Problem #1: Revise Formulation Document

Evolve your 2D-FDTD formulation document to include the following:

- Reduce the 3D update equations to two sets of 2D update equations. Distinguish between the E_z and H_z modes.
- Periodic boundary conditions along all borders
- TF/SF source
- Calculation of diffraction efficiencies, reflectance, transmittance, and conservation of power
- A complete block diagram or outline of the 2D FDTD method for the E_z mode.

Problem #2: Develop a Periodic 2D-FDTD Algorithm for E_z Mode

Starting with the code you wrote for Homework #8, make the following modifications:

- Set the material properties to free space (i.e. $\varepsilon_r = \mu_r = 1.0$)
- Set the grid size to 41×200 cells.
- Set the PML size on the *x*-axis boundaries to zero and use periodic boundary conditions.
- Incorporate a TF/SF source that injects a plane wave Gaussian pulse across the grid, but centered on the *y*-axis.
- Visualize the field at each iteration and superimpose the PML using `draw2d()`.
- Calculate the transmittance and reflectance from 0 to 150 MHz in 1 MHz increments.

Run your code and ensure that you get 100% transmittance and 0% reflectance for all frequencies. Provide the plot of transmittance, reflectance, and conservation of energy on a linear percent scale.

Problem #3: Model Diffraction Through a Grating

Modify the code from Problem #2 to model diffraction through the diffraction grating shown on Slide 39 of Lecture 17. Provide the following results:

1. Transmittance, reflectance, and conservation of energy from 0 GHz to 15 GHz on a linear percent scale.
2. Diffraction efficiencies of the reflected and transmitted modes at 10 GHz.

Hint: The FDTD parameters from prior homework will not work with this device. You will have to recalculate them following the steps outlined in the FDTD walkthrough. Also, pay special attention to the number of iterations and convergence issues in order to get accurate results.