IMPORTANT !!!!

YOU WILL BE GRADED HEAVILY ON THE ACCURACY OF YOUR ANSWERS.

Problem #1: Diffraction Efficiency

The triangular diffraction grating shown in Figure 1 was designed to operate at 10 GHz. Simulate transmission and reflection from this device using FDTD for a wave at normal incidence and with the electric field polarized parallel to the grooves. The grating parameters are Λ=3.5 cm, f=80%, d=10.8 mm, ε_{r1}=1.0, and ε_{r2}=9.0. Assume the device is infinitely periodic along the x-axis, infinitely uniform along the z-axis, and the substrate extends to infinity along the y-axis.

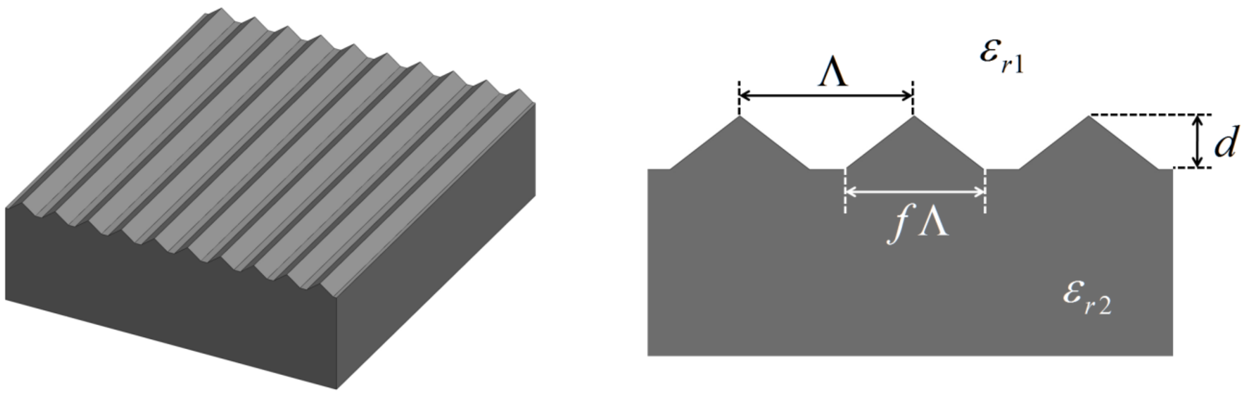

Figure 1. Diffraction grating with infinite substrate

Provide the following using professional looking graphics and formatting:

- Plot the overall reflectance, transmittance, and conservation of energy from 5.0 to 15.0 GHz. In the same plot, show the diffraction efficiency of the zero-order transmitted spatial harmonic.
- Calculate diffraction efficiencies of all the reflected and transmitted spatial harmonics at 10 GHz from order -3 up to order +3. Summarize the results in a table.
- Explain any anomalies in the frequency response of the device.
- Report the grid resolution (i.e. NRES) and number of iterations (i.e. STEPS) necessary to obtain a converged result. Justify your answer.

Problem #2: Resonant Devices

A grating residing in air is made of alternating layers of two materials with dielectric constants $\varepsilon_{r,\text{low}}$=4.0 and $\varepsilon_{r,\text{high}}$=4.41. Use a 2D FDTD algorithm to simulate transmission and reflection from this device for a wave at normal incidence and with the electric field polarized parallel to the grooves. The grating parameters are Λ=3.44 cm, f=59%, d=1.43 cm. Assume the device is infinitely periodic along the x-axis and infinitely uniform along the z-axis.

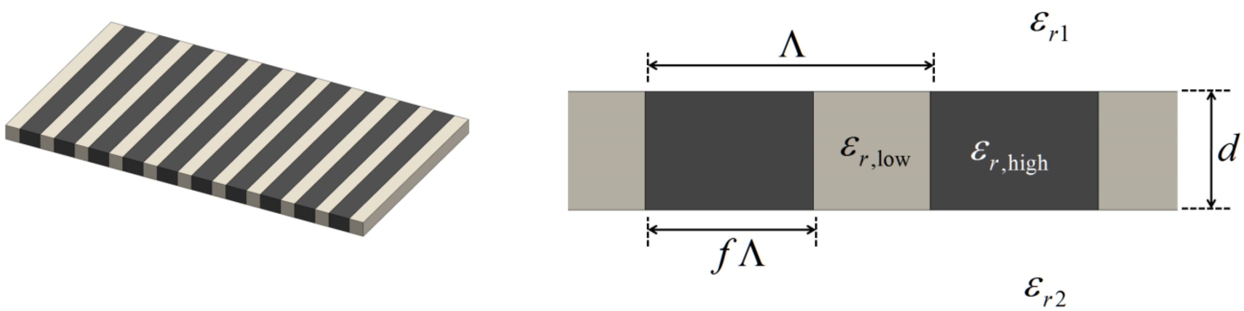

Figure 2. Diffraction grating in air

Provide the following using professional looking graphics and formatting:

- Plot the overall reflectance, transmittance, and conservation of energy from 4.0 to 6.0 GHz.
- Calculate the position, full-width-at-half-maximum (FWHM), and the fractional bandwidth (FBW) of the narrow reflection band observed in the frequency response.
- Report the grid resolution (i.e. NRES) and number of iterations (i.e. STEPS) necessary to obtain a converged result. Justify your answer.