Physics 50 **Assignment #2** **Spring 2008**

The topic for this week is **Fourier Series.**

Readings: Riley, Hobson and Pence - Chapter - 8,10,11
(selected topics)
Boccio - 00_Review

http://chaos.swarthmore.edu/courses/Physics50_2008/P50_Optics/04_Polariz_Matrices.pdf

Some More review Problems:

8.10 Pauli Matrices
8.13 Gram-Schmidt
8.21 Eigenvectors
8.34 Simultaneous Equations
10.13 Vector Identity (use ε_{ijk})
11.01 Vector Field

Polarization Problems:

1. Two Polarizers: A beam of light, having intensity I_1=1, and moving along the z-axis is incident on a first polarizer P_1 (in the xy plane) and whose pass-direction is parallel to the x-axis. The beam emerging from P_1 is incident on a second parallel polarizer P_2, rotating around the z-axis.

Plot the intensity I_2 emerging from P_2 when the angle θ between its pass-direction and the x-axis increases from $0°$ to $180°$.

Assume that the polarizers do not absorb any light.

2. Three Polarizers: A beam of light, having intensity I_1=1, and moving along the z-axis is incident on a first polarizer P_1 (in the xy plane) and whose pass-direction is parallel to the x-axis. The beam emerging from P_1 is incident on a second parallel polarizer P_2, rotating around the z-axis. The beam emerging from P_2 is incident on a third parallel polarizer P_3, whose pass-direction is perpendicular to the x-axis.

Plot the intensity I_2 emerging from P_2 when the angle θ between its pass-direction and the x-axis increases from $0°$ to $360°$ and the intensity I_3 of the beam emerging from the third polarizer.

Assume that the polarizers do not absorb any light.

3. Retarders: A beam of monochromatic light($\lambda = 0.5893\mu$), of intensity I_1, is moving along the z-axis and reaches a polarizer P_1 whose plane is perpendicular to the z-axis(in the x-y plane). The beam emerging from P_1 reaches a retarder that has its plane parallel to the x-y plane. The optic(fast) axis of the retarder subtends an angle $\beta = 45°$ with the x-axis. The beam emerging from the retarder reaches another polarizer P_2, whose transmission axis has the same direction as P_1.

(a) Find the intensity of the beam emerging from polarizer P_2 when the retarder is half-wave R_{h-w} and when it is quarter-wave R_{q-w}.

(b) If another half-wave plate R_{h-w}, whose optic axis is at $45°$ from the x-axis takes the place of the polarizer P_2, after the half-wave R_{h-w} or the quarter-wave R_{q-w}, find the polarization of the final beams and their intensities.

Assume that the polarizers and retarders do not absorb any light.

4. A Half-Wave Plate: A beam of light, having intensity I_1=1, and moving along the z-axis is incident on a first polarizer P_1 (in the xy plane) and whose pass-direction(transmission axis) subtends angle $\theta = 45°$ with the x-axis. The beam emerging from P_1 is incident on a half-wave plate R_{h-w}, parallel to P_1 and whose optic axis is parallel to the x-axis. Emerging from the half-wave plate the beam is incident on a second polarizer P_2, parallel to P_1 and Rh-w, rotating on the z-axis.

Plot the intensity I_2 of the beam emerging from P_2 when the angle θ between its pass-direction and the x-axis is increasing from $0°$ to $360°$.

Assume that the polarizers and retarders do not absorb any light.

5. A Quarter-Wave Plate: A beam of light, having intensity I_1=1, and moving along the z-axis is incident on a first polarizer P_1 (in the xy plane) and whose pass-direction is parallel to the x-axis. The beam emerging from P_1 is incident on a quarter-wave plate R_{q-w}, parallel to P_1. The optic axis of R_{q-w} is parallel to

the x-axis. Emerging from the quarter-wave plate the beam is incident on a second polarizer P_2 parallel to P_1 and R_{q-w}.

Plot the intensity I_2 of the beam emerging from P2 when the angle θ between its pass-direction and the x-axis is increasing from $0°$ to $360°$.

Next the direction of the pass-direction of the first polarizer P_1, changes from $0°$ to $45°$ leaving unchanged the direction of the optic axis of R_{q-w}.

Plot the intensity I_2 of the beam emerging from P2 when the angle θ between its pass-direction and the x-axis is increasing from $0°$ to $360°$.

Assume that the polarizers and retarders do not absorb any light.

NOTE: Optics Experiment #2 involves calculated intensities similar to these problems.