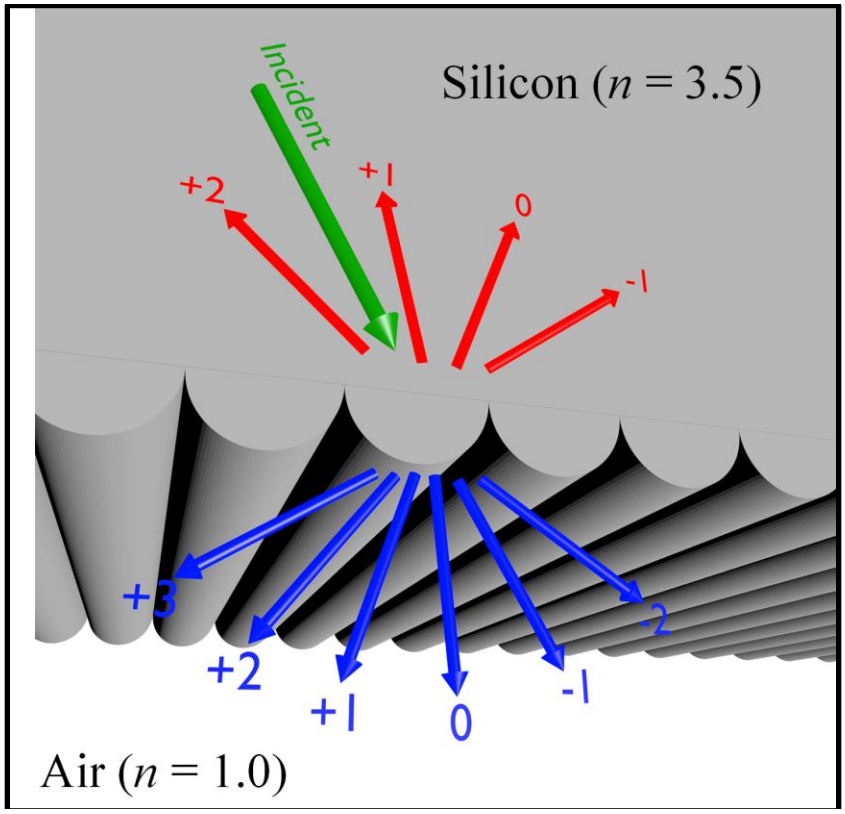
Problem #1 (HW): Closed-Form Analysis

A beam of light is incident from inside a silicon substrate (n = 3.5) onto a diffraction grating with air (n = 1.0) on the outside. The angle of incidence is 30° and the period of the grating is 1.0 μm. Note, the diffraction orders depicted in the figure below may not accurately convey what modes are actually present.



Part A

How many diffracted modes are reflected and how many are transmitted at a free space wavelength of 500 nm?

Part B

What maximum value for the grating period Λ would ensure that only the zero-order mode is present on the reflection side?

Problem #2 (Test): Numerical Analysis

Reproduce the results given in Fig. 5 of the following paper by simulating the device.

> Anne-Laure Fehrembach and Anne Sentenac, "Study of waveguide grating eigenmodes for unpolarized filtering applications," J. Opt. Soc. Am. A, Vol. 20, No. 3, pp. 481-488, 2003.

Your wavelength sweep should cover $1.530\ \mu\text{m} < \lambda_0 < 1.532\ \mu\text{m}$ with enough points to fully resolve the curves.

Provide the following professional graphics in your homework:

1. A clear diagram of the device and label all of the dimensions. Try to produce a 3D perspective view of the device. Consider what graphics you would produce for a publication.
2. The simulated response of the device like that shown in Fig. 5 of the paper. Consider superimposing your data onto the authors' data.

Answer the following questions:

1. Determine the center wavelengths λ_c of the resonances for both *s* and *p* polarizations.
2. Determine are the linewidths $\Delta\lambda$ of the resonances (i.e. FWHM) for both *s* and *p* polarizations.
3. Do your results match the publication? If not, why not and what are the differences between your results and the authors'?