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 $30^\circ$ and the period of the grating is $1.0 \, \mu\text{m}$. 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 $\Lambda$ 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.


Your wavelength sweep should cover $1.530 \, \mu m < \lambda < 1.532 \, \mu m$ 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 $\lambda_c$ 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’?