1. Interference (Grating)
(a) Obtain the angle of incidence $\theta$ at which a reflection grating (grating period = $a$) retro-reflects (reflects back) the m-th order of a monochromatic incident beam at wavelength $\lambda_0$. (See figure below). 3 points

(b) For a CO$_2$ laser at $\lambda_0=10.6$ $\mu$m, which of the following gratings is suitable for the above experiment: (1) 800 lines/mm, (2) 300 lines/mm, and (3) 50 lines/mm? Explain. What is (are) the order (m\neq0) and the incidence angle(s) at which retro-reflection occurs? 4 points

(c) In part (b), what is the highest resolution ($\Delta\lambda$) attainable if the CO$_2$ laser has a diameter of 1 cm? 3 points

2. Interference (Fabry-Perot)
Light from an IR laser source ($\lambda=8-10$ $\mu$m) is incident on a Germanium parallel plane thin slab ($d=10$ $\mu$m, $n=4$) as shown.
(a) Plot the transmission versus wavelength (in the range of 8 to 10 $\mu$m) at normal incidence. Be quantitative and give values for $T_{\text{max}}$, $T_{\text{min}}$, Finesse, and $\Delta\lambda_{1/2}$ (assume high finesse for the latter) (6 points)

(b) b) Fix the wavelength at one of the transmission peaks. Can we rotate the sample by an amount $\Delta\theta$ such that the transmission becomes a minimum? Is this practical? (4 points) (Assume surface reflectivities remain constant)