2.1391$ and $n_e = 2.1432$.

(10 points)

Problem 2:
Consider a zero-order quarter wave plate made from α-SiO_2 (quartz) with $n_o = 1.5328$ and $n_e = 1.5415$ at $\lambda_0 = 1.1559\,\mu\text{m}$. Determine the plate thickness *d*. Using the appropriate formula derived in class, determine the transmission $(T = I_{out} / I_{in})$ of a system where the incident wave is linearly y-polarized, the slow axis is aligned 45° relative to the x-axis, and there is an x-polarizer behind the retardation plate (same geometry as that discussed in class, except that now the incoming wave is already y-polarized). Also, express the transmission loss in dB, which is $A = -10\log_{10}(I_{out} / I_{in})$.

(10 points)

Problem 3:
In a Wollaston polarizing beam splitter, two waves (with wave #1 experiencing the ordinary refractive index n_o and wave #2 the extraordinary refractive index n_e) propagate parallel (in z-direction) until they hit an interface making a 45° angle with the z-axis. Determine the angles of propagation of the two waves after the interface, assuming $n_o = 2.1316$ and $n_e = 2.1498$.

(10 points)

Problem 4:
Consider polarization rotation due to the Faraday effect. The rotation of the azimuthal angle is given by $\theta = \rho d$ where ρ is the rotatory power and *d* the propagation distance. Using a linear dependence of the rotatory power on the externally applied magnetic field with magnetic flux density *B*, $\rho = \mathcal{V} B$, where $\mathcal{V}$ is the so-called Verdet constant, estimate the thickness d needed for a -22.5° rotation, assuming a magnetic field of 1450 G. Let the Verdet constant be -8×10^3 deg/T-m (a value appropriate for terbium gallium garnet, TGG, at $\lambda_0 = 600\text{nm}$).

Also, do the same as before, but for terbium aluminum garnet TAG, with a Verdet constant of -1.16 min/Oe-cm at $\lambda_0 = 500\text{nm}$. Determine first the Verdet constant in units of deg/T-m.

(10 points)