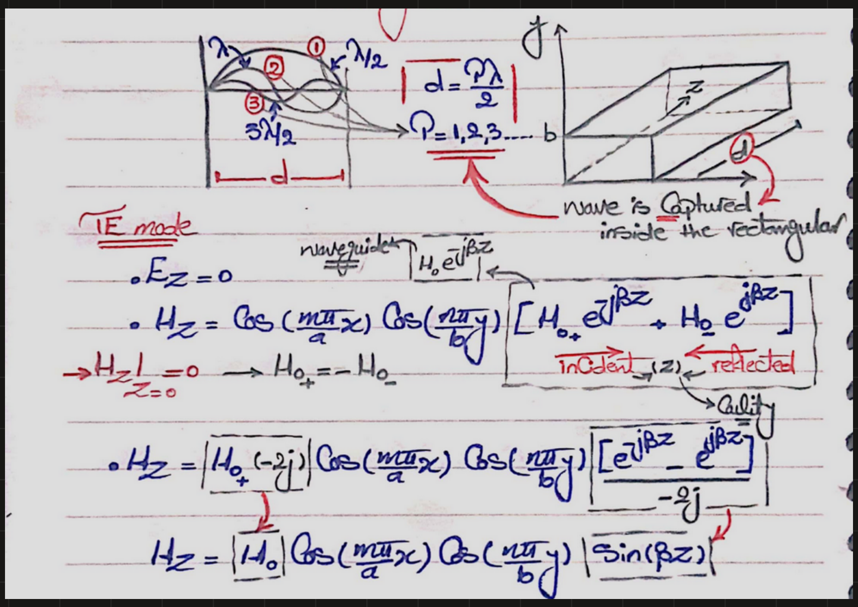


$d = \frac{P\lambda}{2}$

$P = 1, 2, 3, \ldots$

wave is Captured inside the rectangular Cavity

TE mode

- $E_z = 0$
- $H_z = \cos\left(\frac{m\pi}{a}x\right)\cos\left(\frac{n\pi}{b}y\right)\left[H_{o+}e^{-j\beta z} + H_{o-}e^{j\beta z}\right]$

waveguide $\neq$ $H_o e^{-j\beta z}$

incident (z) reflected

$\rightarrow H_z\big|_{z=0} = 0 \rightarrow H_{o+} = -H_{o-}$

- $H_z = \boxed{H_{o+}(-2j)}\cos\left(\frac{m\pi}{a}x\right)\cos\left(\frac{n\pi}{b}y\right)\boxed{\frac{\left[e^{-j\beta z} - e^{j\beta z}\right]}{-2j}}$

$H_z = \boxed{H_o}\cos\left(\frac{m\pi}{a}x\right)\cos\left(\frac{n\pi}{b}y\right)\boxed{\sin(\beta z)}$

$$H_z = H_o\cos\left(\frac{\pi m}{a}x\right)\cos\left(\frac{\pi n}{b}y\right)\sin(\beta z)$$

$$H_z\big|_{z=d} = 0 \rightarrow \therefore \sin(\beta d) = 0 \rightarrow \therefore \beta d = P\pi$$

$$\therefore \beta = \frac{P\pi}{d}, \quad P = 1, 2, 3, \ldots$$

$$\beta = \frac{2\pi}{\lambda}$$

- $H_z = H_o\cos\left(\frac{\pi m}{a}x\right)\cos\left(\frac{\pi n}{b}y\right)\sin\left(\frac{\pi P}{d}z\right)$

Transverse Components:

$$\begin{bmatrix} E_x \\ H_y \\ E_y \\ H_x \end{bmatrix} = \frac{1}{K_c^2}\begin{bmatrix} \partial/\partial z & -j\omega\mu & 0 & 0 \\ -j\omega\epsilon & \partial/\partial z & 0 & 0 \\ 0 & 0 & \partial/\partial z & j\omega\mu \\ 0 & 0 & j\omega\epsilon & \partial/\partial z \end{bmatrix}\begin{bmatrix} \partial E_z/\partial x \\ \partial H_z/\partial y \\ \partial E_z/\partial y \\ \partial H_z/\partial x \end{bmatrix}$$

- $K_c^2 = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 \rightarrow$ Same as waveguide

TE_{101} mode $\rightarrow$ dominate mode :

$\rightarrow E_z = 0, \quad H_z = H_o\cos\left(\frac{\pi}{a}x\right)\sin\left(\frac{\pi}{d}z\right), \quad H_y = 0, \quad E_z = 0, \quad K_c = \frac{\pi}{a}$

$\rightarrow E_y = j\omega\epsilon/K_c^2 \cdot \frac{\partial H_z}{\partial x} = \checkmark$

$\rightarrow H_x = \frac{1}{K_c^2}\frac{\partial}{\partial z}\left[-H_o \cdot \frac{\pi}{a}\sin\left(\frac{\pi}{a}x\right)\sin\left(\frac{\pi}{d}z\right)\right]$

$= \frac{-1}{K_c^2} \cdot H_o \cdot \frac{\pi}{a} \cdot \frac{\pi}{d}\sin\left(\frac{\pi}{a}x\right)\cos\left(\frac{\pi}{d}z\right)$

Quality Factor

$\rightarrow Q = \frac{\omega_o W_{av}}{P_L}, \quad W_{av} = W_E + W_H = 2W_E = 2W_H$

P_L: Power loss in Cavity wall

$\rightarrow \therefore K_c^2 = \gamma^2 + K^2 \rightarrow \therefore \left(\frac{\pi}{a}\right)^2 = -\beta^2 + \left(\frac{\omega}{v}\right)^2$

$\therefore \left(\frac{\pi}{a}\right)^2 = -\left(\frac{\pi}{d}\right)^2 + \frac{\omega^2}{v^2}$

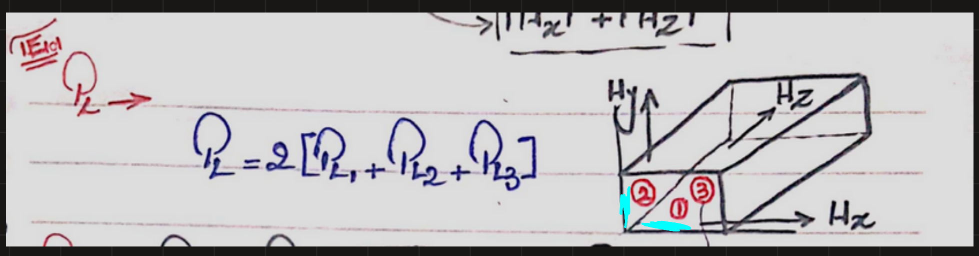
$\therefore \omega^2 = v^2\left[\left(\frac{\pi}{a}\right)^2 + \left(\frac{\pi}{d}\right)^2\right] \rightarrow \therefore \omega_{o_{101}} = v\sqrt{\left(\frac{\pi}{a}\right)^2 + \left(\frac{\pi}{d}\right)^2}$

$\rightarrow W_{av} = 2W_E, \quad W_E = \frac{\epsilon}{4}\iiint |E_t|^2\, dv$ (Ey only)

$\therefore W_E = \frac{\epsilon}{4}\int_0^c\int_0^b\int_0^a \left(\frac{\omega\mu}{K_c}\right)^2 (H_o)^2 \sin^2\left(\frac{\pi}{a}x\right)\sin^2\left(\frac{\pi}{d}z\right)\, dx\, dy\, dz$

$\therefore W_E = \frac{\epsilon}{4}\left(\frac{\omega\mu}{K_c}\right)^2 (H_o)^2 \left(\frac{a}{2}\right)(b)\left(\frac{d}{2}\right)$ #

$\therefore W_{av} = 2W_E = \checkmark$



TE_{101}

$P_L = 2[P_{L1} + P_{L2} + P_{L3}]$

$\rightarrow P_L = 2(P_{L1} + P_{L2} + P_{L3})$

- $P_{L1} = \frac{1}{2}R_s\int_0^d\int_0^a \left(|H_x|^2_{y=0} + |H_z|^2_{y=0}\right) dx\, dz$

$\therefore P_{L1} = \checkmark$

- $P_{L2} = \frac{1}{2}R_s\int_0^d\int_0^b \left(|H_y|^2_{x=0} + |H_z|^2_{x=0}\right) dy\, dz = \checkmark$

- $P_{L3} = \frac{1}{2}R_s\int_0^b\int_0^a \left(|H_x|^2_{z=0} + |H_y|^2_{z=0}\right) dx\, dy = \checkmark$

$\therefore Q = \frac{\omega_o W_{av}}{P_L} = \checkmark \qquad 10^4 : 10^6$