Modulators and Isolators

These problems are taken from *Optoelectronics, an Introduction*, by Wilson and Hawkes.

Problem 1 *Pockels Cell Modulator*

Calculate the half-wave or switching voltage (V_π) for a transverse field Pockels modulator using lithium niobate at a wavelength of 632.8 nm where the value of the appropriate electro-optic coefficient is 6.8 pm/V. Assume your crystal is 40 mm long and 1.5 mm deep, with the electric field applied across the short dimension.

Problem 2 *Optical Isolator*

Design an optical isolator using zinc sulfide. Take the relative permeability of zinc sulfide to be unity and assume that the magnetic field is produced by a solenoid wound directly onto the zinc sulfide at the rate of 5 turns per mm. The Verdet constant of zinc sulfide is 82 rad m^{-1} T^{-1}. Solve for the length of the crystal and the amount of current required to achieve an isolator (you will need to make a choice here). Also show a sketch of *all* the optical components needed to make an isolator from this crystal.

Problem 3 *Acousto-optic modulator*

It can be shown that the internal Bragg angle is given by $\sin\theta_b = \dfrac{\lambda}{2\Lambda}$, where λ is the wavelength of light in the glass. Assuming a Bragg acousto-optic modulator is in the form of a parallel-sided block with the acoustic wave travelling perpendicularly to these faces, show that the external ray deflection angle is given by $\sin\theta_b' = \dfrac{\lambda_o}{2\Lambda}$. Then calculate the external beam deflection $2\theta'_b$ in a fused silica modulator, where the acoustic wave velocity is 3.76×10^3 m/s and the frequency of the acoustic wave is 50 MHz, for light of 1.06 μm wavelength.