

① $0,4738 \sin(377t) \text{ V}$

② $\frac{1}{2} B_0 \omega l^2$

③ -54 V

④ $0,97 \text{ mV}$

⑤ $277,8 \text{ A/m}^2$, $77,78 \text{ mA}$

⑥ a) $0,444 \times 10^{-3}$

b) $5,55$

c) $7,2 \times 10^{-4}$

⑦ 36 GHz

⑧ a) $\vec{\nabla} \times \vec{E} = j\omega \mu \vec{H}_f$ $\vec{\nabla} \times \vec{H} = (\sigma - j\omega \epsilon) \vec{E}_f$

b) forma pontual das Eq's de Maxwell.

⑨ $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$, $\vec{\nabla} \times \vec{H} = -\frac{\partial \vec{D}}{\partial t}$

⑩ Deduzir

⑪ a) $-20 \cos(10^9 t - 4y) \hat{a}_x \text{ mC/m}^2$

b) $-5 \mu \times 10^9 \sin(10^9 t - 4y) \hat{a}_z$

c) $1,44$

12) a) at longo de $+dx$

b) $1,047 \times 10^6 \text{ m/s}$

13) a) $300 \mu_0 [\sin(3 \times 10^8 t - 1) - \sin(3 \times 10^8 t)] \text{ Wb}$

$\downarrow$
logo.

$$f_{em} = -1,13 \times 10^5 [\cos(3 \times 10^8 t - 1) - \cos(3 \times 10^8 t)] \text{ V}$$

b) 0

14) a) $-4,32 \text{ V}$

b) $-0,293 \text{ V}$

15) a) $\vec{J} = \left(\frac{10}{\rho}\right) \cos(10^5 t) \hat{\rho} \text{ A/m}^2$

b) $8\pi \cos(10^5 t) \text{ A}$

c) $-0,8\pi \sin(10^5 t) \text{ A}$

d) 0,1

16) $\vec{D} = -\frac{2\beta}{10^{10}} \cos(10^{10} t - \beta x) \hat{a}_y \text{ C/m}^2$

$$\vec{E} = -1,67\beta \cos(10^{10} t - \beta x) \hat{a}_y \text{ V/m}$$

$$\vec{B} = (1,67 \times 10^{-10}) \beta^2 \cos(10^{10} t - \beta x) \hat{a}_z$$

$$\beta = \pm 600 \text{ rad/m}$$

17) Demonstração.

c

18) Repetida com a 16) - excluir!

$$19) a) \vec{\nabla} \cdot \vec{A} = -\mu_0 \epsilon_0 \left(\frac{\partial V}{\partial t} \right) \Rightarrow \propto \sqrt{\mu_0 \epsilon_0} = - \frac{\propto}{\sqrt{\mu_0 \epsilon_0}}$$

$$b) \vec{B} = \left(t - \frac{z}{c} \right) \hat{a}_y \quad T$$

$$\vec{H} = \frac{1}{\mu_0} \left(t - \frac{z}{c} \right) \hat{a}_y \quad A/m$$

$$\vec{E} = (ct - z) \hat{a}_x \quad V/m$$

$$\vec{D} = \epsilon_0 (ct - z) \hat{a}_x \quad C/m^2$$

① a) $\gamma = \alpha + j\beta = 5,41 + j 6,129 \text{ /m}$

b) $\lambda = 1,025 \text{ m}$

c) $u = 5,125 \times 10^7 \text{ m/s}$

d) $\eta = 101,41 \angle 41,44^\circ \Omega$

② a) $\gamma = 0,05 + j2 \text{ /m}$

b) $\lambda = 3,142 \text{ m}$

c) $u = 10^8 \text{ m/s}$

d) $S = 20 \text{ m}$

③ $\omega = 6 \times 10^8 \text{ rad/s}$

$\vec{J}_d = -40 \cos(\omega t - 4z) \hat{a}_y \text{ mA/m}^2$

$\lambda = 1,571 \text{ m}$

④ a) $3,6 \times 10^{-4} \ll 1$

b) $\beta = 12,83 \text{ rad/m} \quad \lambda = 0,49 \text{ m}$

c) $\eta = 4617 \Omega$

⑤ a) 5,6993

b) 1,2566 m e $1,257 \times 10^8$ m/s

E

c) 157,91 Ω

d) $4,737 \sin(2\pi \times 10^8 t - 5x) \hat{a}_y$ V/m

e) $0,15 \cos(2\pi \times 10^8 t - 5x) \hat{a}_y$ A/m

⑥ 5,76 e $-0,2546 \sin(10^9 t - 8x) \hat{a}_y + 0,3183 \cos(10^9 t - 8x) \hat{a}_z$
[A/m]

⑦

a) 1,5

b) 3,515

c) 694,4

⑧

$\lambda = 113,75$ m e $u = 1,5 \times 10^8$ m/s

⑨ $2,94 \times 10^{-6}$ m

⑩

a) $1,34 \times 10^8$ m/s

b) $4,69$ m⁻¹

c) 1,34 m

d) $E_0 \exp(-j4,69z) \hat{a}_x$ V/m

e) $(E_0/169) \exp(-j4,69z) \hat{a}_y$ A/m

⑪

a) 3 cm e 0 ; b) 2,95 cm e $9,24 \times 10^{-2}$ Np/m

c) 1,33 cm e 335 Np/m

⑫

$1,2 \times 10^{10}$ W/m²

⑬

a) $3,3 \mu\text{m}$ e $0,42 \Omega/\text{m}$

b) $0,12 \Omega/\text{m}$

c) $0,54 \Omega/\text{m}$

14) 160Hz e $1,1 \times 10^5 \text{ S/m}$

15)

a) $T = 13,33 \text{ ms}$, $\lambda = 2 \text{ m}$, $v_p = 1,5 \times 10^8 \text{ m/s}$, $\epsilon_r = 4$

$\eta = 188,5 \Omega$

b) $\vec{E}(t) = 266,6 \cos(4,71 \times 10^8 t - \pi x) \hat{y} \text{ V/m}$

$\vec{H}(t) = 1,414 \cos(4,71 \times 10^8 t - \pi x) \hat{z} \text{ A/m}$

c) ~~188,5~~ $188,5 \text{ W/m}^2$

16) 314Ω e 10^8 m/s , $\epsilon_r = 3,6$, $\mu_r = 2,5$

17)

f _{req.}	$P_m(\text{max})$	E_{max}	H_{max}
150 MHz	2 W/m^2	$27,46 \text{ V/m}$	$72,8 \text{ mA/m}$
1,5 GHz	10 W/m^2	$61,4 \text{ V/m}$	163 mA/m
15 GHz	100 W/m^2	$194,2 \text{ V/m}$	515 mA/m

18) Cancelado

Respostas - Problema: Linhas de Transmissão

1) Teônico

2) Teônico

3) Teônico

4) $FGL = \ln \frac{d}{a} = 5,0$

$$FGC = \frac{1}{FGL} = 0,2$$

$$FGR_{cc} = \frac{2}{a^2} = 4,72 \times 10^5 \text{ m}^{-2}$$

$$FGR_{ca} = \frac{2}{a} = 971 \text{ m}^{-1}$$

$$L = \frac{\mu_0}{\pi} (FGL) = 2 \mu\text{H/m}$$

$$C = \pi \epsilon_0 (FGC) = 5,55 \text{ pF/m}$$

$$G = 0 \text{ S/m}$$

$$R_{cc} = \frac{1}{\pi \sigma_c} (FGR_{cc}) = 2,59 \times 10^{-3} \Omega/\text{m}$$

$$R_{ca} = \frac{1}{2\pi \delta_c \sigma_c} (FGR_{ca}) = 4,04 \times 10^{-2} \Omega/\text{m}$$

6) $Z = 6,289 \times 10^{-2} \angle 87,6^\circ \Omega/\text{m}$

$$Y = 1,747 \times 10^{-7} \angle 90^\circ \text{ S/m}$$

$$Z_0 = 600 \angle -1,2^\circ \Omega$$

$$\gamma = 1,048 \times 10^{-4} \angle 88,8^\circ \text{ m}^{-1}$$

$$v_p = 2,998 \times 10^8 \text{ m/s}$$

$$\lambda = 59,96 \text{ km}$$

7) $R = 20,8 \Omega/\text{mi}$

$$L = 630 \mu\text{H}/\text{mi}$$

$$G = 0$$

$$C = 0,103 \mu\text{F}/\text{mi}$$

$$8) \gamma = 0,034 + j 2,25 \text{ m}^{-1}$$

$$\alpha = \uparrow \text{ Np/m}$$

$$\beta = \text{rad/m}$$

$$\lambda = 2,79 \text{ m}$$

$$Z_0 = 93,6 - j 3,64 \Omega$$

9)

$$R = 0$$

$$G = 0$$

$$L = 0,2 \mu\text{H}$$

$$C = 80 \text{ pF}$$

$$\lambda = 15,7 \text{ m}$$

$$10) C = 96 \text{ pF/m}$$

$$v_p = 1,44 \times 10^8 \text{ m/s}$$

$$\beta = 3,5 \text{ rad/m}$$

11)

$$L = 334,2 \text{ mH/m}$$

$$C = 68,2 \text{ pF/m}$$

$$12) \left. \begin{array}{l} R = \\ L = \\ G = \\ C = \end{array} \right\} \begin{array}{l} (c) \\ (d) \\ (e) \end{array}$$

$$13) \text{ Resp: } (b), (e)$$

$$14) Z_0 = \cancel{10,76 - j 7,886} \Omega$$

$$v_p = 2,148 \times 10^7 \text{ m/s}$$

Guia de Onda

$$1) \text{ Resp: } (c)$$

$$2) \text{ Resp: } (a)$$

$$3) \text{ Resp: } (d)$$

$$4) f_c = 4,507 \text{ GHz}$$

$$\beta = 816,2 \text{ rad/m}$$

$$v_p = 1,54 \times 10^8 \text{ m/s}$$

$$5) f_c = 0,833$$

$$f_c = 3,333$$

$$6) a = 8 \text{ mm}$$

$$b = 3 \text{ mm}$$

$$7) f_c = 18,75 \text{ MHz}$$

$$8) a = 3 \text{ cm}$$

$$b = 1,25 \text{ cm}$$

$$9) v_p = 6,975 \times 10^8 \text{ m/s}$$

$$t = 430 \text{ ns}$$

10) Resp: (a)

~~Vetor de Poynting~~ — Problemas 6.8

$$1) P_{\text{rad}} = \eta \frac{\beta^2 I_0^2 d^2}{6\pi}$$

$$R_{\text{rad}} = \frac{\eta \beta^2 d^2}{6\pi}$$

$$2) D = 10$$

$$3) D = \frac{2}{1 - \cos \alpha} = 14,93$$

$$D = \frac{1}{\sin \alpha} = \csc \alpha = 2$$

$$4) A_{\text{eff}} = 0$$

$$A_{\text{eff}}(90^\circ) = 235,6 \text{ cm}^2$$

$$A_{\text{eff}}(30^\circ) = 41,12 \text{ cm}^2$$

$$A_{\text{eff}}(60^\circ) = 157,1 \text{ cm}^2$$

5) $G = 51 \text{ dB}$

6)

$r_{\text{max}} = 1.191 \text{ km}$

7) Teônico

8) Dedução matemática

9) Cancelado

10) teônico

11) $R_{\text{rad}} = 1.974 \Omega$

12) $G = 1.447 \times 10^{-4} \text{ dB}$

13) $P_{\text{med}} = 12.73 \text{ mW/m}^2$

$E_{\text{max}} = 0.098 \text{ V/m}$

14)
$$P_{\text{rad}} = \frac{25}{120} \int_0^\pi 4 (\sin^2 \theta \cos^2 \theta) \sin \theta d\theta = 22 \text{ mW}$$

15) $G = 8 \sin \theta \cos \phi$