HW #3 due 2/15/18 5PM

No later than 2/19/18 5PM

1. A polarizing beam splitter cube, known as Glan-Thompson polarizer, contains Canada balsam in the gap between the calcite prisms. If the refractive index of the Canada balsam is 1.54. a) What is the minimum angle of incidence on the internal glass interfaces to ensure that the polarizer works correctly ($n_{\|} = 1.486$, $n_{\perp} = 1.658$)? b) Draw a diagram to show paths of split beams and indicate polarization of each path. (For example, check the following site for description of Glan-Thompson polarizer:
http://www.thorlabs.com/NewGroupPage9_PF.cfm?Guide=10&Category_ID=133&ObjectGroup_ID=116)

2. What will be the effect of cascading two quarter-wave plates that contribute phase shift in x axis? What will happen if we orient them so that one quarter-wave plate causes phase shift in y axis while another cause phase shift in x axis? Demonstrate your idea by consider a linearly polarized wave with plane of polarization making 45^o with the x axis.

3. a) Consider a laser beam with wavelength of 633nm propagating inside a calcite crystal ($n_{\|} = 1.486$, $n_{\perp} = 1.658$) and initial polarization angle of 45^o between the optic axis ($\|$) and perpendicular ($\perp$) axis of the crystal. How thickness should be the crystal for the wave to become circularly polarized? b) How high is the magnet field intensity to rotate linearly polarized light by 45^o with an optical fiber functioning as a Faraday rotator with Verdet constant of $2.64 \times 10^{-4} deg/A$ (silica glass) and length of 0.1km.

Extra-Credit for undergraduate (regular for graduate)

Derive the grating equation for a blazed reflection grating with blaze angle α, such as the one shown in Figure 3.11. [Problem 3.5 (page 227 (page 232 in 3rd Ed.) of the textbook]. Do this problem using the Blazed grating diagram in Jan. 30 summary. (Hint: It is be almost the same as Eq. (3.9) on page 121 (page 1 27 in 3rd Ed.).)

Extra-Credit

Given that a linearly polarized wave with plane of polarization making an angle θ with the x axis is equivalent to superposition of right circularly polarized unit vector $\hat{e}_R$ and left circularly polarized unit vector $\hat{e}_L$ with weights $e^{j\theta}/\sqrt{2}$ and $e^{-j\theta}/\sqrt{2}$, respectively, i.e. $\hat{e}_R\, e^{j\theta}/\sqrt{2} + \hat{e}_L\, e^{-j\theta}/\sqrt{2} = \hat{x}\cos(\theta) + \hat{y}\sin(\theta)$. Use this idea, representing a plane wave in terms of circularly polarized unit vectors, to show that if you introduce phase shift of θ_+ to left circular component and phase shift of θ_- to right circular component through Faraday effect, the plane of polarization will be rotated by an angle of $(\theta_- - \theta_+)/2$.