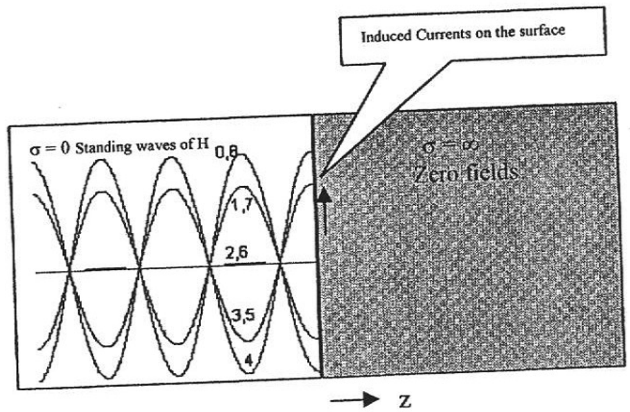
$$E_{ot} = \tau E_o = 0.857\angle 38.89^o$$

$$\underline{\underline{E_t = 0.857 e^{43.94z} \sin(9\times 10^8 t + 51.48z + 38.89^o) \text{ V/m}}}$$

Prob. 10.48



Curve 0 is at t = 0; curve 1 is at t = T/8; curve 2 is at t = T/4; curve 3 is at t = 3T/8, etc.

Prob. 10.49 Since $\mu_o = \mu_1 = \mu_2$,

$$\sin\theta_{t1} = \sin\theta_i \sqrt{\frac{\varepsilon_o}{\varepsilon_1}} = \frac{\sin 45^o}{\sqrt{4.5}} = 0.3333 \longrightarrow \underline{\underline{\theta_{t1} = 19.47^o}}$$

$$\sin\theta_{t2} = \sin\theta_{t1}\sqrt{\frac{\varepsilon_1}{\varepsilon_2}} = \frac{1}{3}\sqrt{\frac{4.5}{2.25}} = 0.4714 \longrightarrow \underline{\underline{\theta_{t2} = 28.13^o}}$$

Prob. 10.50

$$\mathbf{E}_s = \frac{20(e^{jk_x x} - e^{-jk_x x})}{j2}\frac{(e^{jk_y y} + e^{-jk_y y})}{2}\mathbf{a}_z$$

$$= -j5\left[e^{j(k_x x + k_y y)} + e^{j(k_x x - k_y y)} - e^{-j(k_x x - k_y y)} - e^{-j(k_x x + k_y y)}\right]\mathbf{a}_z$$

which consists of four plane waves.

$$\nabla\times\mathbf{E}_s = -j\omega\mu_o\mathbf{H}_s \longrightarrow \mathbf{H}_s = \frac{j}{\omega\mu_o}\nabla\times\mathbf{E}_s = \frac{j}{\omega\mu_o}\left(\frac{\partial E_z}{\partial y}\mathbf{a}_x - \frac{\partial E_z}{\partial x}\mathbf{a}_y\right)$$

$$H_s = -\frac{j20}{\omega\mu_o}\left[k_y \sin(k_x x)\sin(k_y y)\boldsymbol{a}_x + k_x \cos(k_x x)\cos(k_y y)\boldsymbol{a}_y\right]$$

Prob. 10.51
If **A** is a uniform vector and $\Phi(r)$ is a scalar,

$$\nabla\times(\Phi \boldsymbol{A}) = \nabla\Phi\times \boldsymbol{A} + \Phi(\nabla\times \boldsymbol{A}) = \nabla\Phi\times \boldsymbol{A}$$

since $\nabla\times \boldsymbol{A} = 0$.

$$\nabla\times \boldsymbol{E} = (\frac{\partial}{\partial x}\boldsymbol{a}_x + \frac{\partial}{\partial y}\boldsymbol{a}_y + \frac{\partial}{\partial z}\mathrm{a}_z)\times \boldsymbol{E}_o e^{j(k_x x + k_y y + k_z z - \omega t)} = j(k_x\boldsymbol{a}_x + k_y\boldsymbol{a}_y + k_z\boldsymbol{a}_z)e^{j(\boldsymbol{k}\bullet\boldsymbol{r}-\omega t)}\times \boldsymbol{E}_o$$

$$= j\boldsymbol{k}\times \boldsymbol{E}_o e^{j(\boldsymbol{k}\bullet\boldsymbol{r}-\omega t)} = j\boldsymbol{k}\times\boldsymbol{E}$$

Also, $-\dfrac{\partial \boldsymbol{B}}{\partial t} = j\omega\mu\boldsymbol{H}$. Hence $\nabla\times\boldsymbol{E} = -\dfrac{\partial \boldsymbol{B}}{\partial t}$ becomes $\boldsymbol{k}\times\boldsymbol{E} = \omega\mu\boldsymbol{H}$

From this, $\boldsymbol{a}_k\times\boldsymbol{a}_E = \boldsymbol{a}_H$

Prob.10.52

$$\nabla\bullet \boldsymbol{E} = (\frac{\partial}{\partial x}\boldsymbol{a}_x + \frac{\partial}{\partial y}\boldsymbol{a}_y + \frac{\partial}{\partial z}\boldsymbol{a}_z)\bullet \boldsymbol{E}_o e^{j(k_x x + k_y y + k_z z - \omega t)} = j(k_x\boldsymbol{a}_x + k_y\boldsymbol{a}_y + k_z\boldsymbol{a}_z)e^{j(\boldsymbol{k}\bullet\boldsymbol{r}-\omega t)}\bullet \boldsymbol{E}_o$$

$$= j\boldsymbol{k}\bullet \boldsymbol{E}_o e^{j(\boldsymbol{k}\bullet\boldsymbol{r}-\omega t)} = j\boldsymbol{k}\bullet\boldsymbol{E} = 0 \quad\longrightarrow\quad \boldsymbol{k}\bullet\boldsymbol{E} = 0$$

Similarly,

$$\nabla\bullet\boldsymbol{H} = j\boldsymbol{k}\bullet\boldsymbol{H} = 0 \quad\longrightarrow\quad \boldsymbol{k}\bullet\boldsymbol{H} = 0$$

It has been shown in the previous problem that

$$\nabla\times\boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t} \quad\longrightarrow\quad \boldsymbol{k}\times\boldsymbol{E} = \omega\mu\boldsymbol{H}$$

Similarly,

$$\nabla\times\boldsymbol{H} = \frac{\partial \boldsymbol{D}}{\partial t} \quad\longrightarrow\quad kxH = -\varepsilon\omega E$$

From $\boldsymbol{k}\times\boldsymbol{E} = \omega\mu\boldsymbol{H}$, $\boldsymbol{a}_k\times\boldsymbol{a}_E = \boldsymbol{a}_H$ and

$$\tau_{\perp}=\frac{\dfrac{2}{\sqrt{\varepsilon_{r2}}}\cos\theta_i}{\dfrac{1}{\sqrt{\varepsilon_{r2}}}\cos\theta_i+\dfrac{1}{\sqrt{\varepsilon_{r1}}}\cos\theta_t}=\frac{2\cos\theta_i}{\cos\theta_i+\dfrac{\sin\theta_i}{\sin\theta_t}\cos\theta_t}=\frac{2\cos\theta_i\sin\theta_i}{\sin(\theta_t+\theta_i)}$$

Prob.10.54

(a) $k=\sqrt{k_x^2+k_x^2}=\sqrt{6^2+10^2}=10$

$$\omega=kc=3\times10^9=2\pi f \longrightarrow f=\underline{\underline{477.5\text{ MHz}}}$$

$$\lambda=2\pi/k=\frac{2\pi}{10}=\underline{\underline{0.6283\text{ m}}}$$

(b) $\boldsymbol{H}=\dfrac{\boldsymbol{k}\times\boldsymbol{E}}{\omega\mu}$, $\quad \boldsymbol{k}=6\boldsymbol{a}_x+8\boldsymbol{a}_z$

$$\boldsymbol{k}\times\boldsymbol{a}_y=\begin{vmatrix}\boldsymbol{a}_x & \boldsymbol{a}_y & \boldsymbol{a}_z\\ 6 & 0 & 8\\ 0 & 1 & 0\end{vmatrix}=-8\boldsymbol{a}_x+6\boldsymbol{a}_z$$

$$\frac{E_o}{\omega\mu}=\frac{50}{3\times10^9\times4\pi\times10^{-7}}=\frac{50}{1200\pi}=0.01326$$

$$\boldsymbol{H}=\underline{\underline{13.26\sin(\omega t-6x-8z)(-8\boldsymbol{a}_x+6\boldsymbol{a}_z)\text{ mA/m}}}$$

Prob. 10.55

(a) $n_1=1$, $\quad n_2=c\sqrt{\mu_2\varepsilon_2}=c\sqrt{6.4\varepsilon_o\times\mu_o}=\sqrt{6.4}=2.5298$

$$\sin\theta_t=\frac{n_1}{n_2}\sin\theta_i=\frac{1}{2.5298}\sin12^o=0.082185 \longrightarrow \theta_t=4.714^o$$

$$\eta_1=120\pi,\qquad \eta_2=120\pi\sqrt{\frac{1}{6.4}}=47.43\pi$$

$$\frac{E_{ro}}{E_{io}}=\Gamma=\frac{\eta_2\cos\theta_t-\eta_1\cos\theta_i}{\eta_2\cos\theta_t+\eta_1\cos\theta_i}=\frac{47.43\pi\cos4.714^o-120\pi\cos12^o}{47.43\pi\cos4.714^o+120\pi\cos12^o}$$

$$=\frac{47.27-117.38}{47.27+117.38}=\underline{\underline{-0.4258}}$$

$$\frac{E_{to}}{E_{io}}=\tau=\frac{2\eta_2\cos\theta_i}{\eta_2\cos\theta_t+\eta_1\cos\theta_i}=\frac{2x47.43\cos12^o}{47.27+117.33}=\frac{92.787}{164.65}=\underline{\underline{0.5635}}$$

But $\quad (E_{ry}\boldsymbol{a}_y + E_{rz}\boldsymbol{a}_z) = E_{ro}(\sin\theta_r\boldsymbol{a}_y + \cos\theta_r\boldsymbol{a}_z) = -2.53(\frac{3}{5}\boldsymbol{a}_y + \frac{4}{5}\boldsymbol{a}_z)$

$$\underline{\underline{\boldsymbol{E}_r = -(1.518\boldsymbol{a}_y + 2.024\boldsymbol{a}_z)\sin(\omega t + 4y - 3z)}} \;\; \text{V/m}$$

Similarly, let

$$\boldsymbol{E}_t = (E_{ty}\boldsymbol{a}_y + E_{tz}\boldsymbol{a}_z)\sin(\omega t - \boldsymbol{k}_t \bullet \boldsymbol{r})$$

$$k_t = \beta_2 = \omega\sqrt{\mu_2\varepsilon_2} = \omega\sqrt{4\mu_o\varepsilon_o}$$

But $\quad k_i = \beta_1 = \omega\sqrt{\mu_o\varepsilon_o}$

$$\frac{k_t}{k_i} = 2 \quad \longrightarrow \quad k_t = 2k_i = 10$$

$$k_{ty} = k_t\cos\theta_t = 9.539, \qquad k_{tz} = k_t\sin\theta_t = 3,$$

$$k_t = 9.539a_y + 3a_z$$

Note that $\;k_{iz} = k_{rz} = k_{tz} = 3$

$$\tau_{\backslash\backslash} = \frac{E_{to}}{E_{io}} = \frac{2\eta_2\cos\theta_i}{\eta_2\cos\theta_t + \eta_1\cos\theta_i} = \frac{\eta_o(0.8)}{\frac{\eta_o}{2}(0.9539) + \eta_o(0.8)} = 0.6265$$

$$E_{to} = \tau_{\backslash\backslash}E_{io} = 6.265$$

But

$$(E_{ty}\boldsymbol{a}_y + E_{tz}\boldsymbol{a}_z) = E_{to}(\sin\theta_t\boldsymbol{a}_y - \cos\theta_t\boldsymbol{a}_z) = 6.256(0.3\boldsymbol{a}_y - 0.9539\boldsymbol{a}_z)$$

Hence,

$$\underline{\underline{\boldsymbol{E}_t = (1.879\boldsymbol{a}_y - 5.968\boldsymbol{a}_z)\sin(\omega t - 9.539y - 3z)}} \;\; \text{V/m}$$

Prob. 10.57 (a)

$$\tan\theta_i = \frac{k_{ix}}{k_{iz}} = \frac{1}{\sqrt{8}} \quad \longrightarrow \quad \underline{\underline{\theta_i = \theta_r = 19.47^o}}$$

$$\sin\theta_t = \sin\theta_i\sqrt{\frac{\varepsilon_{r1}}{\varepsilon_{r2}}} = \frac{1}{3}(3) = 1 \longrightarrow \underline{\underline{\theta_t = 90^o}}$$

(b) $\beta_1 = \dfrac{\omega}{c}\sqrt{\varepsilon_{r1}} = \dfrac{10^9}{3\times10^8}\times 3 = 10 = k\sqrt{1+8} = 3k \longrightarrow \underline{\underline{k = 3.333}}$

(c) $\lambda = 2\pi/\beta, \quad \lambda_1 = 2\pi/\beta_1 = 2\pi/10 = \underline{\underline{0.6283}}$ m

$\beta_2 = \omega/c = 10/3, \quad \lambda_2 = 2\pi/\beta_2 = 2\pi x 3/10 = \underline{\underline{1.885}}$ m

(d)
$$\begin{aligned} \boldsymbol{E}_i &= \eta_1 \boldsymbol{H}_x \times \boldsymbol{a}_k = 40\pi(0.2)\cos(\omega t - \boldsymbol{k}\bullet\boldsymbol{r})\boldsymbol{a}_y \times \frac{(\boldsymbol{a}_x + \sqrt{8}\boldsymbol{a}_z)}{3} \\ &= \underline{\underline{(23.6954\boldsymbol{a}_x - 8.3776\boldsymbol{a}_z)\cos(10^9 t - kx - k\sqrt{8}z)\ \text{V/m}}} \end{aligned}$$

(e) $\tau_{//} = \dfrac{2\cos\theta_i\sin\theta_t}{\sin(\theta_i+\theta_t)\cos(\theta_t-\theta_i)} = \dfrac{2\cos 19.47^o \sin 90^o}{\sin 19.47^o \cos 19.47^o} = 6$

$$\Gamma_{//} = -\frac{\cot 19.47^o}{\cot 19.47^o} = -1$$

Let $\boldsymbol{E}_t = -E_{io}(\cos\theta_t\boldsymbol{a}_x - \sin\theta_t\boldsymbol{a}_z)\cos(10^9 t - \beta_2 x\sin\theta_t - \beta_2 z\cos\theta_t)$

where

$$\boldsymbol{E}_t = -E_{io}(\cos\theta_i\boldsymbol{a}_x - \sin\theta_i\boldsymbol{a}_z)\cos(10^9 t - \beta_1 x\sin\theta_i - \beta_1 z\cos\theta_i)$$

$$\sin\theta_t = 1, \quad \cos\theta_t = 0, \quad \beta_2\sin\theta_t = 10/3$$

$$E_{to}\sin\theta_t = \tau_{\backslash\backslash}E_{io} = 6(24\pi)(3)(1) = 1357.2$$

Hence,

$$\underline{\underline{\boldsymbol{E}_t = 1357\cos(10^9 t - 3.333x)\boldsymbol{a}_z}}\ \text{V/m}$$

Since $\Gamma = -1, \quad \theta_r = \theta_i$

$$\underline{\underline{\boldsymbol{E}_r = (213.3\boldsymbol{a}_x + 75.4\boldsymbol{a}_z)\cos(10^9 t - kx + k\sqrt{8}z)}}\ \text{V/m}$$

(f) $\tan\theta_{B//} = \sqrt{\frac{\varepsilon_2}{\varepsilon_1}} = \sqrt{\frac{\varepsilon_o}{9\varepsilon_o}} = 1/3 \quad \longrightarrow \quad \underline{\underline{\theta_{B//} = 18.43^o}}$

Prob. 10.58

$$\beta_1 = \sqrt{3^2 + 4^2} = 5 = \omega / c \quad \longrightarrow \quad \underline{\underline{\omega = \beta_1 c = 15\times 10^8 \text{ rad/s}}}$$

Let $\boldsymbol{E}_r = (E_{ox}, E_{oy}, E_{oz})\sin(\omega t + 3x + 4y)$. In order for

$$\nabla \bullet \boldsymbol{E}_r = 0, \qquad 3E_{ox} + 4E_{oy} = 0 \qquad (1)$$

Also, at y=0, $E_{1\tan} = E_{2\tan} = 0$

$$E_{1\tan} = 0, \qquad 8a_x + 5a_z + E_{ox}a_x + E_{oz}a_z = 0$$

Equating components, $E_{ox} = -8, \quad E_{oz} = -5$

From (1), $4E_{oy} = -3E_{ox} = 24 \qquad E_{oy} = 6$

Hence,

$$\underline{\underline{\boldsymbol{E}_r = (-8\boldsymbol{a}_x + 6\boldsymbol{a}_y - 5\boldsymbol{a}_z)\sin(15\times 10^8 t + 3x + 4y)}} \text{ V/m}$$

Prob. 10.59 Since both media are nonmagnetic,

$$\tan\theta_{B//} = \sqrt{\frac{\varepsilon_2}{\varepsilon_1}} = \sqrt{\frac{2.6\varepsilon_o}{\varepsilon_o}} = 1.612 \quad \longrightarrow \quad \theta_{B//} = 58.19^o$$

But

$$\cos\theta_t = \frac{\eta_1}{\eta_2}\cos\theta_{B//} = \frac{\eta_o}{\eta_o / \sqrt{2.6}}\cos\theta_{B//} = \sqrt{2.6}\cos 58.19^o \quad \longrightarrow \quad \underline{\underline{\theta_t = 31.8^o}}$$

Prob. 10.60

$$\sin\theta_B = \frac{n_2}{\sqrt{n_2^2 + n_1^2}} \quad \text{or} \quad \tan\theta_B = \frac{n_1}{n_2}$$

$$\theta_B = \tan^{-1}(\frac{n_1}{n_2}) = \tan^{-1} 2 = \underline{\underline{63.4^0}}$$

Prob. 11.1

$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma_c}} = \frac{1}{\sqrt{\pi \times 500 \times 10^6 \times 4\pi \times 10^{-7} \times 7 \times 10^7}}$$

$$\delta = 2.6902 \times 10^{-6}$$

$$R = \frac{2}{w\delta\sigma_c} = \frac{2}{0.3 \times 2.6902 \times 10^{-6} \times 7 \times 10^7} = \underline{\underline{0.0354\Omega / \text{m}}}$$

$$L = \frac{\mu_o d}{w} = \frac{4\pi \times 10^{-7} \times 1.2 \times 10^{-2}}{0.3} = \underline{\underline{50.26 \text{ nH / m}}}$$

$$C = \frac{\varepsilon_o w}{d} = \frac{10^{-9}}{36\pi} \times \frac{0.3}{1.2 \times 10^{-2}} = \underline{\underline{221 \text{ pF / m}}}$$

Since $\sigma = 0$ for air,

$$G = \frac{\sigma w}{d} = 0$$

Prob. 11.2

$$\delta = \frac{1}{\sqrt{\pi f \mu_c \sigma_c}} = \frac{1}{\sqrt{\pi x 80x10^6 x 4\pi x10^{-7} x5.28x10^7}} = 7.744x10^{-6}$$

$$R = \frac{1}{2\pi\delta\sigma_c}\left[\frac{1}{a} + \frac{1}{b}\right] = \frac{\left[\frac{1}{0.8x10^{-3}} + \frac{1}{2.6x10^{-3}}\right]}{2\pi x7.744x10^{-6}x5.28x10^7} = \frac{10^3(1.25 + 0.3836)}{2569.09} = \underline{\underline{0.6359 \ \Omega/\text{m}}}$$

$$L = \frac{\mu}{2\pi}\ln\frac{b}{a} = \frac{4\pi x10^{-7}}{2\pi}\ln\frac{2.6}{0.8} = \underline{\underline{2.357x10^{-7} \ \text{H/m}}}$$

$$G = \frac{2\pi\sigma}{\ln\frac{b}{a}} = \frac{2\pi x10^{-5}}{\ln\frac{2.6}{0.8}} = \underline{\underline{5.33x10^{-5} \ \text{S/m}}}$$

$$C = \frac{2\pi\varepsilon}{\ln\frac{b}{a}} = \frac{2\pi x3.5x\frac{10^{-9}}{36\pi}}{\ln\frac{2.6}{0.8}} = \underline{\underline{1.65x10^{-10} \ \text{F/m}}}$$

Prob. 11.13

$$L = \frac{\mu}{\pi}\cosh^{-1}\frac{d}{2a} = 4\times 10^{-7}\cosh^{-1}\frac{0.32}{0.12}$$

$$\underline{\underline{L = 0.655\ \mu\text{H/m}}}$$

$$C = \frac{\pi\varepsilon}{Cosh^{-1}\dfrac{d}{2a}} = \frac{\pi\times\dfrac{10^{-9}}{36\pi}\times 3.5}{Cosh^{-1}2.667}$$

$$\underline{\underline{C = 59.4\ \text{pF/m}}}$$

$$Z_o = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.655\times10^{-6}}{59.4\times10^{-12}}} = \underline{\underline{105\Omega}}$$

or

$$Z_o = \frac{120}{\sqrt{3.5}}\cosh^{-1}2.667 = \underline{\underline{105\Omega}}$$

Prob. 11.14

(a) $\alpha = \underline{\underline{0.0025\ \text{Np/m}}}, \quad \beta = \underline{\underline{2\ \text{rad/m}}},$

$$u = \frac{\omega}{\beta} = \frac{10^8}{2} = \underline{\underline{5\times 10^7\ \text{m/s}}}$$

(b) $\Gamma = \dfrac{V_o}{V_o^+} = \dfrac{60}{120} = \dfrac{1}{2}$

But $\Gamma = \dfrac{Z_L - Z_o}{Z_L + Z_o} \rightarrow \dfrac{1}{2} = \dfrac{300 - Z_o}{300 + Z_o} \rightarrow \underline{\underline{Z_o = 100\Omega}}$

$$I(l') = \frac{120}{Z_o}e^{0.0025l'}\cos\left(10^8 + 2l'\right) - \frac{60}{Z_o}e^{-0.0025l'}\cos\left(10^8 t - 2l'\right)$$

$$\underline{\underline{= 1.2e^{0.0025l'}\cos\left(10^8 + 2l'\right) - 0.6e^{-0.0025l'}\cos\left(10^8 t - 2l'\right) A}}$$

Prob. 11.15

$$Z_o = \sqrt{\frac{L}{C}} = \sqrt{\frac{R}{G}} = 75 \qquad (1)$$

$$\alpha = \sqrt{RG} = 0.06 \qquad (2)$$

$$u = \frac{\omega}{\beta} = \frac{1}{\sqrt{LC}} = 2.8\times10^8 \qquad (3)$$

$$\alpha Z_o = R = 75\times 0.06 = \underline{\underline{4.5\ \Omega/\text{m}}}$$

From (2),

(b) (i) $\tau_L = \frac{2nZ_o}{nZ_o + Z_o} = \frac{2n}{n+1}$

(ii) $\tau_L =_{Y_L} \xrightarrow{\lim} {}_0 = \frac{2}{1+ Z_o/Z_L} = 2$

(iii) $\tau_L =_{Z_L} \xrightarrow{\lim} {}_0 = \frac{2Z_L}{Z_L + Z_o} = 0$

(iv) $\tau_L = \frac{2Z_o}{2Z_o} = 1$

Prob. 11.18

$$\Gamma_L = \frac{Z_L - Z_o}{Z_L + Z_o} = \frac{75 + j20 - 50}{75 + j20 + 50} = \underline{\underline{0.2529\angle 29.57^o}}$$

$$s = \frac{1+|\Gamma|}{1-|\Gamma|} = \frac{1+0.2529}{1-0.2529} = \underline{\underline{1.677}}$$

Prob. 11.19

$$\gamma = \sqrt{(R + j\omega L)(G + j\omega C)} = \sqrt{(3.5 + j2\pi x400x10^6 x2x10^{-6})(0 + j2\pi x400x10^6 x120x10^{-12})}$$
$$= \sqrt{(3.5 + j5026.55)(j0.3016)} = 0.0136 + j38.94$$

$$\alpha = \underline{\underline{0.0136 \text{ Np/m}}}, \qquad \beta = \underline{\underline{38.94 \text{ rad/m}}}$$

$$u = \frac{\omega}{\beta} = \frac{2\pi x400x10^6}{38.94} = \underline{\underline{6.452x10^7 \text{ m/s}}}$$

$$Z_o = \sqrt{\frac{R + j\omega L}{G + j\omega C}} = \sqrt{\frac{3.5 + j5026.55}{j0.3016}} = \underline{\underline{129.1 - j0.045\ \Omega}}$$

Prob. 11.20

From eq. (11.33)

$$Z_{sc} = Z_{in}\Big|_{Z_L=0} = Z_o \tanh \gamma l$$

$$Z_{oc} = Z_{in}\Big|_{Z_L=\infty} = \frac{Z_o}{\tanh \gamma l} = Z_o \coth(\gamma l)$$

For lossless line, $\gamma = j\beta, \tan(\gamma l) = \tanh(j\beta l) = j\tan(\beta l)$

Prob. 11.23

$$I_l = \frac{V_L}{Z_L}, \ \Gamma = \frac{Z_L - Z_o}{Z_L + Z_o} = \frac{50e^{j30^o} - 50}{50e^{j30^o} + 50}$$
$$\approx j0.2679$$

From eq.(11.30),

$$V_o^+ = \frac{1}{2}(V_L + Z_o.\frac{V_L}{Z_L})e^{\gamma l} = \frac{V_L}{2Z_L}(Z_L + Z_o)e^{\gamma l}$$
$$V_o^- = \frac{V_L}{2Z_L}(Z_L - Z_o)e^{-\gamma l}$$

Substituting these in eq.(11.25),

$$I_s = \frac{V_L}{2Z_L Z_o}\left[(Z_L + Z_o)e^{\gamma l}e^{-\gamma z} - (Z_L - Z_o)e^{-\gamma l}e^{\gamma z}\right]$$
$$= \frac{V_L / \ Z_o}{1+\Gamma}\left[e^{-\gamma(z-l)} - \Gamma e^{\gamma(z-l)}\right]$$

But $l - z = \frac{\lambda}{8} \quad or \quad z - l = -\frac{\lambda}{8}$

$$I_s = \frac{10\angle 25^o}{1.035\angle 15^o}\left(\frac{1}{50}\right)\left(e^{j\pi/4} - j0.2679e^{-j\pi/4}\right)$$
$$= \underline{\underline{0.1414\angle 55^o \ A}}$$

Prob. 11.24

$$(a) \quad \beta l = \frac{1}{4}\times 100 = 25 rad = 1432.4^o = 352.4^o$$
$$Z_{in} = 60\left[\frac{j40 + j60\tan 352.4^o}{60 - 40\tan 352.4^o}\right] = \underline{\underline{j29.375\Omega}}$$

$$V(z=0) = V_o = \frac{Z_{in}}{Z_{in} + Z_g}V_g = \frac{j29.375(10\angle 0^o}{j29.375 + 50 - j40}$$
$$= \frac{293.75\angle 90^o}{51.116\angle -12^o} = \underline{\underline{5.75\angle 102^o}}$$

$(b)\quad Z_{in} = Z_L = \underline{\underline{j40\Omega.}}$

$$V_o^+ = \frac{V_g}{(e^{j\beta l} + \Gamma e^{-j\beta l})} \qquad \text{(l is from the load)}$$

$$V_L = \frac{V_g(1+\Gamma)}{(e^{j\beta l} + \Gamma e^{-j\beta l})} = \underline{\underline{12.62\angle 0^o}}$$

$(c)\quad \beta l' = \frac{1}{4} \times 4 = 1rad = 57.3^o$

$$Z_{in} = 60\left[\frac{j40 + j60\tan 57.3^o}{60 - 40\tan 57.3^o}\right] = \underline{\underline{-j3471.88\Omega.}}$$

$$V = \frac{V_g(e^{j} + \Gamma e^{-j})}{(e^{j25} + \Gamma e^{-j25})} = \underline{\underline{22.74\angle 0^o\ \text{V}}}$$

(d) 3m from the source is the same as 97m from the load., i.e.

$$l' = 100 - 3 = 97m, \quad \beta l' = \frac{1}{4} \times 97 = 24.25rad = 309.42^o$$

$$Z_{in} = 60\left[\frac{j40 + j60\tan 309.42^o}{60 - 40\tan 309.42^o}\right] = \underline{\underline{-j18.2\Omega}}$$

$$V = \frac{V_g(e^{j97/4} + \Gamma e^{-j97/4})}{(e^{j25} + \Gamma e^{-j25})} = \underline{\underline{6.607\angle 180^o\ \text{V}}}$$

Prob. 11.25

$(a)\quad \beta l = \frac{2\pi}{\lambda}(1.25\lambda) = \frac{\pi}{2} + 360^o,$

$\tan \beta l \to \infty$

$$Z_{in} = \frac{Z_o^2}{Z_L} = \underline{\underline{46.875\Omega.}}$$

(b) $\Gamma = 0.23$

$$V_L = \frac{V_g(1+\Gamma)}{e^{j\beta l} + \Gamma e^{-j\beta l}} = \underline{\underline{160\angle -90^o\ \text{V}}}$$