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1)

Tarea Mod 3

1. $\vec{H}^{inc}(z) = (2\hat{a}_x - j\hat{a}_y)e^{-j\beta z}$ [A/m] y $f = 3\times10^{8}$ [Hz]

medio homogeneo: $\mu = \mu_0$ $\varepsilon = 9\varepsilon_0$ $\sigma = 0$

a) $\vec{H}^{inc}(z) = (2\hat{a}_x - j\hat{a}_y)e^{-j\beta z}$ [A/m] $\longrightarrow \vec{H}^{inc}(r) = \hat{a}_H H_0 e^{-j\vec{k}\cdot\vec{r}}$ [A/m]

$$\vec{K}\cdot\vec{r} = \beta z$$

$$\vec{H}^{inc}(r) = \frac{(2\hat{a}_x - j\hat{a}_y)}{\sqrt{2^2+1^2}}\cdot\sqrt{5}\cdot e^{-j\beta z}$$

$$\left(\frac{2}{\sqrt{3}}\hat{a}_x - \frac{1}{\sqrt{3}}j\hat{a}_y\right)\sqrt{5}\,e^{-j\beta z}$$

- $H_0 = \sqrt{5}$
- $\hat{a}_H = \frac{2}{\sqrt{5}}\hat{a}_x - \frac{1}{\sqrt{5}}j\hat{a}_y$

$$\vec{K}\cdot\vec{r} = \beta z = \underbrace{K_z\cdot\hat{a}_z}_{\vec{K}}\cdot\underbrace{z\,\hat{a}_z}_{\vec{r}}$$

$$\Rightarrow \vec{K} = \beta\hat{a}_z$$

$f = 3\cdot10^{8}$ Hz $= 0{,}3$ [GHz] ; $\lambda = \frac{V_p}{f} = \frac{1}{\sqrt{\mu_0\cdot 9\varepsilon_0}}\cdot\frac{1}{f} = \frac{1}{\sqrt{4\pi\cdot10^{-7}\cdot 9\cdot\frac{1}{36\pi}\cdot10^{-9}}}\cdot\frac{1}{f}$

- $\lambda = \frac{1}{\sqrt{1\cdot10^{-16}}}\cdot\frac{1}{3\cdot10^{8}} = 0{,}33$ mt
- $\beta = \frac{2\pi}{\lambda} = 6{,}06\pi$ [rad/mt] $\Rightarrow \vec{K} = 6{,}06\pi\hat{a}_z$, $\vec{r} = z\hat{a}_z$

$\therefore \vec{H}^{inc}(r) = \left(\frac{2}{\sqrt{5}}\hat{a}_x - j\frac{1}{\sqrt{5}}\hat{a}_y\right)\cdot\sqrt{5}\cdot e^{-j6{,}06\pi\hat{a}_z\cdot\vec{r}}$ [A/m]

b) $\vec{H}^T = \vec{H}^{inc} + \vec{H}^{ref}$ [A/m] $\qquad \vec{E} = -\eta\cdot\vec{H}\times\hat{a}_K$

$$\eta_1 = \sqrt{\frac{j\omega\mu_0}{\cancel{\sigma}+j\omega\varepsilon}} \Rightarrow \eta_1 = \sqrt{\frac{4\pi\cdot10^{-7}}{9\cdot\frac{1}{36\pi}\cdot10^{-9}}} = \sqrt{\frac{4\cdot10^{-7}}{2{,}5\cdot10^{-10}}}\,\pi = 40\pi$$

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$\eta_2 = 0 \Rightarrow \Gamma_{12} = -1 : \dfrac{\eta_2 - \eta_1}{\eta_2 + \eta_1} \Rightarrow \tau = 0$: reflexión total interna de E

$$\vec{H}(z) = \sqrt{5}\,\left(e^{-j6,06\pi z} - (-1)e^{j6,06\pi z}\right)\left(\frac{2}{\sqrt{5}}\hat{a}_x - \frac{1}{\sqrt{5}}j\hat{a}_y\right) \; [A/m]$$

$$\vec{H}(z) = \sqrt{5}\,\left(e^{-j6,06\pi z} + e^{j6,06\pi z}\right)\left(\frac{2}{\sqrt{5}}\hat{a}_x - \frac{1}{\sqrt{5}}j\hat{a}_y\right) \; [A/m]$$

$$\therefore \vec{E}(z) = \eta_1 H_0 \left(e^{-\gamma_1 z} + \Gamma e^{\gamma_1 z}\right)(\hat{a}_E) \; [V/m]$$

$$= 40\sqrt{5}\pi\left(e^{-j6,06\pi z} - e^{j6,06\pi z}\right)(\hat{a}_E) \; [V/m]$$

$\hat{a}_E$, $\vec{K}$, $\hat{a}_H$ $\qquad \hat{a}_H \times \vec{K} = \hat{a}_E$

$$\left(\frac{2}{\sqrt{5}}\hat{a}_x - \frac{1}{\sqrt{5}}j\hat{a}_y\right) \times 6,06\pi\,\hat{a}_z = \hat{a}_E$$

$$\begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{2}{\sqrt{5}} & -\frac{1}{\sqrt{5}}j & 0 \\ 0 & 0 & 6,06\pi \end{vmatrix} = -\frac{6,06\pi j\hat{a}_x}{\sqrt{5}} - \frac{12,12\pi}{\sqrt{5}}\hat{a}_y$$

$$\therefore \vec{E}(z) = 40\sqrt{5}\pi\left(e^{-j6,06\pi z} - e^{j6,06\pi z}\right)\left(-\frac{6,06\pi}{\sqrt{5}}j\hat{a}_x - \frac{12,12\pi}{\sqrt{5}}\hat{a}_y\right) \; [V/m]$$

c) $\vec{J}_s$, $z=0$

de (b) se que $H^T = \left(\dfrac{2}{\sqrt{5}}\hat{a}_x - \dfrac{1}{\sqrt{5}}j\hat{a}_y\right)\sqrt{5}\left(e^{-j6,06\pi z} + e^{j6,06\pi z}\right)$ [A/m]

$\hat{a}_n = -\hat{a}_z$

$$\vec{J} = -\hat{a}_z \times \left(\frac{2\hat{a}_x}{\sqrt{5}} - \frac{1}{\sqrt{5}}j\hat{a}_y\right)\sqrt{5}\left(e^{-j6,06\pi z} + e^{j6,06\pi z}\right)$$

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$$\begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ 6 & 0 & -1 \\ \frac{2}{\sqrt{3}} & -\frac{1}{\sqrt{3}} & 0 \end{vmatrix} = \frac{-1}{\sqrt{3}}\hat{a}_x + \frac{2}{\sqrt{5}}\hat{a}_y$$

$$\therefore \vec{J}_s = \left(\frac{-1}{\sqrt{5}}\hat{a}_x + \frac{2}{\sqrt{5}}\hat{a}_y\right)\sqrt{3}\left(e^{-j6,06\pi z} + e^{j6,06\pi z}\right) \quad [A/m]$$

d) polarización de la OEMPU reflejada:

$$\vec{E}^r(z) = 40\sqrt{5}\pi\left(-e^{j6,06\pi z}\right)\left(-\frac{6,06\pi j}{\sqrt{5}}\hat{a}_x - \frac{12,12}{\sqrt{5}}\hat{a}_y\right) \quad [V/m]$$

$$\vec{E}^r(z,t) = \mathrm{Re}\left\{\vec{E}^r(z)\cdot e^{j\omega t}\right\}$$

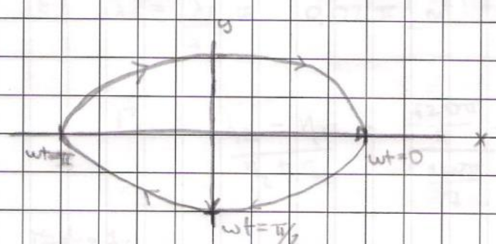
$$= \mathrm{Re}\left\{40\sqrt{5}\pi\, e^{j6,06\pi z}\cdot e^{j\omega t}\cdot\left(\frac{6,06}{\sqrt{5}}j\pi\,\hat{a}_x + \frac{12,12}{\sqrt{5}}\hat{a}_y\right)\right\}$$

$$= \mathrm{Re}\left\{242,4\pi^2 e^{j(6,06\pi z + \omega t + \pi/2)}\hat{a}_x + 484,8\pi\, e^{j(\omega t + 6,06\pi z)}\hat{a}_y\right\}$$

$$= 242,4\pi^2\cos(6,06\pi z + \omega t + \pi/2)\hat{a}_x + 484,8\pi\cos(\omega t + 6,06\pi z)\hat{a}_y$$

$$\vec{E}^r(z,t) = -242,4\pi^2\,\mathrm{sen}(6,06\pi z + \omega t)\hat{a}_x + 484,8\pi\cos(6,06\pi z + \omega t)\hat{a}_y$$

$$\vec{E}(z=0,t) = -242,4\pi^2\,\mathrm{sen}(\omega t)\hat{a}_x + 484,8\pi\cos(\omega t)\hat{a}_y$$



Polarización a la derecha
favor manecillas del reloj

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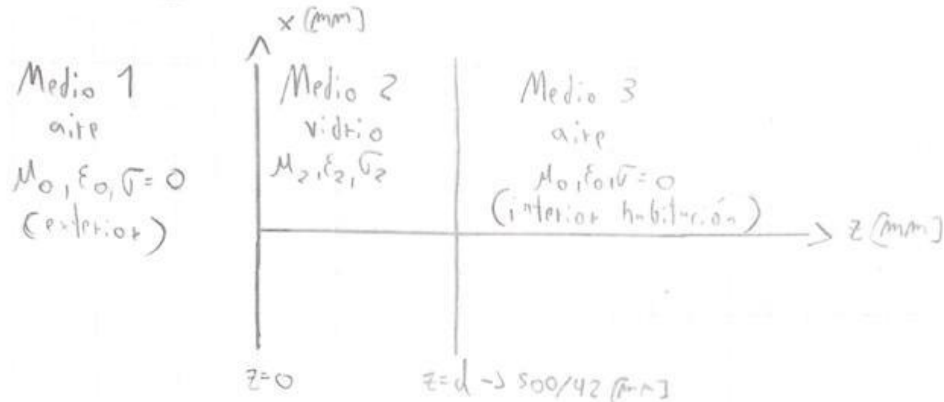
2)

Ejercicio 2



Medio 1
↳ $\vec{E}^{in}(\vec{r}) = \hat{a}_x\, 2\times10^{-3}\sqrt{60\pi}\, e^{-j12\pi z}$ [V/m]

- Smartphone requiere una densidad de potencia promedio mínima de 1 [μW/m²]
- El vidrio de la ventana (medio 2) tiene un espesor $d = 500/42$ [mm]
- $\mu_2 = \mu_0$, $\varepsilon_2 = 49\cdot\varepsilon_0$, $\sigma_2 = 10^{-10}$ [S/m]

2a) Medio ①

$\mu_1 = \mu_0$; $\varepsilon_1 = \varepsilon_0$, $\sigma = 0$

η_1 (Impedancia intrínseca) $= \eta_0$

$^*\beta_1 = 12\pi$ [rad/m]

$\lambda_1 = \frac{2\pi}{\beta} = \frac{2\pi}{12\pi} = 0{,}16$ [m]

$\gamma = \alpha + j\beta$, $\alpha = 0$

$^*\gamma = j\cdot 12\pi$

$^*\eta_0 = \sqrt{\frac{4\pi\cdot10^{-7}\cdot 36\cdot\pi}{10^{-9}}} = \sqrt{14\,2122{,}3034} = 120\cdot\pi$

Medio ②

$\varepsilon_2 = 49\cdot\varepsilon_0$

$\eta_2 = \eta_0/\sqrt{49} = \eta_0/7$

$\lambda_2 = \lambda_1/7 = 0{,}02$ [m]

$\boxed{\eta_2 = \frac{120\cdot\pi}{7} = 17\cdot\pi}$

$\beta_2 = 7\cdot\beta_1 = 7\cdot12\pi = 84\pi$ [rad/m]

$\boxed{\gamma_2 = j\pi\cdot 84}$

Medio ③

$\varepsilon_3 = \varepsilon_0$

$\mu_3 = \mu_0$

$^*\lambda_3 = \lambda_1 = 1{,}6$ [m]

$^*\beta_3 = 12\cdot\pi$

$^*\eta_3 = 120\cdot\pi$

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2b) Medio 2

$$\vec{H}_2^{\,T}(z) = \hat{a}_H \, \frac{E_2^+}{\eta_2} \cdot e^{-j\cdot\beta_2 z} \left(1 - \Gamma_2(z)\right) \; [A/m]$$

$$\vec{E}_2^{\,T}(z) = \hat{a}_E \, E_2^+ \cdot e^{-j\beta_2 z} \left(1 + \Gamma_2(z)\right) \; [V/m]$$

$$P_{av} = \frac{1}{2} \cdot \frac{|E_2^+|^2}{\eta_2} \rightarrow 10^{-6} = \frac{1}{2} \cdot \frac{|E_2^+|^2}{17\pi} \rightarrow |E_2^+|^2 = \frac{34\pi}{10^6} \rightarrow |E_2^+|^2 = 3{,}4\times 10^{-5}\,\pi$$

$$E_2^+ = 5{,}830 \times 10^{-3}\sqrt{\pi} \quad \checkmark$$

$$\Gamma_2(z) = \Gamma_{23} \cdot e^{-j2\beta_2(d-z)} = \frac{3}{4} \cdot e^{-j168\pi\left(\overset{d}{\frac{1}{84}} - z\right)}$$

$$\vec{E}_2^{\,T} = \hat{a}_x \, 5{,}83\times 10^{-3}\sqrt{\pi} \cdot e^{-j84\pi z} \left(1 + \frac{3}{4} \cdot e^{-j168\pi\left(\frac{1}{84} - z\right)}\right) \; [V/m]$$

$$\boxed{\vec{H}_2^{\,T}(z) = \hat{a}_y \cdot \frac{5{,}83\times 10^{-3}\sqrt{\pi}}{17\cdot\pi} \cdot e^{-j84\pi z} \left(1 - \frac{3}{4} \cdot e^{-j168\pi\left(\frac{1}{84} - z\right)}\right) \; [A/m]}$$

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2c)

Calculamos coef. de reflexión locales:

① | ② | ③

$$\Gamma_{12}^{\text{(y-a)}} = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = \frac{\eta_0/7 - \eta_0}{\eta_0/7 + \eta_0} = \frac{17\pi - 120\pi}{17\pi + 120\pi} = \frac{-103\pi}{137\pi} =$$

$$\Gamma_{12} = -0{,}75 = -\frac{3}{4}$$

① | ② | ③

$$\Gamma_{23} = \frac{\eta_3 - \eta_2}{\eta_3 + \eta_2} = \frac{120\pi - 17\pi}{120\pi + 17\pi} = 0{,}75 \rightarrow \Gamma_{23} = \frac{3}{4}$$

Medio 1

$$E_1^T(z) = \hat{a}_E \left[\underbrace{E_1^+ \cdot e^{-j\beta_1 z}}_{\rightarrow} + \underbrace{E_1^- e^{j\beta_1 z}}_{\leftarrow} \right] [V/m]$$

eléctrico

$$= \hat{a}_E E_1^+ e^{-j\beta_1 z} \left[1 + \underbrace{\frac{E_1^-}{E_1^+} e^{j2\beta_1 z}}_{\Gamma_1^{(y\ldots)}(z)} \right] [V/m]$$

$*$, eléctrico

$$\vec{E}_1^T = \hat{a}_E E_1^+ e^{-j\beta_1 z} (1 + \Gamma_1(z)) \, [V/m] \quad , \Gamma_1 \neq \Gamma_{12}$$

Calculamos $\Gamma_1(z) \rightarrow$ $\left| \Gamma_2(z) \right|_{z=0}^{z=d} \rightarrow \Gamma_{23} = 3/4 \rightarrow \Gamma_2(z) = \Gamma_{23} \cdot e^{-j2\beta_2(d-z)}$

$z = d \rightarrow \Gamma_2(z=d) = \Gamma_{23} \rightarrow z = 0 \ \boxed{\Gamma_2(z=0^+) = \Gamma_{23} \cdot e^{-j2\beta_2 d}} \rightarrow Z_2(z=0^+) = \eta_2 \frac{(1 + \Gamma_2(z=0^+))}{(1 - \Gamma_2(z=0^+))}$

$Z_1(z=0^-) = Z_2(z=0^+)$

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2c/(continuación)

$$\Gamma_1(z) = \Gamma_{12} \cdot e^{-j2 \cdot 12\pi z} \quad , \Gamma_{12} = \frac{-3}{4}$$

$$\boxed{\therefore \; E_1^T = \hat{a}_x \cdot 2 \times 10^{-3} \sqrt{60\pi} \cdot e^{-j12\pi z} \left(1 - \frac{3}{4} \cdot e^{-j24\pi z}\right) [V/m]}$$

2d) $\vec{E}_2^T(z) = \hat{a}_x \, 5{,}83 \times 10^{-3} \sqrt{\pi} \cdot e^{-j84\pi z} \left(1 + \frac{3}{4} \cdot e^{-j168\pi\left(\frac{1}{84} - z\right)}\right) (V/m)$

$$\vec{H}_2^T(z) = \hat{a}_y \frac{5{,}83 \times 10^{-3} \sqrt{\pi}}{17 \cdot \pi} \cdot e^{-j84\pi z} \left(1 - \frac{3}{4} \cdot e^{-j168\pi\left(\frac{1}{84} - z\right)}\right) [A/m]$$

Vector Poynting

$$S = \vec{E}(z) \times \vec{H}(z)^* = \frac{(5{,}83 \times 10^{-3})^2}{17} = 1{,}99 \times 10^{-6} \, \hat{a}_z$$

$$\boxed{\text{Potencia Promedio: } P_{av} = \frac{1}{2} \cdot 1{,}99 \times 10^{-6} \, \hat{a}_z = 9{,}99 \times 10^{-7} \, [W/m^2]}$$

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2e)

$\beta_1 = 12 \cdot \pi = 2\pi f \qquad 12 = 2 \cdot f \rightarrow f = 6 \rightarrow f/2 \rightarrow$ a la mitad $f = 3$

$2 \cdot f \rightarrow 2 \cdot 3 \rightarrow \boxed{\beta_1 = 6\pi}$, Nuevo βheta 1

$\lambda_1 = \frac{2\pi}{\beta} \rightarrow$ Antes $\lambda_1 = \frac{2\pi}{12\pi} = 0{,}16$ [m]

Ahora $\Rightarrow \lambda_1 = \frac{2\pi}{6\pi} = \frac{1}{3}$ [m] $= 0{,}3$ [m]

Por lo tanto $\lambda_2 = \frac{\lambda_1}{7} = \frac{0{,}3}{7} = 0{,}04$ [m]

$\eta_2 = \frac{120 \cdot \pi}{7} = 17\pi$

$\beta_2 = 7 \cdot \beta_1 = 7 \cdot 6\pi \rightarrow \boxed{\beta_2 = 42\pi \text{ [rad/m]}}$

Nuevo βheta 2

Los nuevos campos quedarían :

$$E_2^T = \hat{a}_x \, 5{,}83 \times 10^{-3} \sqrt{\pi} \cdot e^{-j42\pi z} \left(1 + 3/4 \cdot e^{-j84\pi\left(\frac{1}{84} - z\right)}\right) \text{ [V/m]}$$

$$H_2^T = \hat{a}_y \cdot \frac{5{,}83 \times 10^{-3} \sqrt{\pi}}{17\pi} \cdot e^{-j42\pi z} \left(1 - 3/4 \cdot e^{-j84\pi\left(\frac{1}{84} - z\right)}\right) \text{ [A/m]}$$

Vector Poynting

$$S = \vec{E}(z) \times H(z)^* = \frac{(5{,}83 \times 10^{-3})^2}{17} = 1{,}99 \times 10^{-6} \, \hat{a}_z \rightarrow \boxed{P_{av} = \frac{1}{2} \cdot S = 9{,}99 \times 10^{-7} \text{ W/m}^2}$$

Al final vemos que el "λ_2" y el "β_2" cambian debido a que la frecuencia disminuye, por lo tanto los resultados de los campos eléctrico y magnético cambian.

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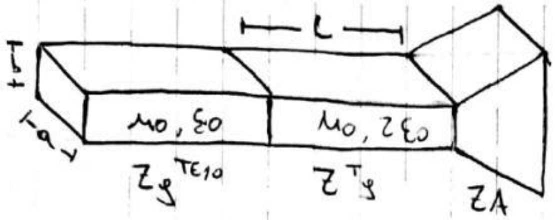
3)

3.



$$\frac{a}{b} = \frac{30}{24} = \frac{5}{4} = 1{,}25$$

a) Mono modo

$$F_c\,TE_{10} = C/2a = [3{,}7 - 0{,}1]\,[GHz] = 3{,}6\,[GHz]$$

$$a = \frac{3\times10^8}{2\cdot 3{,}6\times10^9} = \frac{1}{24}\,[m]$$

$$F_c\,TE_{01} = \frac{C}{2b} = [4{,}2 + 0{,}3]\,[GHz] = 4{,}5\,[GHz]$$

$$b = \frac{3\times10^8}{2\cdot 4{,}5\times10^9} = \frac{1}{30}\,[m]$$

b) Potencia Máximo Promedio 10 [kW]

$$P_{av}\,TE_{10} = \frac{1}{4 Z_g^{TE_{10}}}\cdot E_{max}^2\, a\times b \Rightarrow, \quad Z_g^{TE_{10}} = \frac{120\pi}{\sqrt{1-(F_cTE_{10}/F_{op})^2}}$$

El Máximo Campo se logra en el extremo superior ($Z_g^{TE_{10}}$ Mayor)

$$F_{op} = 3{,}7\,[GHz] \Rightarrow Z_g^{TE_{10}} = \frac{120\pi}{\sqrt{1-(3{,}6/3{,}7)^2}} = 1632{,}5685\,[\Omega]$$

$$E_{Max} = \sqrt{\frac{4\cdot Z_g^{TE_{10}}\cdot 10^4}{a\cdot b}} = \sqrt{\frac{4\cdot 1632{,}5685\cdot 10^4}{\frac{1}{24}\cdot\frac{1}{30}}}$$

$$E_{Max} = 216\,836.2811\,[V/m]$$

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c) $f_{central} = \frac{3,7+4,2}{2} = 3,95 \text{ [GHz]}$

$$Z_g^{TE10} = \frac{120\pi}{\sqrt{1-(3,6/3,95)^2}} = 916,05 \text{ [}\Omega\text{]}$$

$\varepsilon = 2\varepsilon_0$

$$F_{c\,TE10} = \frac{c}{\sqrt{\varepsilon}\cdot 2\cdot a} = \frac{3\times10^8}{\sqrt{2}\cdot 2\cdot \frac{1}{24}} = 2545584412 \text{ [Hz]}$$

$$Z_{g\,TE10}^{T} = \frac{120\pi}{\sqrt{2}\cdot\sqrt{1-\left(\frac{3,6}{\sqrt{2}\cdot 3,95}\right)^2}} = 348,6 \text{ [}\Omega\text{]}$$

$$Z_A = \frac{{Z'}_{g\,TE10}^{T\,2}}{Z_g^{TE10}} = \frac{348,6^2}{916,05} = 132,6586 \text{ [}\Omega\text{]}$$

$L = \lambda_g/4 \qquad \lambda_g = \frac{\lambda_0}{\sqrt{1-\left(\frac{3,6}{\sqrt{2}\cdot 3,95}\right)^2}\cdot\sqrt{\varepsilon}}$

$$\lambda_g = \frac{300}{3950\cdot\sqrt{2}\cdot\sqrt{1-\left(\frac{3,6}{\sqrt{2}\cdot 3,95}\right)^2}} = \underline{0,0702 \text{ [m]}} \;//$$

$$L = \frac{0,0702}{4}$$

$$L = \underline{0,01755 \text{ [m]}} \;//$$

4)

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4 a)

$a/b = 3/2 = 1,5 \Rightarrow TE_{10} < f \leq TE_{01}$

Principal : $FCTE_{10}^{(1)} = \frac{c}{2a} = \frac{3\times10^{8}}{2\cdot 3\times10^{-2}} = \underline{5\,[GHz]}$ //

$FCTE_{01}^{(1)} = 1,5 \cdot FCTE_{10} = 1,5\cdot 5 = \underline{7,5\,[GHz]}$ //

Guia $\lambda g/4$: $FcTE_{10}^{(2)} = \frac{c/\sqrt{\varepsilon_{r2}}}{2a} = \underline{5/\sqrt{\varepsilon_{r2}}\,[GHz]}$ (A)

$FCTE_{01}^{(2)} = 1,5\cdot 5/\sqrt{\varepsilon_{r2}} = \underline{7,5/\sqrt{\varepsilon_{r2}}\,[GHz]}$ (B)

$Z_A = [Z_g^{(2)}]^2 / Z_g^{(1)} = 300\,[\Omega]$

$Z_g^{(1)} = \frac{120\pi}{\sqrt{1-\left(5\Big/\frac{5+7,5/\sqrt{\varepsilon_{r2}}}{2}\right)^2}}$

$Z_g^{(2)} = \frac{120\pi\sqrt{\varepsilon_{r2}}}{\sqrt{1-\left(5/\sqrt{\varepsilon_{r2}}\Big/\frac{5+7,5/\sqrt{\varepsilon_{r2}}}{2}\right)^2}}$

$F_{central} = \frac{5+7,5/\sqrt{\varepsilon_{r2}}}{2}$

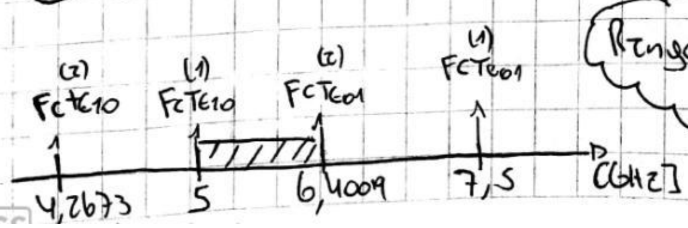
$F_{central} = \frac{5+7,5/\sqrt{1,37287}}{2} = 5,7004\,[GHz]$ //

Usando Wolfram para $[Z_g^{(2)}]^2 / Z_g^{(1)} = 300$ tenemos :

$\underline{\varepsilon_{r2} = 1,37287}$

(A) $= 5/\sqrt{\varepsilon_{r2}} = 5/\sqrt{1,37287} = \underline{4,2673}$ // $FcTE_{10}^{(2)}$

(B) $= 7,5/\sqrt{\varepsilon_{r2}} = 7,5/\sqrt{1,37287} = \underline{6,4009}$ // $FcTE_{01}^{(2)}$



Rango de onda :
$5\,[GHz] < f \leq 6,4009\,[GHz]$

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c) $L = \lambda_g^{(2)}/4 = ?$

$$\lambda_g^{(2)} = \frac{\lambda_0/\sqrt{\varepsilon_{r2}}}{\sqrt{1-(f_{c\,TE_{10}}^{(2)}/F)^2}} = \frac{(30/5{,}7004)/\sqrt{1{,}37287}}{\sqrt{1-(4{,}2673/5{,}7004)^2}}$$

$$\lambda_g^{(2)} = 6{,}7743\,[cm]$$

$$L = \lambda_g^{(2)}/4 = \frac{6{,}7743}{4} = \underline{1{,}6935\,[cm]}\,//$$