Prob. 11.27

$$z_L = \frac{Z_L}{Z_O} = \frac{210}{100} = 2.1 = s$$

Or $\Gamma = \frac{Z_L - Z_O}{Z_L + Z_O} = \frac{110}{310}$,

$$s = \frac{1+|\Gamma|}{1-|\Gamma|} = 2.1$$

But $s = \frac{V_{\max}}{V_{\min}} \rightarrow V_{\max} = sV_{\min}$

Since the line is $\frac{\lambda}{4}$ long, $\frac{\lambda}{4} \rightarrow \frac{720^o}{4} = 120^o$

Hence the sending end will be $V_{\min}$, while the receiving end at $V_{\max}$

$V_{\min} = V_{\max} / s = 80/2.1 = 38.09$

$V_{sending} = \underline{\underline{38.09 < 90^o}}$

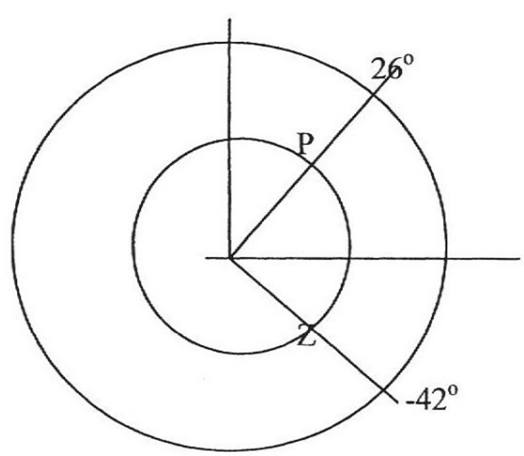
Prob. 11.28

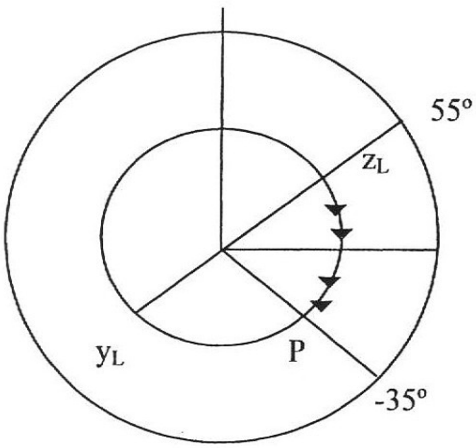
$$z_L = \frac{Z_L}{Z_o} = \frac{100 + j150}{50} = 2 + j3$$

$$z_{in} = \frac{Z_{in}}{Z_o} = \frac{50 + j110}{50} = 1 + j2.2$$

$$\theta = 26^o - -42^o = 68^o$$

If $720 \rightarrow \lambda$, $68^o \rightarrow d = \frac{\lambda}{720^o} 68^o = \underline{\underline{0.0944\lambda}}$

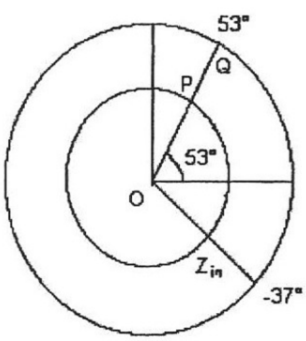




At P, $z_{in} = \underline{\underline{1.4 - j2.6}}$

(Exact value = 1.379-j2.448)

(c)



$$\Gamma = 0.3 + j0.4 = 0.5 < 53.13^o$$

$$\frac{OP}{OQ} = 0.5, \qquad z_{in} = \underline{\underline{1.667 - j1.333}}$$

Prob. 11.34

(a) $$z_L = \frac{Z_L}{Z_o} = \frac{75 + j60}{50} = 1.5 + j1.2$$

$$|\Gamma| = \frac{OP}{OQ} = \frac{3.8\text{cm}}{8\text{cm}} = 0.475, \qquad \theta_\Gamma = 42^o$$

$$\Gamma = \underline{\underline{0.475\angle 42^0}}$$

(Exact value = $0.4688 \ \angle 41.76^o$)

(b) s=2.8

(Exact value = 2.765)

(c) $0.2\lambda \to 0.2x720^o = 144^o$

$$z_{in} = 0.55 - j0.65$$

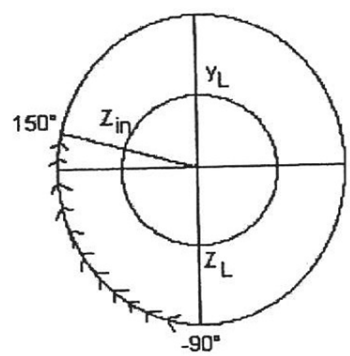
$$Z_{in} = Z_o z_{in} = 50(0.55 + j0.65) = \underline{\underline{27.5 + j32.5\ \Omega}}$$

(d) Since $\theta_\Gamma = 42^o$, V_{min} occurs at

$$\frac{42}{720}\lambda = \underline{\underline{0.05833\lambda}}$$

(e) same as in (d), i.e.. $\underline{\underline{0.05833\lambda}}$

Prob. 11.35



If $\lambda \to 720^o$, then $\dfrac{\lambda}{6} \to 120^o$

$$z_{in} = \underline{\underline{0.35 + j0.24}}$$

Prob. 11.36

(a) $Z_{in} = \frac{Z_{in}}{Z_o} = \frac{100 - j120}{80} = 1.25 - j1.5$

$\lambda = \frac{u}{f} = \frac{0.8 \times 3 \times 10^8}{12 \times 10^6} = 20m$

$l_1 = 22m = \frac{22\lambda}{20} = 1.1\lambda \rightarrow 720° + 72°$

$l_2 = 28m = \frac{28\lambda}{20} = 1.4\lambda \rightarrow 720° + 72° + 216°$

To locate P(the load), we move 2 revolutions plus 72° toward the load. At P,

$|\Gamma_L| = \frac{OP}{OQ} = \frac{5.1cm}{9.2cm} = 0.5543$

$\theta_\Gamma = 72° - 47° = 25°$

$\Gamma_L = \underline{\underline{0.5543\angle 25°}}$

(Exact value = 0.5624<25.15°)

$Z_{in}, \max = sZ_o = 3.7(80) = \underline{\underline{296\Omega}}$

(Exact value = 285.59 Ω)

$Z_{in}, \min = \frac{Z_o}{s} = \frac{80}{3.7} = \underline{\underline{21.622\Omega}}$

(Exact value =22.41 Ω)

(b) Also, at P, $Z_L = 2.3 + j1.55$

$$Z_L = 80(2.3 + j1.55) = \underline{\underline{184 + j124\Omega}}$$

(Exact value = 183.45+j128.25 Ω)

At S, $s = \underline{\underline{3.7}}$

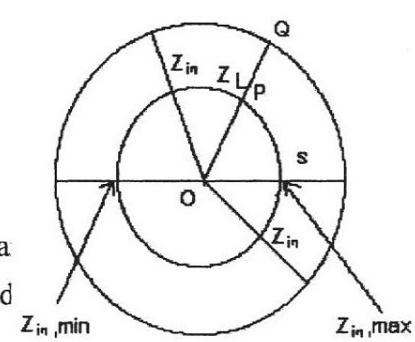
To Locate Z'_{in}, we move 216° from Z_{in} toward the generator

At Z'_{in},

$z'_{in} = 0.48 + j0.76$

$Z'_{in} = 80(0.48 + j0.76) = \underline{\underline{38.4 + j60.8\Omega}}$

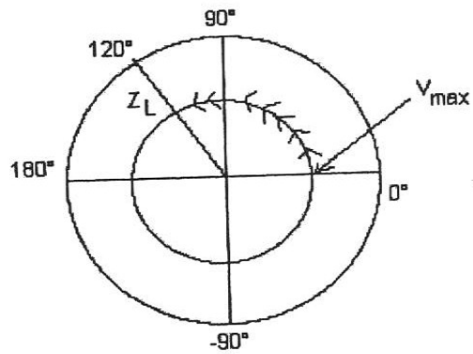
(Exact=37.56+j61.304 Ω)



(c) Between Z_L and Z_{in}, we move 2 revolutions a the movement, we pass through $Z_{in,\max}$ 3 times and Thus there are:

$$\underline{\underline{3\ Z_{in,\max} \text{ and } 2\ Z_{in,\min}}}$$

Prob. 11.37



(a) $\frac{\lambda}{2} = 120cm \rightarrow \lambda = 2.4m$

$u = f\lambda \rightarrow f = \frac{u}{\lambda} = \frac{3\times10^8}{2.4} = \underline{\underline{125MHz}}$

(b) $40cm \quad = \frac{40\lambda}{240} = \frac{\lambda}{6} \rightarrow \frac{720°}{6} = 120°$

$Z_L = Z_o z_L = 150(0.48 + j0.48$

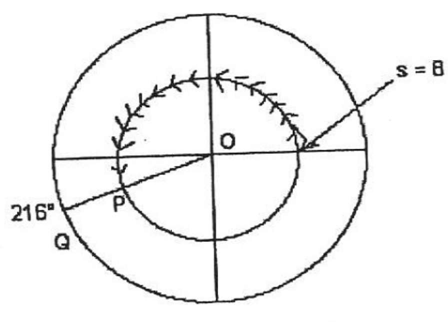
$= \underline{\underline{72 + j72\ \Omega}}$

(Exact value = 73.308+j70.324 Ω)

(c) $|\Gamma| = \frac{s-1}{s+1} = \frac{1.6}{3.9} = 0.444,$

$\Gamma = \underline{\underline{0.444\angle 120°}}$

Prob. 11.38



$0.3\lambda \rightarrow 720° \times 0.3 = 216°$

At P, $z_L = 0.15 - j0.32$

$Z_L = Z_o z_L = \underline{\underline{15 - j32\Omega}}.$

(Exact value = 13.7969 -j31.9316 Ω)

$$|\Gamma| = \frac{OP}{OQ} = \frac{7.2 \text{ cm}}{9.3 \text{ cm}} = 0.7742$$

$\Gamma = \underline{\underline{0.7742\angle 216°}}$

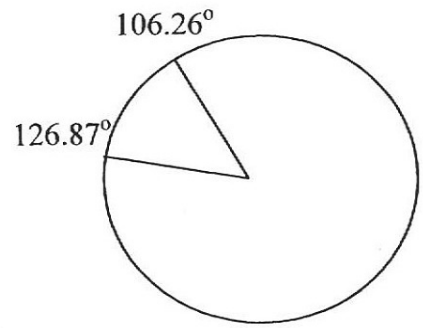
(Exact value = $0.7778\angle 216°$)

Prob. 11.39

(a)

$$z_L = \frac{Z_L}{Z_o} = \frac{j60}{80} = j0.75, \qquad z_{in} = \frac{Z_{in}}{Z_o} = \frac{j40}{80} = j0.5$$

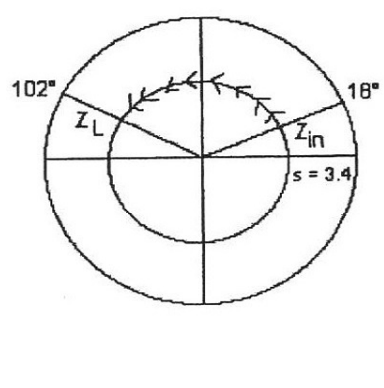
The two loads fall on the r=0 circle, the outermost resistance circle. The shortest distance between them is



$$\frac{360^o - (126.87^o - 106.26^o)\lambda}{720^o} = \underline{\underline{0.4714\lambda}}$$

(b) $\underline{\underline{s = \infty}}$, $\quad \Gamma_L = \underline{\underline{1\angle 106.26^o}}$

Prob. 11.40



$l = 0.2\lambda \rightarrow 720° \times 0.2 = 144°$

$$Z_{in} = \frac{V_s}{I_s} = \frac{2+j}{10\times10^{-3}} = 200 + j100$$

$$Z_{in} = \frac{Z_{in}}{Z_L} = 2.667 + j1.33$$

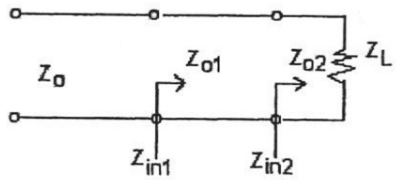
$$Z_L = 0.3 + j0.12$$

$$Z_L = 75(0.3 + j0.12) = \underline{\underline{22.5 + j9\Omega}}$$

(Exact value = 22.4233+j10.4251 Ω)

$s = \underline{\underline{3.4}}$

Prob. 11.41



(a) From Eq. (11.43), $Z_{in2} = \dfrac{Z_{o2}^2}{Z_L}$

$$Z_{in1} = \frac{Z_{o1}^2}{Z_{in2}} = Z_o, \text{i.e. } Z_{in2} = \frac{Z_{o1}^2}{Z_o} = \frac{Z_{o2}^2}{Z_L}$$

$$Z_{o1} = Z_{o2}\sqrt{\frac{Z_o}{Z_L}} = 30\sqrt{\frac{50}{75}} = \underline{\underline{24.5\Omega.}}$$

(b) Also, $\dfrac{Z_o}{Z_{o1}} = \left(\dfrac{Z_{o2}}{Z_L}\right) \rightarrow Z_{o2} = \dfrac{Z_o Z_L}{Z_{o1}}$ (1)

Also, $\dfrac{Z_{o1}}{Z_{o2}} = \left(\dfrac{Z_{o2}}{Z_L}\right)^2 \rightarrow (Z_{o2})^3 = Z_{o1}Z_L^2$ (2)

From (1) and (2), $(Z_{o2})^3 = Z_{o1}Z_L^2 = \dfrac{Z_o^3 Z_L^3}{Z_{o1}^3}$ (3)

or $Z_{o1} = \sqrt[4]{Z_o^3 Z_L} = \sqrt[4]{(50)^3(75)} = \underline{\underline{55.33\Omega}}$

From (3), $Z_{o2} = \sqrt[3]{Z_{o1}Z_L^2} = \sqrt[3]{(55.33)(75)^2} = \underline{\underline{67.74\Omega.}}$

Prob. 11.42

$$\frac{\lambda}{4} \rightarrow 180°, \quad z_L = \frac{74}{50} = 1.48, \quad \frac{1}{z_L} = 0.6756$$

This acts as the load to the left line. But there are two such loads in parallel due to the two lines on the right. Thus

$$Z_L' = 50\frac{\left(\frac{1}{Z_L}\right)}{2} = 25(0.6756) = 16.892$$

$$z_L' = \frac{16.892}{50} = 0.3378, \quad z_{in} = \frac{1}{z_L'} = 2.96$$

$$Z_{in} = 50(2.96) = \underline{\underline{148\Omega.}}$$

Prob. 11.43

From the previous problem, $Z_{in} = 148\Omega$

$$I_{in} = \frac{V_g}{Z_g + Z_{in}} = \frac{120}{80+148} = 0.5263A$$

$$P_{ave} = \frac{1}{2}|I_{in}|^2 R_{in} = \frac{1}{2}(0.5263)^2(148) = 20.5W$$

Since the lines are lossless, the average power delivered to either antenna is $\underline{\underline{10.25W}}$

Prob. 11.44

(a) $\beta l = \frac{2\pi}{4}.\frac{\lambda}{4} = \frac{\pi}{2}, \qquad \tan\beta l = \infty$

$$Z_{in} = Z_o\left(\frac{Z_L + jZ_o\tan\beta l}{Z_o + jZ_L\tan\beta l}\right) = Z_o\frac{\left(\frac{Z_L}{\tan\beta l} + jZ_o\right)}{\left(\frac{Z_o}{\tan\beta l} + jZ_L\right)}$$

As $\tan\beta l \to \infty$,

$$Z_{in} = \frac{Z_o^2}{Z_L} = \frac{(50)^2}{200} = \underline{\underline{12.5\Omega}}$$

(b) If $Z_L = 0$,

$$Z_{in} = \frac{Z_o^2}{0} = \underline{\underline{\infty}} \qquad \text{(open)}$$

(c) $Z_L = 25 // \infty = \frac{25\times\infty}{25+\infty} = \frac{25}{1+\frac{25}{\infty}} = 25\Omega$

$$Z_{in} = \frac{(50)^2}{12.5} = \underline{\underline{200\Omega}}$$

Prob. 11.45

$$l_1 = \frac{\lambda}{4} \rightarrow Z_{in1} = \frac{Z_o^2}{Z_L} \quad or \quad y_{in1} = \frac{Z_L}{Z_o^2}$$

$$y_{in1} = \frac{200 + j150}{(100)^2} = \underline{\underline{20 + j15 \text{ mS}}}$$

$$l_2 = \frac{\lambda}{8} \rightarrow Z_{in2} =_{Z_L} \underline{\lim}_0 Z_o \left(\frac{Z_L + jZ_o \tan\frac{\pi}{4}}{Z_o + jZ_L \tan\frac{\pi}{4}} \right) = jZ_o$$

$$y_{in2} = \frac{1}{jZ_o} = \frac{1}{j100} = \underline{\underline{-j10 \text{ mS}}}$$

$$l_3 = \frac{7\lambda}{8} \rightarrow Z_{in3} = Z_o \frac{\left(Z_i + jZ_o \tan\frac{7\pi}{4}\right)}{\left(Z_o + jZ_i \tan\frac{7\pi}{4}\right)} = \frac{Z_o(Z_i - jZ_o)}{(Z_o - jZ_i)}$$

But

$$y_i = y_{in1} + y_{in2} = 20 + j5 \text{ mS}$$

$$z_i = \frac{1}{y_i} = \frac{1000}{20 + j5} = 47.06 - j11.76$$

$$y_{in3} = \frac{Z_o - jZ_{in}}{Z_o(Z_{in} - jZ_o)} = \frac{100\text{-}j47.06\text{-}11.76}{100(47.06\text{-}j11.76\text{-}j100)}$$

$$= \underline{\underline{6.408 + j5.189 \text{ mS}}}$$

If the shorted section were open,

$$y_{in1} = \underline{\underline{20 + j15 \text{ mS}}}$$

$$y_{in2} = \frac{1}{Z_{in2}} = \frac{j\tan \pi/4}{Z_o} = \underline{\underline{\frac{j}{100} = j10 \text{ mS}}}$$

$$l_3 = \frac{7\lambda}{8} \rightarrow Z_{in3} = Z_o \frac{\left(Z_i + jZ_o \tan\frac{7\pi}{4}\right)}{\left(Z_o + jZ_i \tan\frac{7\pi}{4}\right)} = \frac{Z_o(Z_i - jZ_o)}{(Z_o - jZ_i)}$$

$$y_i = y_{in1} + y_{in2} = 20 + j15 + j10 = 20 + j25 \text{ mS}$$

$$Z_i = \frac{1}{y_i} = \frac{1000}{20 + j25} = 19.51 - j24.39\Omega$$

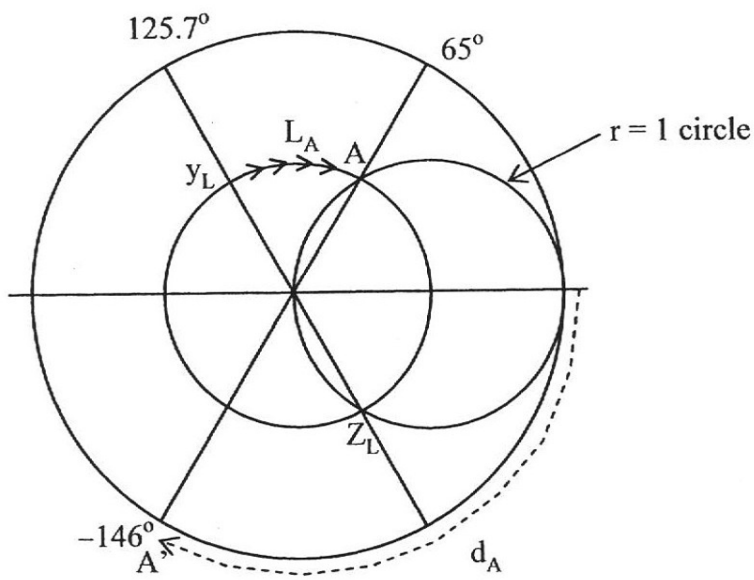
$$y_{in3} = \frac{Z_o - jZ_i}{Z_o(Z_i - jZ_o)} = \frac{75.61 - j19.51}{100(19.51 - j124.39)}$$

$$= \underline{\underline{2.461 + j5.691 \text{ mS}}}$$

Prob. 11.46

$$z_L = \frac{Z_L}{Z_o} = \frac{60 - j50}{50} = 1.2 - j1$$

$$y_L = \frac{1}{z_L}$$



At A, $y = 1 + j0.92$, $y_s = -j0.92$

$$Y_s = Y_o y_s = \frac{-j0.92}{50} = \underline{\underline{-j18.4 \text{ mS}}}$$

Stub length = $\underline{\underline{0.1307\lambda}}$

Stub position = $\underline{\underline{0.0843\lambda}}$