

10.1

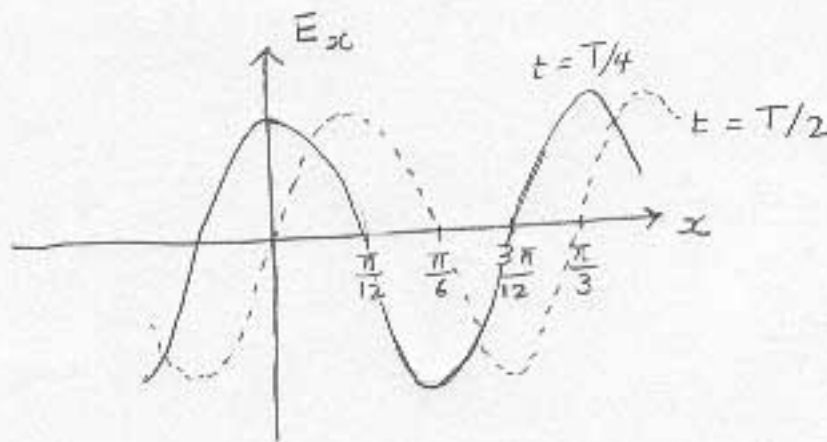
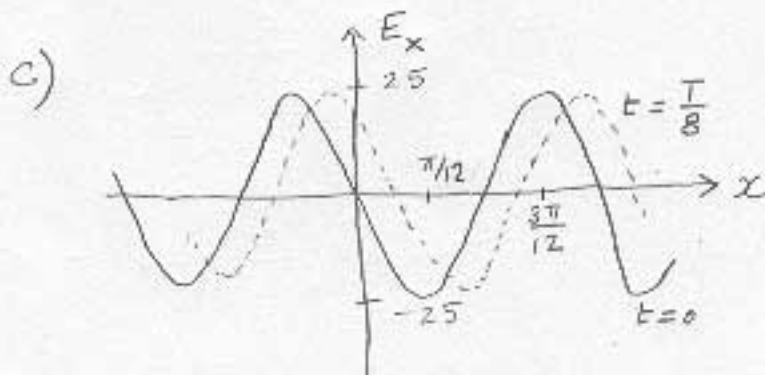
$$\vec{E} = 25 \sin(2\pi \times 10^6 t - 6x) \vec{a}_z \quad [\text{V/m}]$$

a)  $+x$ 

$$b) T = \frac{2\pi}{\omega} = 10^{-6} [\text{s}]$$

$$\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{6} = \frac{\pi}{3} [\text{m}]$$

$$u = \frac{\omega}{\beta} = \frac{2\pi \times 10^6}{6} = 1.047 \times 10^6 [\text{m/s}]$$



There is clearly motion in the  $+x$ -direction.

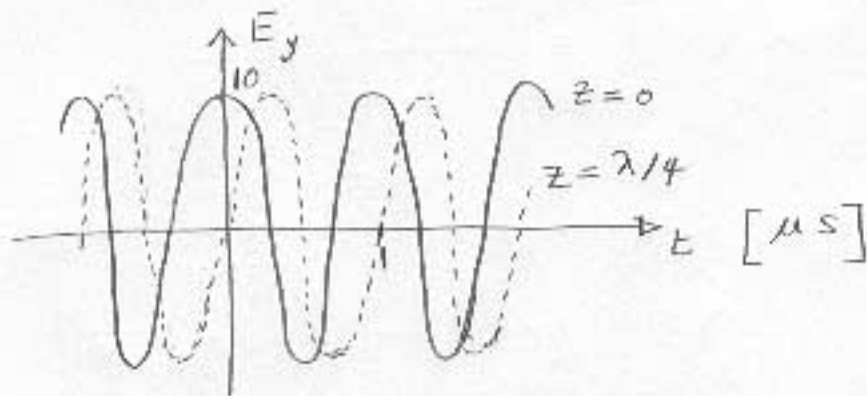
10.10

$$a) \frac{\omega}{\beta} = c = 3 \times 10^8 \Rightarrow \beta = \frac{\omega}{c} = \frac{2\pi \times 10^6}{3 \times 10^8} = 0.0209 \left[ \frac{\text{rad}}{\text{m}} \right].$$

$$\lambda = \frac{2\pi}{\beta} = 300 \text{ [m]}$$

$$b) \text{ At } z=0, \vec{E} = 10 \cos(2\pi \times 10^6 t) \vec{a}_y$$

$$\text{ At } z = \frac{\lambda}{4}, \vec{E} = 10 \cos\left(2\pi \times 10^6 t - \frac{\pi}{2}\right) \vec{a}_y$$



$$c) \vec{H} = -\vec{a}_x \frac{10}{377} \cos(2\pi \times 10^6 t - 0.0209 z)$$

10.11

$$a) -x$$

$$b) u = \frac{\omega}{\beta} = \frac{2 \times 10^8}{6} = \frac{10^8}{3}$$

$$u = \frac{3 \times 10^8}{\sqrt{\epsilon_r}} = \frac{10^8}{3} \Rightarrow \sqrt{\epsilon_r} = 9, \epsilon_r = 81$$

$$\therefore \epsilon = 81\epsilon_0 = 716.2 \times 10^{-12} \text{ [F/m]}.$$

$$c) \eta = \eta_0 \sqrt{\frac{1}{\epsilon_r}} = \frac{377}{9} = 41.89 \text{ [\Omega]}.$$

$$\begin{aligned} \vec{E} &= 25 \times 41.89 \sin(2 \times 10^8 t + 6x) \vec{a}_z \text{ [mV/m]} \\ &= \vec{a}_z 1.047 \sin(2 \times 10^8 t + 6x) \vec{a}_z \text{ [V/m]} \end{aligned}$$

10.16

$$a) u = \frac{3 \times 10^8}{\sqrt{\epsilon_r}} = \frac{\omega}{\beta} = \frac{2\pi \times 10^8}{5}$$

$$\sqrt{\epsilon_r} = \frac{15}{2\pi} \Rightarrow \epsilon_r = 5.7$$

$$b) u = \frac{2\pi \times 10^8}{5} = 1.257 \times 10^8 \text{ [m/s]}$$

$$\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{5} = 0.4\pi \text{ [m]}$$

$$c) \eta = 377 \sqrt{\frac{1}{\epsilon_r}} = 157.91 \text{ [\Omega]}$$

d) y-polarized (polarization is based on  $\vec{E}$  not  $\vec{H}$ ).

$$e) \vec{E} = \vec{a}_y 30 \times 157.91 \sin(2\pi \times 10^8 t - 5x) \text{ [mV/m]} \\ = \vec{a}_y 4.737 \sin(2\pi \times 10^8 t - 5x) \text{ [V/m]}.$$

$$f) \frac{\partial \vec{D}}{\partial t} = \epsilon \frac{\partial \vec{E}}{\partial t} = (5.7\epsilon_0) \left[ (2\pi \times 10^8) \vec{a}_y 4.737 \right. \\ \left. \cos(2\pi \times 10^8 t - 5x) \right] \\ = \vec{a}_y 0.15 \cos(2\pi \times 10^8 t - 5x) \text{ [A/m}^2\text{]}$$

10.18

$$u = \frac{3 \times 10^8}{\sqrt{50 \times 2}} = 3 \times 10^7 \text{ [m/s]}$$

$$\beta = \frac{\omega}{u} = \frac{2\pi \times 10^7}{3 \times 10^7} = \frac{2\pi}{3} \text{ [rad/m]}$$

$$\eta = 377 \sqrt{\frac{50}{2}} = 377 \times 5 = 1885 \text{ [\Omega]}$$

Use superposition to find  $\vec{H} \Rightarrow$

$$\vec{H} = \frac{10}{1885} \cos\left(2\pi \times 10^7 t - \frac{2\pi}{3} x\right) (\vec{a}_z - \vec{a}_y) \text{ [A/m]}$$