Semester S1

Foundations of electromagnetic wave propagation

TUTORIAL 4

PROPAGATION IN A METALLIC RECTANGULAR WAVEGUIDE

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I. Consider the waveguide presented figure 1. The material embedded in this support is characterized by its relative permeability $\mu_r = 1$ and its relative permittivity $\varepsilon_r = 1$. It is bounded by perfect electric walls (PEW), placed in x=0, x=a=22.86 mm, y=0 and y=b=10.16 mm. We will work in the frequency domain.

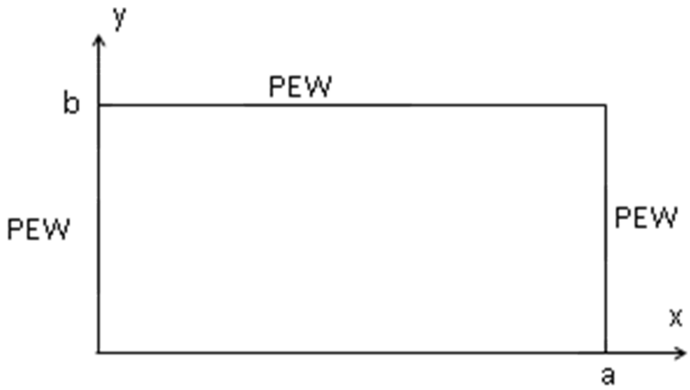


Figure 1

This waveguide is excited on TE modes. The longitudinal magnetic field is then :

$$H_z(x,y) = H_0 \cos((n\pi/a)x) \cos((n\pi/b)y)$$

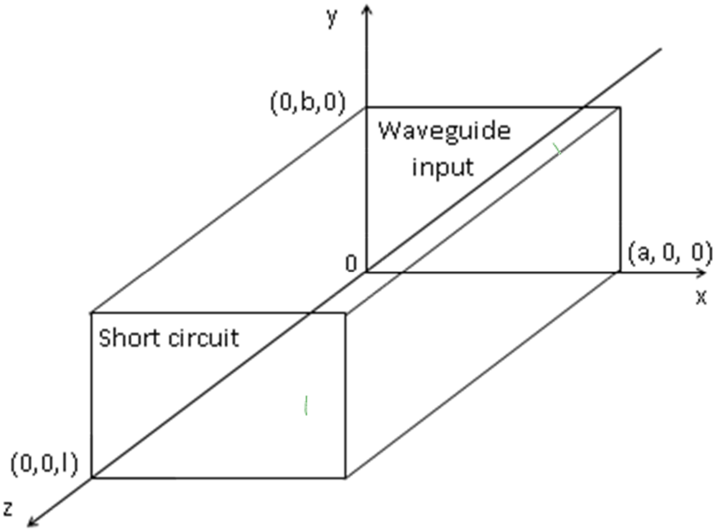
a. Compute the first 3 cutoff frequencies of these TE modes.
b. Is the first TM mode cutoff frequency higher than these TE first cutoff frequencies?
c. From their expressions given in the lesson, compute all the E and H field components of the first TE mode.

II. The metallic enclosure placed in the plane x=0 is now a real conductor, characterized by its conductivity σ. The other electric walls are perfect conductors.
a. Compute the waveguide metallic losses on the first TE mode
b. Compute the power transmitted through the waveguide
c. Compute the attenuation coefficient of the waveguide.

III. The same waveguide, considered in this part lossless, which length is l as shown in figure 2, is again excited on the first TE mode

$H_{z1}^{+}(x,z) = H_{01}^{+} f_1^{+}(x,z)$ is the H_z component of the incident wave in the waveguide input, in the z=0 plane.

$H_{z1}^{-}(x,z) = H_{01}^{-} f_1^{-}(x,z)$ is the H_z component of the reflected wave in the waveguide input, in the z =0 plane.



a. Give $f_1^+(x,z)$ and $f_1^-(x,z)$ as a function of a, x, z, β (propagation constant).

b. A short circuit is placed in the plane z=l. The reflection coefficient is defined by $\rho\,(z)= E_y^-(x,y,z)/E_y^+(x,y,z)$
Give the expression of ρ (z).

Draw the component $E_y(x=a/4,y=b/2,z)$ along the propagation axis.