1. Explain the physical meanings of following Maxwell's equations

$$\nabla \times \bar{\mathcal{E}} = \frac{-\partial \bar{\mathcal{B}}}{\partial t} - \bar{\mathcal{M}},$$

$$\nabla \times \bar{\mathcal{H}} = \frac{\partial \bar{\mathcal{D}}}{\partial t} + \bar{\mathcal{J}},$$

$$\nabla \cdot \bar{\mathcal{D}} = \rho,$$

$$\nabla \cdot \bar{\mathcal{B}} = 0.$$

2. An infinite magnetic current sheet, $\overrightarrow{M_s} = \hat{u}_x M_0$, and an infinite electric current sheet, $\overrightarrow{J_s} = \hat{u}_y J_0$, are placed over the z=0 plane in free space (M_0 and J_0 are constant). Assuming outward travelling plane waves and using the boundary conditions, determine all fields for z>0 and z<0.

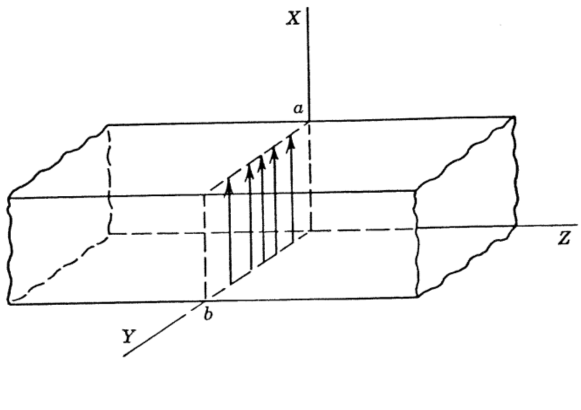
3. Explain the elementary wave functions for the rectangular coordinate.

4. Explain the elementary wave functions for the cylindrical coordinate.

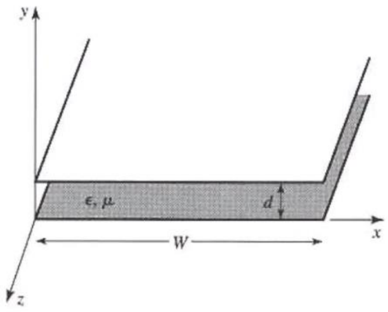
5. In the following figure, two electric and magnetic current sheets are simultaneously applied over the cross section z=0 in the rectangular waveguide. We would like to produce an electric field as follows,

$$E_x = \begin{cases} 0 & z > 0 \\ -A\sin\frac{\pi y}{b} e^{-j\beta z} & z < 0 \end{cases}$$

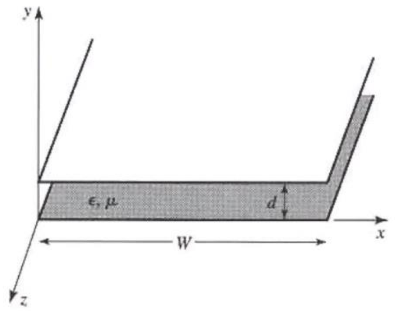
Determine the two electric and magnetic current sheets over the cross section z=0.



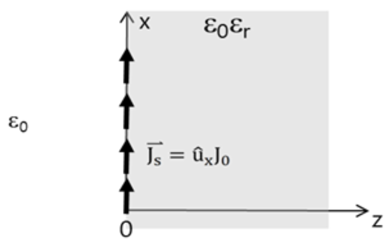
6. Consider the following the parallel plate waveguide. Assume that the strip width W is much greater than the separation d. A material with permittivity ε and permeability μ is assumed to fill the region between the two plates. Find $E_z(x,y,z)$. (Assume that $k^2=\omega^2\mu\varepsilon$ and $E_z(x,y,z) = e_z(x,y)e^{-j\beta z}$)



7. Consider the following the parallel plate waveguide. Assume that the strip width W is much greater than the separation d. A material with permittivity ε and permeability μ is assumed to fill the region between the two plates. Find Find $H_x(x,y,z)$ and $E_y(x,y,z)$. (Assume that $k^2=\omega^2\mu\varepsilon$ and $E_z(x,y,z) = e_z(x,y)e^{-j\beta z}$)



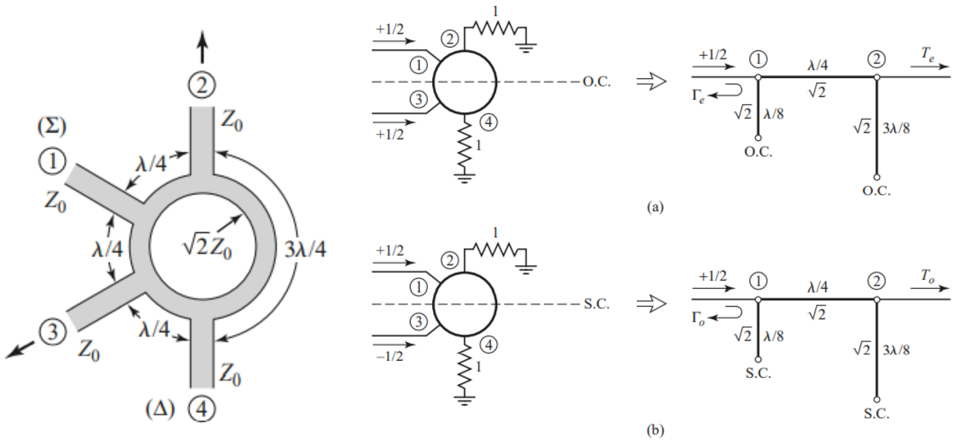
8. Assume that an infinite sheet of electric surface current density, $\vec{J_s} = \hat{u}_x J_0$ is placed on the z=0 plane between free-space for z<0, and a dielectric with $\varepsilon_0\varepsilon_r$ for z>0, as shown below. Assuming outward travelling plane waves and using the boundary conditions, find the resulting electric and magnetic fields in the two regions.



9. From Maxwell's equation, derive the following equation.

$$E_y = \frac{j}{k_c^2}\left(-\beta\frac{\partial E_z}{\partial y} + \omega\mu\frac{\partial H_z}{\partial x}\right), \quad k_c^2 = k^2 - \beta^2$$

10. In order analyze a ring hybrid in the following figure, we want to use even- and odd-mod analysis technique as shown in the following figures, (a) and (b).



Derive the following ABCD parameters for the figures (a) and (b).

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix}_e = \begin{bmatrix} 1 & j\sqrt{2} \\ j\sqrt{2} & -1 \end{bmatrix},$$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix}_o = \begin{bmatrix} -1 & j\sqrt{2} \\ j\sqrt{2} & 1 \end{bmatrix}.$$