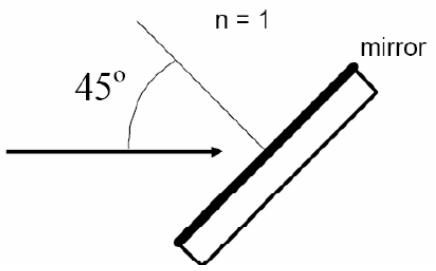
BI-A1) Two plane waves with the same wavelength, but different amplitudes, interfere in space.

a.) If $\boldsymbol{k}_1 = k\hat{\boldsymbol{k}}_1$ and $\boldsymbol{k}_2 = k\hat{\boldsymbol{k}}_2$, where $\hat{\boldsymbol{k}}_1 = 0.5\hat{\boldsymbol{x}} + 0.866\hat{\boldsymbol{z}}$ and $\hat{\boldsymbol{k}}_2 = \hat{\boldsymbol{z}}$, what is the orientation of the fringe planes?
b.) What is the minimum spacing between fringe planes if λ = 532 nm?
c.) Does visibility depend on orientation of the observation screen?

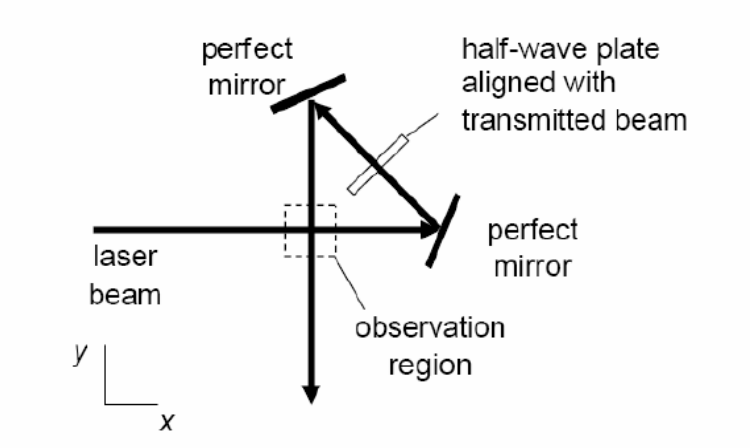
BI-A2) A plane wave illuminates a mirror in air as shown below. Assume a perfect mirror (no phase shifts on reflection). Polarization is out of the drawing plane.

a.) Write expressions for the two plane waves that interfere to produce a fringe pattern.
b.) If λ = 500nm, what is the orientation of the resulting fringe pattern? (Show your answer pictorially with a simple drawing of the mirror.)
c.) What is the minimum spacing between fringe planes?
d.) How does the fringe pattern change if the mirror is immersed in water? (*n* = 1.33)



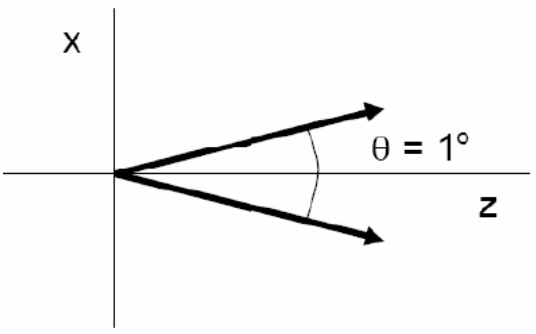

BI-A3) Fringes in the observation region shown below are to be analyzed. Both beams overlap completely in the observation region. The mirrors are perfect (no phase shifts on reflection).

a.) What is the orientation and fringe spacing of the fringes if λ = 550 nm?
b.) Assume that the laser beam entering the system is *z* polarized and the half-wave plate fast axis is in the plane of the drawing. Plot the fringe visibility versus rotation angle of the half-wave plate. (The half-wave plate is rotated around an axis parallel to the beam passing through it.)




BI-A4) Consider two plane waves traveling with a 1° separation angle. If $\lambda_1 = 640$ nm and $\lambda_2 = \lambda_1 + \Delta\lambda$, where $\Delta\nu = 100$GHz.

a.) Write expressions for the two plane waves that interfere to produce the fringe pattern.
b.) What is the orientation of the fringe planes with respect to the *x* and *z* axes?
c.) What is the equivalent wavelength?
d.) What is the velocity and direction of the modulation envelope?




BI-A5) An observation screen is illuminated with two mutually coherent collimated beams of like polarization and equal irradiance. The two beams make an angle of ±1 milliradian with respect to the normal to the observation screen.

a.) What is the irradiance distribution and fringe spacing on the observation screen?
b.) Let the interference fringes be observed by use of a photocell, which has an effective area of a slit. The height *H* of the slit, which is parallel to the fringes, is fixed, while the width *w* is variable. Assume that the photocurrent is proportional to the light flux falling on the detector. Give the variation of the current as a function of abscissa *x* of the slit and show that the observed fringe visibility is given by $\sin(\pi w/s)/(\pi w/s)$, where *s* is the spacing of the fringes. Plot the visibility as a function of *w*/*s*.

BI-A6) A plane wave traveling along the *z* axis interferes with a point source at the origin. At some position $z_0 >> \lambda$ and over a small region near the axis, derive:

a.) The expression for the radii of the fringes in the *xy* plane.
b.) The area of each fringe in the *xy* plane, where area is defined between lines of maximum irradiance.