Guias de Ondas Metálicos - Parte 3

1) Considere um guia com $a = 5cm$ e $b = 2cm$

$$E_z = 20 \sin(40\pi x) \sin(50\pi y) e^{-j\beta_z z} \ V/m \Rightarrow TM$$

$f = 15\ GHz$

a) Modo propagante = ?
b) $\beta_z = ?$
c) E_y / E_x

a) $\beta_x = \frac{m\pi}{a} = 40\pi \qquad m = 40 \cdot 0{,}05 = 2$

$\beta_y = \frac{n\pi}{b} = 50\pi \qquad n = 50 \cdot 0{,}02 = 1$

modo $\Rightarrow$ TM_{21}

b) $\beta_z = \sqrt{\omega^2 \mu\epsilon - \beta_x^2 - \beta_y^2} = 241{,}3\ rd/m$

c) $\frac{E_y}{E_x} = -\frac{\beta_x}{\beta_y} \tan(\beta_x x) \cot(\beta_y y)$ (checar)

2) Considere um guia com $a = 1{,}5cm$ e $b = 0{,}8cm$, $\sigma = 0$, $\mu = \mu_0$ e $\epsilon = 4\epsilon_0$

$$H_x = 2 \sin\left(\frac{\pi x}{a}\right) \cos\left(\frac{3\pi y}{b}\right) \sin\left(\pi \times 1 \times 10^{11} t - \beta_z z\right) A/m$$

a) modo de operação
b) freq. de corte
c) $\beta_z = ?$
d) $\gamma = ? \qquad \gamma = \alpha + j\beta$
e) Impedância intrínseca. Prove que $\eta_{TM} = \frac{E_x}{H_y} = -\frac{E_y}{H_x}$

a) $\beta_x = \frac{m\pi}{a} = \frac{\pi}{a} \Rightarrow m = 1$

$\beta_y = \frac{n\pi}{b} = \frac{3\pi}{b} \Rightarrow n = 3$

$\Big\}$ TM_{13} ou TE_{13}

b) Supondo TM

$$f_{13c} = \frac{1}{2\pi\sqrt{\mu_0 4\epsilon_0}}\left[\frac{\pi^2}{0{,}015^2} + \frac{9\pi^2}{0{,}008^2}\right]^{1/2}$$

$f_{13c} = 28{,}57\ GHz$

c) $\beta_z = \sqrt{\omega^2 \mu_0 4\epsilon_0 - \frac{\pi^2}{a^2} - \frac{9\pi^2}{b^2}}$

$\beta_z = 1720{,}667\ rd/m$

d) $\gamma = \alpha + j\beta$ $\qquad \sigma = 0 \Rightarrow \alpha = 0$

$\gamma = j\beta$

e) $\eta_{TM} = \frac{E_x}{H_y} = -\frac{E_y}{H_x}$

$\eta_{TM} = \frac{\beta_z}{\omega\epsilon} = \frac{1720{,}667\ rd/m}{\pi \times 10^{11} \cdot 4 \cdot \epsilon_0}$

$\eta_{TM} = 154{,}7\ \Omega$

3) Que modos existem em um guia quadrado (100mm x 100mm) p/ frequencias abaixo de 3.75 GHz ?