Prob. 10.3 (a)

$$\frac{\sigma}{\omega\varepsilon} = \frac{8x10^{-2}}{2\pi x50x10^{6}\,x3.6x\dfrac{10^{-9}}{36\pi}} = 8$$

$$\alpha = \omega\sqrt{\frac{\mu\varepsilon}{2}\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}-1\right]} = \frac{2\pi\times50\times10^{6}}{3\times10^{8}}\sqrt{\frac{2.1\times3.6}{2}[\sqrt{65}-1]} = 5.41$$

$$\beta = \omega\sqrt{\frac{\mu\varepsilon}{2}\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}+1\right]} = 6.129$$

$\gamma = \alpha + j\beta =$ *5.41 + j6.129* /m

(b) $\lambda = \dfrac{2\pi}{\beta} = \dfrac{2\pi}{6.129} =$ *1.025* m

(c) $u = \dfrac{\omega}{\beta} = \dfrac{2\pi\times50\times10^{6}}{6.129} =$ 5.125×10^{7} m/s

(d) $|\eta| = \dfrac{\sqrt{\dfrac{\mu}{\varepsilon}}}{\sqrt[4]{1+\left(\dfrac{\sigma}{\omega\varepsilon}\right)^2}} = \dfrac{120\pi\sqrt{\dfrac{2.1}{3.6}}}{\sqrt[4]{65}} = 101.4$

$\tan 2\theta_\eta = \dfrac{\sigma}{\omega\varepsilon} = 8 \longrightarrow \theta_\eta = 41.44^{o}$

$\eta =$ $101.41\angle 41.44^{o}\,\Omega$

(e) $\boldsymbol{H}_s = \boldsymbol{a}_k \times \dfrac{\boldsymbol{E}_s}{\eta} = \boldsymbol{a}_x \times \dfrac{6}{\eta}e^{-\gamma z}\boldsymbol{a}_z = -\dfrac{6}{\eta}e^{-\gamma z}\boldsymbol{a}_y =$ $-59.16e^{-j41.44^{o}}e^{-\gamma z}\boldsymbol{a}_y$ mA/m

Prob. 10.9

(a)

Let $x=\sqrt{1+\left(\dfrac{\sigma}{\omega\varepsilon}\right)^2}, \quad \alpha=1, \beta=5$

$$\frac{\alpha}{\beta}=\left(\frac{x-1}{x+1}\right)^{1/2}=\frac{1}{5}$$

Solving for x gives

$$x=\frac{13}{12}=\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}$$

$$\alpha=1=\omega\sqrt{\frac{\mu\varepsilon}{2}\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}-1\right]} \longrightarrow 1=\frac{\omega}{c}\sqrt{\frac{\varepsilon_r}{2}\left[\frac{15}{12}-1\right]}$$

$$\sqrt{\frac{\varepsilon_r}{24}}=\frac{c}{\omega}=\frac{3\times10^8}{2\pi\times10^8} \longrightarrow \varepsilon_r=\frac{24\times9}{4\pi^2}=\underline{\underline{5.471}}$$

$$\frac{13}{12}=\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2} \longrightarrow \frac{\sigma}{\omega\varepsilon}=\frac{5}{12}$$

$$\sigma=\frac{5}{12}\omega\varepsilon=\frac{5}{12}\times2\pi\times10^8\times5.471\times\frac{10^{-9}}{36\pi}=\underline{\underline{0.0127 \text{ S/m}}}$$

(b) Let $\boldsymbol{E}=E_o e^{-y}\cos(\omega t-2y+\theta_\eta)\boldsymbol{a}_E$

$$|\eta|=\frac{\sqrt{\dfrac{\mu}{\varepsilon}}}{\sqrt[4]{1+\left(\dfrac{\sigma}{\omega\varepsilon}\right)^2}}=\frac{\dfrac{120\pi}{\sqrt{5.471}}}{\sqrt{\dfrac{13}{12}}}=154.85$$

$$E_o=H_o|\eta|=30.97$$

$$\tan2\theta_\eta=\frac{\sigma}{\omega\varepsilon}=5/12 \longrightarrow \theta_\eta=11.31^o$$

$$\boldsymbol{a}_E\times\boldsymbol{a}_H=\boldsymbol{a}_k \longrightarrow \boldsymbol{a}_E\times\boldsymbol{a}_z=\boldsymbol{a}_y \longrightarrow \boldsymbol{a}_E=-\boldsymbol{a}_x$$

$$\boldsymbol{E}=\underline{\underline{-30.97e^{-y}\cos(2\pi\times10^8t-5y+11.31^o)\boldsymbol{a}_x \text{ V/m}}}$$

Prob. 10.19

$$\beta = \omega\sqrt{\mu\varepsilon} = \frac{\omega}{c}\sqrt{\mu_r\varepsilon_r} = \frac{2\pi\times10^7}{3\times10^8}(10) = \underline{\underline{2.0943}} \text{ rad/m}$$

$$\boldsymbol{H} = -\frac{1}{\mu}\int \nabla\times\boldsymbol{E}dt$$

$$\nabla\times\boldsymbol{E} = \begin{vmatrix} \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 0 & E_y(x) & E_z(x) \end{vmatrix} = -\frac{\partial E_z}{\partial x}\boldsymbol{a}_y + \frac{\partial E_y}{\partial x}\boldsymbol{a}_z = -10\beta\sin(\omega t-\beta x)(a_y - a_z)$$

$$\boldsymbol{H} = -\frac{10\beta}{\omega\mu}\cos(\omega t-\beta x)(\boldsymbol{a}_y - \boldsymbol{a}_z) = -\frac{10\times2\pi/3}{2\pi\times10^7\times50\times4\pi\times10^{-7}}\cos(\omega t-\beta x)(\boldsymbol{a}_y - \boldsymbol{a}_z)$$

$$\boldsymbol{H} = \underline{\underline{5.305\cos(2\pi\times10^7 t - 2.0943x)(-\boldsymbol{a}_y + \boldsymbol{a}_z)}} \text{ mA/m}$$

Prob. 10.20

$$0.4E_o = E_o e^{-\alpha z} \longrightarrow \frac{1}{0.4} = e^{2\alpha}$$

Or $\alpha = \frac{1}{2}\ln\frac{1}{0.4} = 0.4581 \longrightarrow \delta = 1/\alpha = \underline{\underline{2.183}}$ m

$$\lambda = 2\pi/\beta = 2\pi/1.6$$

$$u = f\lambda = 10^7\times\frac{2\pi}{1.6} = \underline{\underline{3.927\times10^7}} \text{ m/s}$$

Prob. 10.25

(a) $$\tan\theta = \frac{\sigma}{\omega\varepsilon} = \frac{3.5\times10^{7}}{2\pi\times150\times10^{6}\times\frac{10^{-9}}{36\pi}} = \frac{3.5\times18\times10^{9}}{15} >> 1$$

$$\alpha = \beta = \sqrt{\frac{\omega\mu\sigma}{2}} = \sqrt{\pi f\mu\sigma} = \sqrt{150\pi\times10^{6}\times4\pi\times10^{-7}\times3.5\times10^{7}} = 143,965.86$$

$$\gamma = \alpha + j\beta = \underline{\underline{1.44(1+j)x10^{5}\ /\text{m}}}$$

(b) $$\delta = 1/\alpha = \underline{\underline{6.946\times10^{-6}\ \text{m}}}$$

(c) $$u = \frac{\omega}{\beta} = \frac{150\times2\pi\times10^{6}}{1.44\times10^{5}} = \underline{\underline{6547\ \text{m/s}}}$$

Extra Question:

$$f' = \frac{f}{1 - \frac{u}{c}\cos\theta}$$

$$f'' = \frac{f'(1 - \frac{u}{c}\cos\theta)}{(1 - \frac{u}{c}\cos\theta)^2} = \frac{f'}{(1 - \frac{u}{c}\cos\theta)} = \frac{f}{(1 - \frac{u}{c}\cos\theta)^2} \approx f(1 + \frac{2u}{c}\cos\theta)$$

$$\Rightarrow f'' \approx f(1 + \frac{2u}{c}\cos\theta)$$

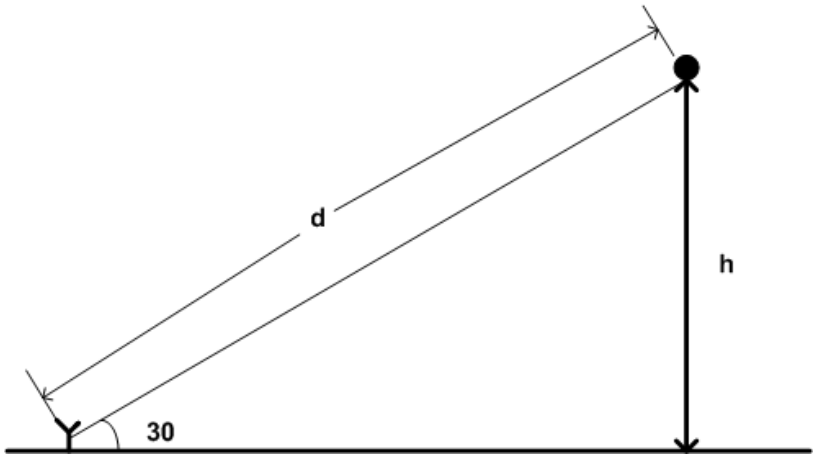
$$\frac{f''}{f} \approx 1 + \frac{2u}{c}\cos\theta$$

$$u \approx \frac{c}{2\cos\theta}(\frac{f''}{f} - 1)$$

$$f'' \approx f + \Delta f = 2.4 * 10^9 + 53.6 * 10^3$$

$$u \approx \frac{3 * 10^8}{2\cos 30}(\frac{2.4 * 10^9 + 53.6 * 10^3}{2.4 * 10^9} - 1)$$

$$u \approx 3868\ {}^{m}/_{s}$$



$$2d = c\Delta t$$

$$d = \frac{c\Delta t}{2} = \frac{3 * 10^8 * 0.001}{2} = 150{,}000\ m$$

$$\sin 30° = \frac{h}{d}$$

$$h = \frac{d}{2} = \frac{150{,}000}{2} = 75{,}000\ m$$

$$h = 75\ km$$