SOLUTIONS TO SELECTED PROBLEMS

Chapter 1

1. Area $=\pi a^2$

3. (a) $\mathbf{A}+\mathbf{B}=6\mathbf{i}_x-2\mathbf{i}_y-6\mathbf{i}_z$

   (b) $\mathbf{A}\cdot\mathbf{B}=6$

   (c) $\mathbf{A}\times\mathbf{B}=-14\mathbf{i}_x+12\mathbf{i}_y-18\mathbf{i}_z$

5. (b) $\mathbf{B}_{\parallel}=2(-\mathbf{i}_x+2\mathbf{i}_y-\mathbf{i}_z)$, $\mathbf{B}_{\perp}=5\mathbf{i}_x+\mathbf{i}_y-3\mathbf{i}_z$

7. (a) $\mathbf{A}\cdot\mathbf{B}=-75$

   (b) $\mathbf{A}\times\mathbf{B}=-100\mathbf{i}_z$

   (c) $\theta=126.87°$

12. (a) $\nabla f=(az+3bx^2y)\mathbf{i}_x+bx^3\mathbf{i}_y+ax\mathbf{i}_z$

14. (a) $\nabla\cdot\mathbf{A}=3$

17. (b) $\Phi=\frac{1}{2}abc$

18. (a) $\nabla\times\mathbf{A}=(x-y^2)\mathbf{i}_x-y\mathbf{i}_y-x^2\mathbf{i}_z$

23. (b) $\nabla f=\dfrac{1}{h_u}\dfrac{\partial f}{\partial u}\mathbf{i}_u+\dfrac{1}{h_v}\dfrac{\partial f}{\partial v}\mathbf{i}_v+\dfrac{1}{h_w}\dfrac{\partial f}{\partial w}\mathbf{i}_w$

    (c) $dV=h_uh_vh_w\,du\,dv\,dw$

    (d) $\nabla\cdot\mathbf{A}=\dfrac{1}{h_uh_vh_w}\left[\dfrac{\partial}{\partial u}(h_vh_wA_u)+\dfrac{\partial}{\partial v}(h_uh_wA_v)+\dfrac{\partial}{\partial w}(h_uh_vA_w)\right]$

    $(\nabla\times\mathbf{A})_u=\dfrac{1}{h_vh_w}\left[\dfrac{\partial(h_wA_w)}{\partial v}-\dfrac{\partial(h_vA_v)}{\partial w}\right]$

25. (a) $r_{QP}=\sqrt{30}$, (b) $\mathbf{i}_{QP}=\dfrac{\mathbf{r}_{QP}}{r_{QP}}=\dfrac{\mathbf{i}_x-5\mathbf{i}_y+2\mathbf{i}_z}{\sqrt{30}}$,

    (c) $\mathbf{n}=\dfrac{5\mathbf{i}_x+\mathbf{i}_y}{\sqrt{26}}$

Chapter 2

3. $E_0=\dfrac{4}{3}\dfrac{\pi R^3\rho_m g}{q}$

4. $Q_2=\dfrac{2\pi\varepsilon_0 d^3Mg}{Q_1\sqrt{l^2-\left(\frac{d}{2}\right)^2}}$

5. (a) $\omega=\left[\dfrac{Q_1Q_2}{4\pi\varepsilon_0R^3m}\right]^{1/2}$

7. (a) $m = \dfrac{m_1 m_2}{m_1 + m_2}$,

(b) $v = \pm\sqrt{\dfrac{-q_1 q_2}{2\pi\varepsilon_0 m}\left(\dfrac{1}{\mathrm{r}} - \dfrac{1}{\mathrm{r}_0}\right)}$,

(d) $t = \dfrac{\pi}{2}\mathrm{r}_0^{3/2}\left[\dfrac{2\pi m \varepsilon_0}{-q_1 q_2}\right]^{1/2}$

8. $h = \dfrac{qE_0 L^2}{2mv_0^2}$

10. (b) $q = \dfrac{6\sqrt{3}}{7^{3/2}}Q$

12. (a) $q = 2\lambda_0 a$, (b) $q = \frac{4}{3}\pi\rho_0 a^3$, (c) $q = 2\sigma_0 ab\pi$

15. $\theta = \tan^{-1}\left[\dfrac{Q\sigma_0}{2\varepsilon_0 Mg}\right]$

16. (a) $E_r = \dfrac{\lambda L}{2\pi\varepsilon_0 \mathrm{r}\sqrt{L^2 + \mathrm{r}^2}}$,

(b) $E_x = \dfrac{\sigma_0}{2\pi\varepsilon_0}\left[\sin^{-1}\left(\dfrac{L^2 - x^2}{L^2 + x^2}\right) + \dfrac{\pi}{2}\right]; \quad x > 0$

18. (a) $E_y = \dfrac{-\lambda_0 a^2}{\pi\ \epsilon_0[z^2 + a^2]^{3/2}}$

(b) $E_y = \dfrac{-\sigma_0}{\pi\epsilon_0}\left\{\dfrac{-a}{\sqrt{z^2 + a^2}} + \ln\left[\dfrac{a + \sqrt{z^2 + a^2}}{|z|}\right]\right\}$

20. (a) $E_y = -\dfrac{\lambda_0 a^2}{\pi\varepsilon_0(a^2 + z^2)^{3/2}}$

21. $E_y = \dfrac{\lambda_0 z^2}{2\pi\varepsilon_0(a^2 + z^2)^{3/2}}$

22. (a) $Q_T = 4\pi\varepsilon_0 AR^4$

23. (c) $E_x = \begin{cases} \dfrac{\rho_0}{2\varepsilon_0 d}(x^2 - d^2) & |x| < d \\ 0 & |x| > d \end{cases}$

25. (c) $E_r = \begin{cases} \dfrac{\rho_0 \mathrm{r}^2}{3\varepsilon_0 a} & \mathrm{r} < a \\ \dfrac{\rho_0 a^2}{3\varepsilon_0 \mathrm{r}} & \mathrm{r} > a \end{cases}$

26. $\mathbf{E} = \dfrac{\rho_0 d}{2\varepsilon_0}\mathbf{i}_x$

27. $W = -\dfrac{\lambda\sigma_0 l^2}{4\varepsilon_0}$

28. (a) $v_0 \geq \sqrt{\frac{qQ}{2\pi\varepsilon_0 Rm}}$, (b) $r = 4R$

29. (a) $\mathbf{E} = -2Ax\mathbf{i}_x, \rho_f = -2A\varepsilon_0$

31. (a) $\Delta v = \frac{\sigma_0 a}{\varepsilon_0}$

32. (a) $dq = -\frac{Q}{R}dz'$

33. (c) $V \approx \frac{q_0 a}{4\pi\varepsilon_0 r^2}\cos\theta$, (d) $r = r_0 \sin^2\theta$

34. (d) $q_c = -\frac{qV_p}{V_c}$

36. (a) $E_y = -\frac{\sigma_0}{2\pi\varepsilon_0}\ln\left(1-\frac{d}{y}\right)$

38. (a) $x_0 = \sqrt{\frac{q}{16\pi\varepsilon_0 E_0}}$, (b) $v_0 > \frac{1}{2}\sqrt{\frac{q}{m}}\left[\frac{qE_0}{\pi\varepsilon_0}\right]^{1/4}$,

(c) $W = \frac{q^2}{16\pi\varepsilon_0 d}$

43. (e) $\lambda = \pm\sqrt{\frac{R_1}{R_2}}, \alpha = \pm\frac{R_1}{R_2}$

44. (g) $q_T = -4\pi\varepsilon_0 R^2\frac{\pi^2}{6}$

Chapter 3

2. (a) $p_z = \lambda_0 L^2$, (e) $p_z = QR$

4. (a) $\rho_0 = \frac{3Q}{\pi R_0^3}$

7. (a) $\mathbf{d} = \frac{4\pi\varepsilon_0 R_0^3 \mathbf{E}_0}{Q}$

8. (b) $\frac{Q}{L^2} = 2\pi\varepsilon_0 E_0$

10. (a) $\mathbf{p}_{\text{ind}} = \mathbf{p}\frac{R^3}{D^3}$

12. (a) $V(x) = \frac{V_0}{2}\frac{\sinh x/l_d}{\sinh l/l_d}$

15. (b) $Q = \frac{m\omega RA\sigma}{q}$

17. (a) $D_r = \dfrac{\lambda}{2\pi r}$

19. (a) $\lambda' = -\lambda'' = \dfrac{\lambda(\varepsilon_2 - \varepsilon_1)}{\varepsilon_1 + \varepsilon_2}, \lambda''' = \dfrac{2\varepsilon_2\lambda}{\varepsilon_1 + \varepsilon_2}$

23. (a)
$$E_r = \begin{cases} -\dfrac{P_0 r}{\varepsilon_0 R} & r < R \\ 0 & r > R \end{cases}$$

26. (a) $R = \dfrac{s \ln \dfrac{\sigma_2}{\sigma_1}}{lD(\sigma_2 - \sigma_1)}$

31. $C = \dfrac{2\pi l(\varepsilon_2 a - \varepsilon_1 b)}{(b-a)\ln \dfrac{\varepsilon_2 a}{\varepsilon_1 b}}$

33. $\sigma_f(r = a_1) = \dfrac{\rho_0 a_0^2}{3a_1}(1 - e^{-t/\tau});\ \tau = \varepsilon/\sigma$

35. $\rho_f = \rho_0\, e^{-\sigma r^3/(3\varepsilon A)}$

38. (a) $v(z) = -\dfrac{V_0 \sinh \sqrt{2RG}(z-l)}{\sinh \sqrt{2RG}l}$

41. (b) $\dfrac{\varepsilon\mu}{2}[E^2(l) - E^2(0)] + \varepsilon\dfrac{dv}{dt} = J(t)l$

(c) $E(l) = \dfrac{V_0/l}{1 - \dfrac{\mu t V_0}{2l^2}}$, (f) $\tau = \dfrac{2l^2}{\mu V_0}(1 - e^{-1/2})$

42. (c) $E_i^2 = \left(\dfrac{V_0}{R_0 - R_i}\right)^2 = \dfrac{I}{2\pi\varepsilon\mu l}$

43. (a) $W = -\frac{1}{2}\mathbf{p}\cdot\mathbf{E}$

44. $W = \dfrac{p^2}{12\pi\varepsilon_0 R^3}$

47. (a) $W = \dfrac{-Q^2}{8\pi\varepsilon_0 R}$

48. (a) $W_{\text{init}} = \frac{1}{2}CV_0^2$, (b) $W_{\text{final}} = \frac{1}{4}CV_0^2$

49. (b) $W = -pE(\cos\theta - 1)$

50. $h = \frac{1}{2}(\varepsilon - \varepsilon_0)\dfrac{V_0^2}{\rho_m g s^2}$

52. (b) $f_y=\frac{1}{2}\frac{\varepsilon_0 A}{(s+d)^2}\left[V_0+\frac{P_0 d}{\varepsilon_0}\right]^2$

54. (b) $f_z=\frac{\pi V_0^2}{\ln\frac{b}{a}}(\varepsilon-\varepsilon_0)$

55. $f_x=-\frac{1}{2}\frac{\varepsilon_0 d}{s}V_0^2$

56. (c) $T=\frac{1}{2}v^2\frac{dC}{d\theta}=\frac{-NV_0^2R^2\varepsilon_0}{s}$

57. (a) $v(t)=\frac{\sigma_f Uwt}{4\pi\varepsilon_0 R}$

58. (a) $\rho_f=\rho_0\, e^{-\sigma z/\varepsilon U}$

59. (a) $nC_i>\frac{1}{R}+\frac{2}{R_L}$, (c) $\frac{nC_i}{2}>\frac{1}{R}$, $\omega_0=\frac{\sqrt{3}}{2}\frac{nC_i}{C}$

Chapter 4

2. (a)
$$V=\begin{cases}\frac{\sigma_0}{2\varepsilon a}\cos ay\,e^{-ax} & x>0\\ \frac{\sigma_0}{2\varepsilon a}\cos ay\,e^{ax} & x<0\end{cases}$$

4. (a) $$V=\frac{4V_1}{\pi}\sum_{\substack{n=1\\ n\text{ odd}}}^{\infty}\frac{\sin\frac{n\pi y}{d}\sinh\frac{n\pi(l-x)}{d}}{n\sinh\frac{n\pi l}{d}}$$

7. (a) $V_p=\frac{\rho_0}{\varepsilon_0 a^2}\sin ax$

12.
$$V(\mathrm{r},\phi)=\begin{cases}\left[\frac{P_2-P_1}{2\varepsilon_0}-E_0\right]\mathrm{r}\cos\phi & 0\le \mathrm{r}\le a\\ \left[-E_0\mathrm{r}+\frac{(P_2-P_1)a^2}{2\varepsilon_0\mathrm{r}}\right]\cos\phi & \mathrm{r}>a\end{cases}$$

13. (a) $$\mathbf{E}=\left[E_0\left(1+\frac{a^2}{\mathrm{r}^2}\right)\cos\phi+\frac{\lambda(t)}{2\pi\varepsilon r}\right]\mathbf{i}_r-E_0\left(1-\frac{a^2}{\mathrm{r}^2}\right)\sin\phi\,\mathbf{i}_\phi$$

(b) $\cos\phi<-\frac{\lambda(t)}{4\pi\varepsilon aE_0}$, (c) $\lambda_{\max}=4\pi\varepsilon aE_0$

15. (a) $V(r,z)=\begin{cases}\dfrac{V_0 z}{l\ln\dfrac{b}{a}}\ln\dfrac{r}{a} & a\le r\le b\\ \dfrac{V_0 z}{l} & b\le r\le c\end{cases}$

17. (b) $E_0\ge\sqrt{\dfrac{8\rho_m gR}{27\epsilon}}$

22. $V(2,2)=V(3,2)=V(2,3)=V(3,3)=-4.$

23. (a) $V(2,2)=-1.0000$, $V(3,2)=-.5000$, $V(2,3)$ $=-.5000$, $V(3,3)=.0000$

(b) $V(2,2)=1.2500$, $V(3,2)=-.2500$, $V(2,3)$ $=.2500$, $V(3,3)=-1.2500$

Chapter 5

2. (b) $B_0^2>\dfrac{2mV_0}{es^2}$, (e) $B_0^2>\dfrac{8b^2mV_0}{e(b^2-a^2)^2}$

3. $B_0=\dfrac{-mg}{qv_0}$

4. (d) $\dfrac{e}{m}=\dfrac{E_y}{RB_0^2}$

8. (c) $\mathbf{J}=\sigma(\mathbf{E}+\mathbf{v}\times\mathbf{B})$

10. (a) $B_z=\dfrac{2\mu_0 I(a^2+b^2)^{1/2}}{\pi ab}$, (c) $B_z=\dfrac{n\mu_0 I}{2\pi a}\tan\dfrac{\pi}{n}$

12. (a) $B_z=\dfrac{\mu_0 K_0\pi}{4}$

13. (a) $B_\phi=\dfrac{\mu_0 IL}{2\pi r\sqrt{L^2+r^2}}$

15. (b) $B_y=\dfrac{\mu_0 J_0 d}{2}$

17. (b) $B_x=\begin{cases}-\dfrac{\mu_0 J_0}{2a}(y^2-a^2) & |y|<a\\ 0 & |y|>a\end{cases}$

18. (d) $y=\dfrac{y_0}{2}$ at $x=-\infty$

21. (a) $m_z=\frac{1}{2}q\omega a^2$

23. $\omega_0 = \sqrt{\gamma B_0}$

27. (a) $I' = \dfrac{(\mu_2 - \mu_1)}{(\mu_1 + \mu_2)} I,\ I'' = \dfrac{2\mu_1 I}{\mu_1 + \mu_2}$

34. (a) $\mathbf{H} = \begin{cases} \dfrac{-M_0}{2}\mathbf{i}_x \\ \dfrac{M_0 a^2}{2r^2}[\cos\phi\,\mathbf{i}_r + \sin\phi\, i_\phi] \end{cases}$

35. (a) $H_z(x) = -\dfrac{I}{Dd}(x - d)$, (b) $f_x = \dfrac{1}{2}\mu_0 \dfrac{I^2 s}{D}$

36. (a) $f_x = \frac{1}{2}(\mu - \mu_0) H_0^2 Ds$, (b) $f_x = \mu_0 M_0 Ds[H_0 + M_0]$

Chapter 6

1. (a) $M = \mu_0[D - \sqrt{D^2 - a^2}]$, (e) $f_r = \mu_0 Ii\left[\dfrac{D}{\sqrt{D^2 - a^2}} - 1\right]$

3. (d) $v(t) = v_0\left[\dfrac{\alpha}{2\beta}\sin\beta t + \cos\beta t\right]e^{-\alpha t/2};\ \beta = \sqrt{\omega_0^2 - \left(\dfrac{\alpha}{2}\right)^2}$

$$i(t) = \frac{m v_0 \omega_0^2}{B_0 b \beta}\sin\beta t\, e^{-\alpha t/2}$$

(e) $v_0 > \dfrac{B_0 bs}{\sqrt{mL}}$

4. (a) $M = \dfrac{\mu_0 Ns}{2\pi}\ln\dfrac{a}{b},\ M = \mu_0 N[R - \sqrt{R^2 - a^2}]$

7. (c) $f_z = \dfrac{3\mu_0 (IdS)^2}{32\pi d^4}$

8. (a) $H_z = K(t)$, (b) $K(t) = K_0\left(\dfrac{x_0}{x_0 - Vt}\right)^{(1 - 1/R_m)}$

9. (a) $i = \dfrac{r\sigma d}{2}\dfrac{dB}{dt}dr$, (c) $P = \dfrac{\pi\sigma d a^4}{8}\left(\dfrac{dB}{dt}\right)^2$

10. $L = \mu_0 N^2[b - \sqrt{b^2 - a^2}]$

14. (a) $\dfrac{v_2}{v_1} = \dfrac{N_2}{2N_1},\ \dfrac{i_2}{i_1} = \dfrac{2N_1}{N_2}$

16. (a) $V_{oc} = J_x B_z d \dfrac{(\mu_+^2 n_+ - \mu_-^2 n_-)}{q(\mu_+ n_+ + \mu_- n_-)^2}$

17. (b), (c) $EMF = -\frac{\mu_0 V_0 I}{2\pi}\ln\frac{R_2}{R_1}$,

(d) $EMF = -\frac{(\mu-\mu_0)IV_0}{2\pi}\ln\frac{R_2}{R_1}$

18. (a) $\mathbf{H}=0, \mathbf{B}=\mu_0 M_0 \mathbf{i}_z$, (b) $v_{oc}=\frac{\omega B_z}{2}(b^2-a^2)$

20. (b) $V>\frac{1}{\mu_0\sigma ND}$

21. (a) $\omega>\frac{(R_r+R_f)}{G}$

(b) $C_{crit}=\frac{4L_f}{[R_r+R_f-G\omega]^2}$; $C>C_{crit}(dc)$, $C<C_{crit}(ac)$

(c) $\omega_0\left[\frac{1}{L_fC}-\left[\frac{R_r+R_f-G\omega}{2L_f}\right]^2\right]^{1/2}$

22. (b) $H_z(x,t)=\sum_{\substack{n=1\\ n\text{ odd}}}^{\infty}\frac{2I_0}{n\pi D}\sin\frac{n\pi x}{d}e^{-\alpha_n t}$

23. (c) $H_y(x,t)=H_0-\sum_{\substack{n=1\\ n\text{ odd}}}^{\infty}\frac{4H_0}{n\pi}\sin\frac{n\pi x}{d}e^{-\alpha_n t}$

25. (b) $H_z(y,t)=-K_0+\sum_{n=0}^{\infty}\frac{(-1)^n 4K_0}{\pi(2n+1)}\cos\left[\frac{(2n+1)\pi y}{2D}\right]—e^{-\alpha_n t}$

(d) $\hat{H}_z(y)=K_0\left[\frac{[e^{(1+j)y/\delta}+e^{-(1+j)y/\delta}]}{[e^{(1+j)D/\delta}+e^{-(1+j)D/\delta}]}\right]$

26. (a) $H_z(x)=\frac{K_0}{1-e^{R_m}}[2e^{R_m x/l}-(1+e^{R_m})]$

27. (a) $\hat{H}_z(x)=K_0e^{-\beta x}e^{R_m x/2l}$; $\beta=\frac{R_m}{2l}\sqrt{1+\frac{2jl^2}{R_m^2\delta^2}}$

28. (a)

$$\hat{\mathbf{H}}(x)=\begin{cases}\dfrac{K_0\left\{\left(1-\frac{\mu}{\mu_0}\frac{k}{\gamma}\right)e^{k(x-s)}(\mathbf{i}_z+j\mathbf{i}_x)+\left(1+\frac{\mu}{\mu_0}\frac{k}{\gamma}\right)e^{-k(x-s)}(\mathbf{i}_z-j\mathbf{i}_x)\right\}}{\left[1-\frac{\mu}{\mu_0}\frac{k}{\gamma}\right]e^{-ks}+\left[1+\frac{\mu}{\mu_0}\frac{k}{\gamma}\right]e^{ks}} & 0<x<s\\[2ex] \dfrac{2K_0e^{-\gamma(x-s)}\left[\mathbf{i}_z-\frac{jk}{\gamma}\mathbf{i}_x\right]}{\left[1-\frac{\mu}{\mu_0}\frac{k}{\gamma}\right]e^{-ks}+\left[1+\frac{\mu}{\mu_0}\frac{k}{\gamma}\right]e^{ks}} & x>s\end{cases}$$

29. (a) $H_y = H_0 \dfrac{\cosh k(x - d/2)}{\cosh kd/2}$

32. (b) $\hat{H}_\phi(r) = \dfrac{I_0}{2\pi a} \dfrac{J_1[(r/\delta)(1-j)]}{J_1[(a/\delta)(1-j)]}$

33. (a) $T = -L_1 I_0^2 \cos^2 \omega_0 t \sin 2\theta$

34. (c) $T = M_0 I_1 I_2 \cos\theta,$

(f) $\theta(t) = \theta_0\left[\cos\beta t + \dfrac{\alpha}{2\beta}\sin\beta t\right] e^{-\alpha t/2}$

35. (a) $L(x) = \dfrac{\mu_0 x}{2\pi}\ln\dfrac{b}{a},$ (b) $f_x = \dfrac{\mu_0 i^2}{4\pi}\ln\dfrac{b}{a}$

37. $h = \dfrac{I^2(\mu - \mu_0)\ln\dfrac{b}{a}}{4\pi^2\rho_m g(b^2 - a^2)}$

Chapter 7

4. (b) $W = 4[P_s E_c + \mu_0 M_s H_c]$

9. (b) $\hat{E}_x(z) = \begin{cases} \dfrac{j\eta_0 J_0 \sin kd\, e^{\mp jk_0(z \mp d)}}{\omega\varepsilon[\eta_0 \sin kd - j\eta\cos kd]} & z > d \\ & z < -d \\ -\dfrac{J_0\eta\cos kz}{\omega\varepsilon[\eta_0\sin kd - j\eta\cos kd]} & |z| < d \end{cases}$

10. (b) $E_x = E_0\, e^{j(\omega t \mp \beta z)}\, e^{\mp(\alpha z/2)} \quad \begin{matrix} z > 0 \\ z < 0 \end{matrix};\ \beta = \sqrt{\omega^2\varepsilon\mu - \dfrac{\alpha^2}{4}}$

11. (a) $t_1' - t_2' = \dfrac{\gamma v}{c_0^2}(z_2 - z_1),$

(b) $t_1' - t_2' = \gamma(t_1 - t_2),$ (c) $z_2' - z_1' = \gamma L$

12. (a) $u_z' = \dfrac{u_z - v}{1 - vu_z/c_0^2},\ u_{x,y}' = \dfrac{u_{x,y}\sqrt{1 - (v/c_0)^2}}{1 - vu_z/c_0^2}$

15. (b) $\varepsilon(\omega) = \varepsilon_0\left[1 + \dfrac{\omega_p^2}{\omega_0^2 - \omega^2}\right]$

16. (c) $k^2 = \dfrac{\omega^2}{c^2}\left[1 - \dfrac{\omega_p^2}{\omega(\omega \mp \omega_0)}\right]$

20. (a) $\mathbf{E} = E_0\left[\cos\omega\left(t - \dfrac{z}{c}\right) - \cos\omega\left[\left(1 - \dfrac{2v}{c}\right)\left(t - \dfrac{z}{c}\right)\right]\right]\mathbf{i}_y$

22. $\alpha^2 - k^2 = -\omega^2\varepsilon\mu,\ \boldsymbol{\alpha}\cdot\mathbf{k} = \dfrac{1}{\delta^2}$

26. (a) $L_1+L_2=s_i \sin\theta_i+s_r \sin\theta_r=h_1 \tan\theta_i+h_2 \tan\theta_r$

31. $\theta_t \approx 41.7°$

33. (a) $\left(\frac{x}{R}\right)^2>1-\frac{(n^2-2)^2}{4}$; $\sqrt{2}\leq n\leq 2$

(b) $R'=\frac{\alpha R}{[\sqrt{n^2(1-\alpha^2)}\sqrt{n^2-\alpha^2}+\alpha^2]}$

Chapter 8

2. (c) $\hat{v}(z)=-\frac{V_0 \sin\beta(z-l)\,e^{\alpha z/2}}{\sin\beta l}$ (Short circuited end)

4. (c) $\omega^2=\omega_p^2+k^2c^2$, (d) $v(z,t)=-\frac{V_0 \sin kz \cos\omega t}{\sin kl}$

5. (b) $k=\frac{1}{\omega\sqrt{LC}}$

14. (a) $V_+=-V_-=\frac{V_0Z_0}{2R_s}$

16. (b) $\tan kl=-XY_0$

21. (c) $VSWR=\frac{1+\sqrt{2}}{\sqrt{2}-1}\approx 5.83$

22. (b) $VSWR=2$

23. $Z_L=170.08-133.29j$

24. (a) $l_1=.137\lambda+\frac{n\lambda}{2}$, $l_2=.089\lambda+\frac{m\lambda}{2}$

$l_1=.279\lambda+\frac{n\lambda}{2}$, $l_2=.411\lambda+\frac{m\lambda}{2}$

25. (a) $l_1=.166\lambda+\frac{n\lambda}{2}$, $l_2=.411\lambda+\frac{m\lambda}{2}$

$l_1=.077\lambda+\frac{n\lambda}{2}$, $l_2=.043\lambda+\frac{m\lambda}{2}$

27. (e) $\alpha=\frac{2(\pi/a)^2[b+(a/2)(\omega^2a^2/\pi^2c^2)]}{\omega\mu abk_z\sigma_w\delta}$

28. (b) $=\frac{2\omega\varepsilon(bk_x^2+ak_y^2)}{\sigma_w\delta k_z ab(k_x^2+k_y^2)}$

29. (a) TE mode:

electric field: $\cos k_x x \cos k_y y = \text{const}$

magnetic field: $\dfrac{\sin (k_x x)^{(k_y/k_x)^2}}{\sin k_y y} = \text{const}$

31. (b) $\dfrac{\omega^2}{c^2} = \left(\dfrac{m\pi}{a}\right)^2 + \left(\dfrac{n\pi}{b}\right)^2 + \left(\dfrac{p\pi}{l}\right)^2,$

32. (a) $\omega^2 = \dfrac{k_x^2}{\varepsilon\mu - \varepsilon_0\mu_0}$

Chapter 9

1. (c) $\hat{V} = \dfrac{\hat{Q}}{4\pi\varepsilon r} e^{-jr\sqrt{\omega^2/c^2 - j\omega\mu\sigma}}$

4. (a) $dl_{\text{eff}} = \dfrac{2 \sin (\alpha dl/2)}{\alpha}$, $\hat{\lambda}(z) = \dfrac{I_0\alpha}{j\omega} \sin \alpha z$

6. (a) $\hat{p}_z = 4\pi\varepsilon_0 R^3 \hat{E}_0$

(c) $\langle P \rangle = \dfrac{\omega^4 |\hat{p}_z|^2 \eta}{12\pi c^2}$

7. (a) $m_{\text{ind}} = 2\pi H_0 R^3$

8. (b) $\sin^2\theta \left[\dfrac{\cos (\omega t - kr)}{kr} - \sin (\omega t - kr)\right] = \text{const}$

9. (a) $\hat{E}_\theta \approx \dfrac{2\hat{E}_0}{jkr} \sin \theta \, e^{-j(kr - \chi/2)} \left[\cos \left(ka \cos \theta - \dfrac{\chi}{2}\right)\right]$

11. $\hat{E}_\theta = \dfrac{2jK_0 dl \eta \, e^{-jkr}}{4\pi r \cos \phi} \sin \left(\dfrac{kL}{2} \sin \theta \cos \phi\right)$

12. (a) $\hat{E}_\theta = \dfrac{\eta I_0 \sin \theta \, e^{-jkr}}{j\pi k r L \cos^2 \theta} \cos \left[\left(\dfrac{kL}{2} \cos \theta\right) - 1\right]$