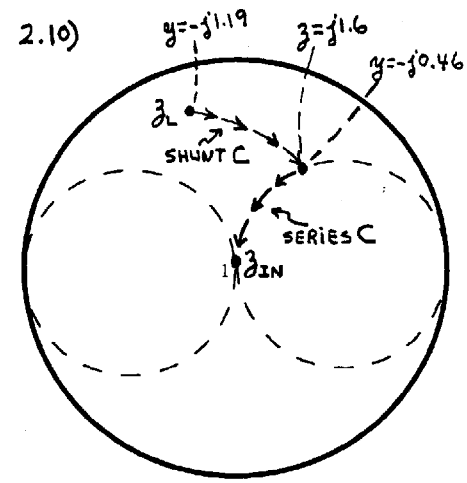
2.3) $$Z(d) = Z_o \frac{Z_L + j Z_o \tan\beta d}{Z_o + j Z_L \tan\beta d}$$

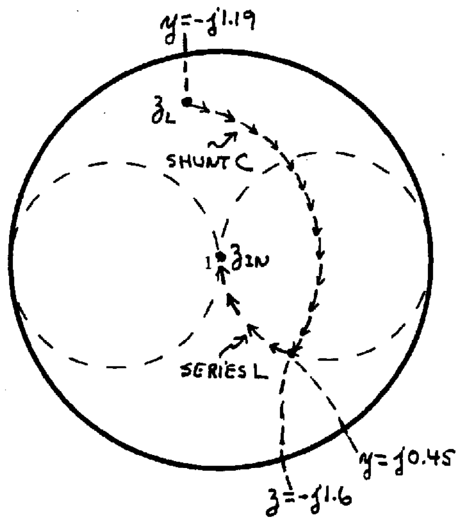
$$Z\left(d+\frac{n\lambda}{2}\right) = Z_o \frac{Z_L + j Z_o \tan\left(\beta d + \frac{n\beta\lambda}{2}\right)}{Z_o + j Z_L \tan\left(\beta d + \frac{n\beta\lambda}{2}\right)} \quad ; \; n\beta\frac{\lambda}{2} = n\frac{2\pi}{\lambda}\frac{\lambda}{2} = n\pi$$

$$\tan(\beta d + n\pi) = \tan\beta d$$

HENCE, $$Z\left(d+\frac{n\lambda}{2}\right) = Z(d)$$

2.10)



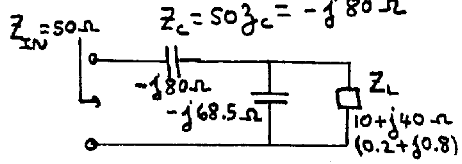


SHUNT C: $y_C = -j0.46 - (-j1.19) = j0.73$

$Z_C = \frac{50}{y_C} = -j68.5\,\Omega$

SERIES C: $z_C = 0 - j1.6 = -j1.6$

$Z_C = 50 z_C = -j80\,\Omega$

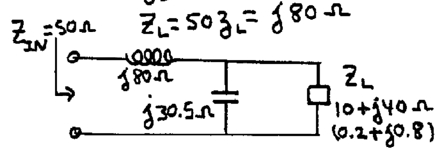


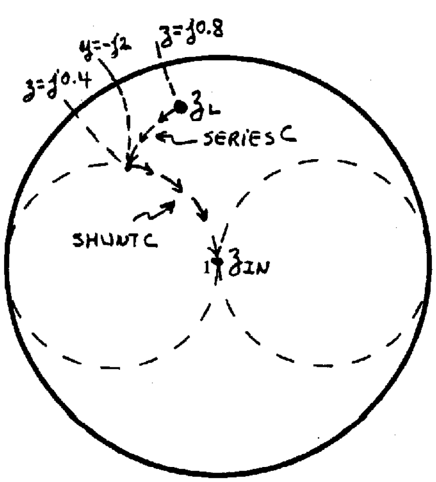
SHUNT C: $y_C = j0.45 - (-j1.19) = j1.64$

$Z_C = \frac{50}{j1.64} = -j30.5\,\Omega$

SERIES L: $z_L = 0 - (-j1.6) = j1.6$

$Z_L = 50 z_L = j80\,\Omega$



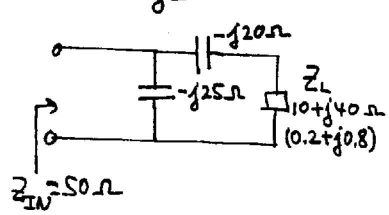


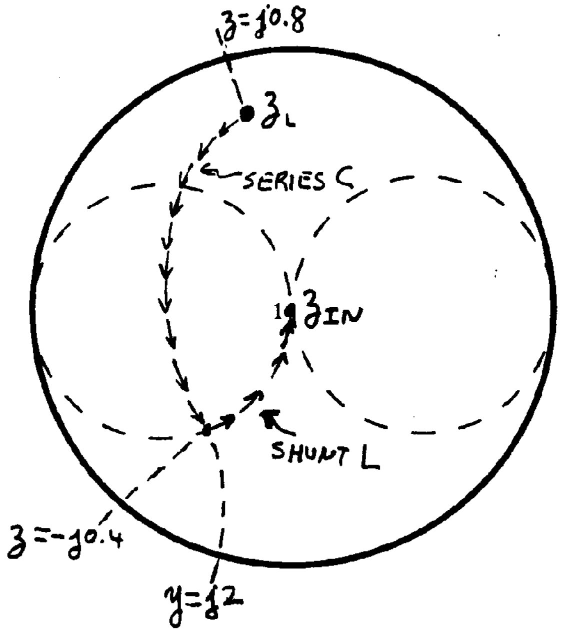
SERIES C: $z_C = j0.4 - j0.8 = -j0.4$

$Z_C = 50 z_C = -j20\,\Omega$

SHUNT C: $y_C = 0 - (-j2) = j2$

$Z_C = \frac{50}{j2} = -j25\,\Omega$



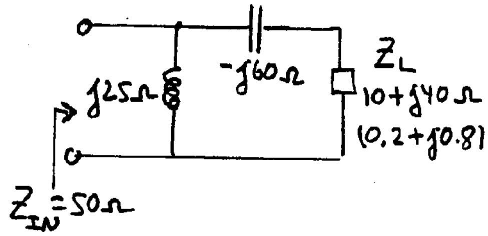


SERIES C: $z_C = -j0.4 - j0.8 = -j1.2$

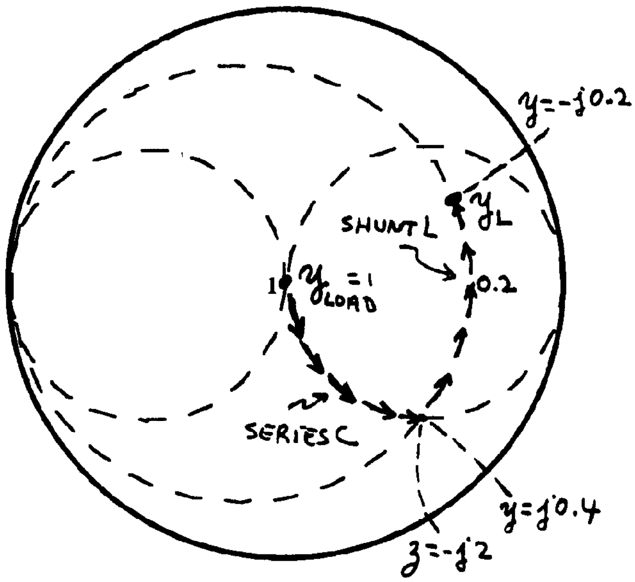
$$Z_C = 50\, z_C = -j60\ \Omega$$

SHUNT L: $y_L = 0 - j2 = -j2$

$$Z_L = \frac{50}{y_L} = j25\ \Omega$$



2.11) $y_L = \frac{Y_L}{Y_0} = Z_0 Y_L = 50(4-j4)10^{-3} = 0.2 - j0.2$



SERIES C: $z_C = -j2 - j0 = -j2$

$Z_C = 50 z_C = -j100\,\Omega$

SHUNT L: $y_L = -j0.2 - j0.4 = -j0.6$

$Z_L = \frac{50}{y_L} = j83.3\,\Omega$

AT $f = 700$ MHz:

$Z_L = j\omega L = j83.3$

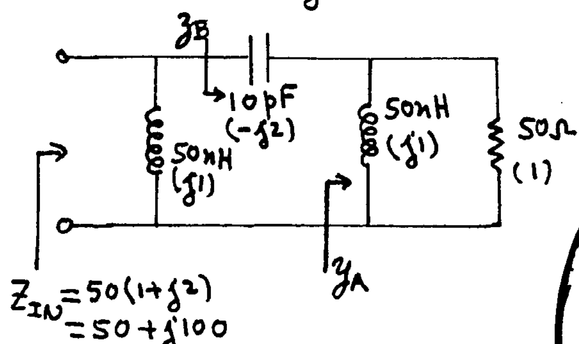
$L = \frac{83.3}{2\pi\, 700\,10^6} = 18.9$ nH

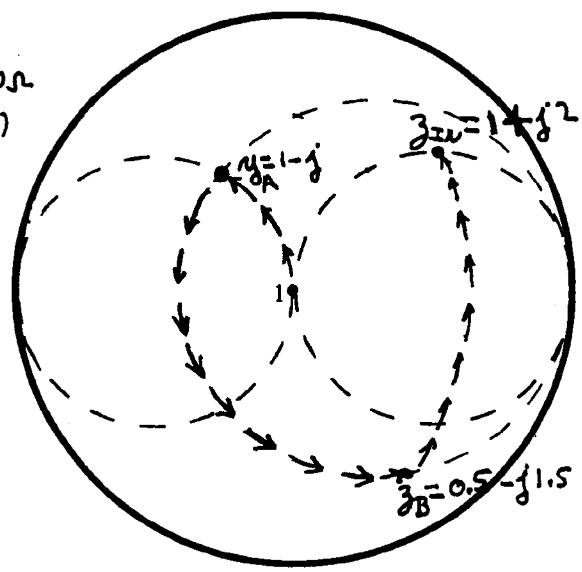
$Z_C = \frac{-j}{\omega C} = -j100$

$C = \frac{1}{100(2\pi\, 700\,10^6)} = 2.27$ pF

2.13) $Z_L = j\omega L = j\,10^9\, 50\, 10^{-9} = j50$ OR $z_L = j\frac{50}{50} = j1$

$Z_C = \frac{1}{j\omega C} = \frac{1}{j\,10^9\, 10\, 10^{-12}} = -j100$ OR $z_C = -j\frac{100}{50} = -j2$





$z_{IN} = 1 + j2$

$Z_{IN} = 50 z_{IN} = 50 + j100\,\Omega$

2.15) (a) $z_L = \frac{50}{50} = 1$

$z_{IN} = \frac{20+j20}{50} = 0.4+j0.4$

DRAW THE Q=5 CIRCLES (SEE FIG. 2.4.16)

THE MOTION FROM A TO B -- SERIES L_1:

AT B: $z_B = 1+j3$

$z_{L_1} = j3$ or $Z_{L_1} = j3(50) = j150\,\Omega$

THE MOTION FROM B TO C -- SHUNT C:

AT B: $y_B = 0.1 - j0.3$

AT C: $y_C = 0.1 + j0.5$

$y_C = j0.5 - (-j0.3) = j0.8$

$Z_C = \frac{50}{j0.8} = -j62.5\,\Omega$

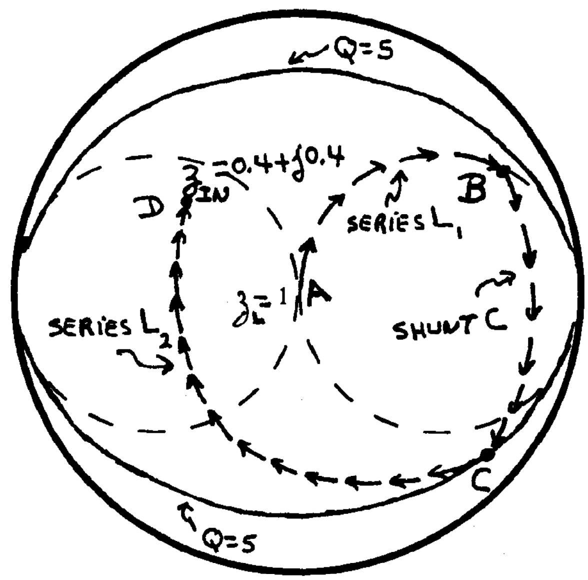
THE MOTION FROM C TO D -- SERIES L_2:

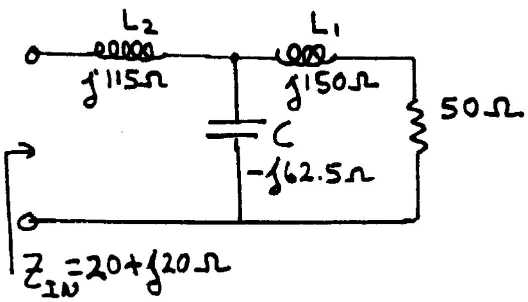
AT C: $z_C = 0.4 - j1.9$

AT D: $z_D = 0.4 + j0.4$

$z_{L_2} = j0.4 - (-j1.9) = j2.3$

$Z_{L_2} = 50(j2.3) = j115\,\Omega$





(b) $z_L = 1$ AND $z_{IN} = 0.5$

AT B: $y_B = 1 - j2.6$, $z_B = 0.13 + j0.335$

AT C: $y_C = 2 - j3.4$, $z_C = 0.13 + j0.215$

AT D: $y_D = 2$, $z_D = z_{IN} = 0.5$

SHUNT L: $y_L = -j2.6$

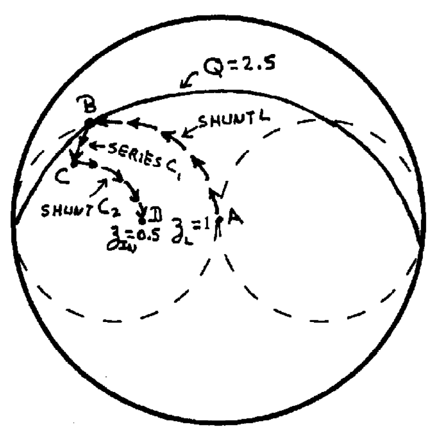
$Z_L = \frac{50}{-j2.6} = j19.2\,\Omega$

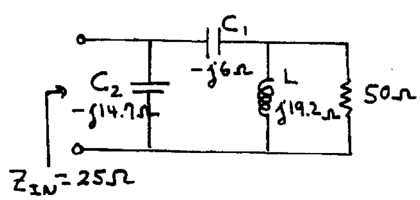
SERIES C_1: $z_{C_1} = j0.215 - j0.335 = -j0.12$

$Z_{C_1} = 50(-j0.12) = -j6\,\Omega$

SHUNT C_2: $y_{C_2} = 0 - (-j3.4) = j3.4$

$Z_{C_2} = \frac{50}{j3.4} = -j14.7\,\Omega$



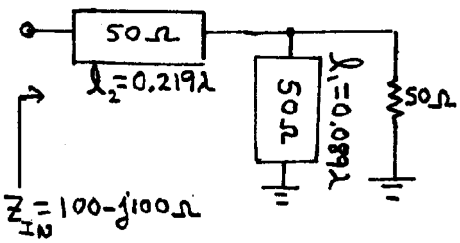


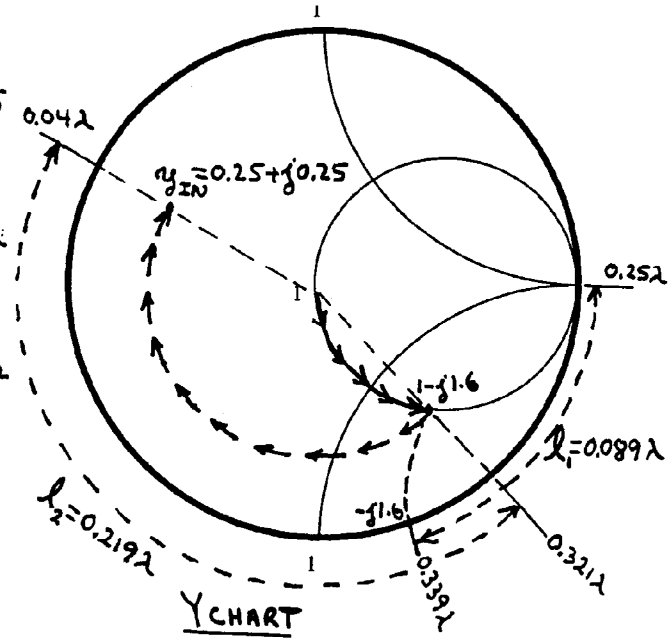
2.19) (a) $z_{IN} = \frac{Z_{IN}}{50} = 2 - j2$

$y_{IN} = \frac{1}{z_{IN}} = 0.25 + j0.25$

$l_1 = 0.339\lambda - 0.25\lambda = 0.089\lambda$

$l_2 = 0.042\lambda + (0.5\lambda - 0.321\lambda) = 0.219\lambda$

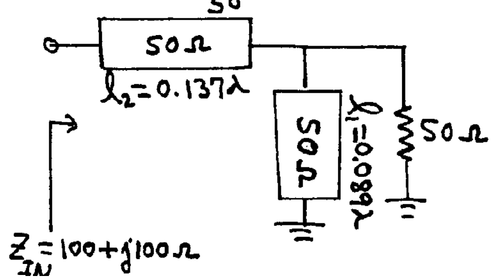




(b) If l_1 is an open-circuited stub, then

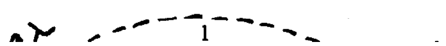
$l_1 = 0.25\lambda + 0.089\lambda = 0.339\lambda$

(c) For $z_{IN} = \frac{Z_{IN}}{50} = 2 + j2$, one answer is:



If l_1 is an open-circuited stub, then

$l_1 = 0.25\lambda + 0.089\lambda = 0.339\lambda$



2.21) (a) $Y_{IN} = G_{IN} + jB_{IN} = 50 + j40$ mS, $R_{IN} = \frac{1}{G_{IN}} = \frac{1}{50 \cdot 10^{-3}} = 20\,\Omega$

$$Z_{01} = \sqrt{Z_L R_{IN}} = \sqrt{50(20)} = 31.62\,\Omega$$

IN A SHORT-CIRCUITED $\frac{3\lambda}{8}$ STUB: $Y_{sc} = jY_{02}$. HENCE, $jY_{02} = jB_{IN} = j40$ mS

OR $Y_{02} = 40$ mS, $Z_{02} = \frac{1}{Y_{02}} = 25\,\Omega$

(b) $Y_{IN} = G_{IN} - jB_{IN} = 50 - j40$ mS, $R_{IN} = \frac{1}{G_{IN}} = 20\,\Omega$.

THEN, $Z_{01} = \sqrt{50(20)} = 31.62\,\Omega$. IN A SHORT-CIRCUITED $\frac{\lambda}{8}$ STUB:

$Y_{sc} = -jY_{02}$. HENCE, $Y_{02} = 40$ mS OR $Z_{02} = \frac{1}{40 \cdot 10^{-3}} = 25\,\Omega$.

(c) $Y_{IN} = G_{IN} + jB_{IN} = 10 + j20$ mS, $R_{IN} = \frac{1}{G_{IN}} = \frac{1}{10 \cdot 10^{-3}} = 100\,\Omega$

THEN, $Z_{01} = \sqrt{50(100)} = 70.7\,\Omega$. IN AN OPEN-CIRCUITED $\frac{\lambda}{8}$ STUB:

$Y_{o.c} = jY_{02}$. HENCE, $Y_{02} = 20$ mS OR $Z_{02} = \frac{1}{20 \cdot 10^{-3}} = 50\,\Omega$.

(d) $Y_{IN} = 10 - j20$ mS. HENCE: $Z_{01} = \sqrt{50(100)} = 70.7\,\Omega$.

IN AN OPEN-CIRCUITED $\frac{3\lambda}{8}$ STUB: $Y_{oc} = -jY_{02}$. HENCE, $Z_{02} = \frac{1}{Y_{02}} = \frac{1}{20 \cdot 10^{-3}} = 50\,\Omega$.

2.22) (a) $\Gamma_L = 0.5\angle 90^\circ$, $z_L = 0.6 + j0.8$

$\therefore y_L = \frac{1}{z_L} = 0.6 - j0.8$

FROM THE SMITH CHART:

$l_1 = 0.136\lambda$, $l_2 = 0.375\lambda - 0.166\lambda = 0.209\lambda$

IN FIG. P.22(b):

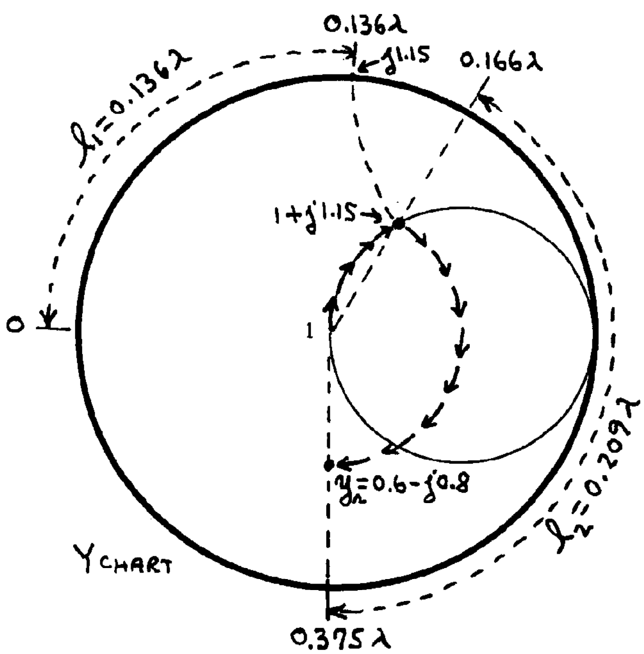
$Y_L = \frac{0.6 - j0.8}{50} = 12 - j16$ mS

$\therefore Z_{01} = \sqrt{50\left(\frac{1}{12 \cdot 10^{-3}}\right)} = 64.5\,\Omega$

USING A $\frac{3\lambda}{8}$ OPEN-CIRCUITED STUB:

$-jY_{02} = -j16$ mS, OR $Y_{02} = 16$ mS

$Z_{02} = \frac{1}{16 \cdot 10^{-3}} = 62.5\,\Omega$



(b) BALANCED FORM OF THE STUBS.

FOR FIG. P.22(a): $y_{bal} = j\frac{1.15}{2} = j0.575 \Rightarrow l_{1(bal)} = 0.083\lambda$

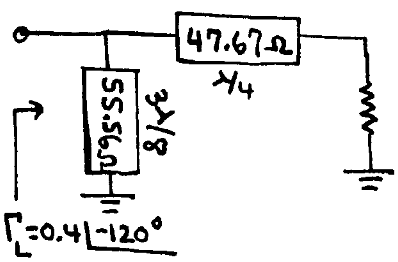
FOR FIG. P.22(b): $Z_{02(bal)} = 2(62.5) = 125\,\Omega$

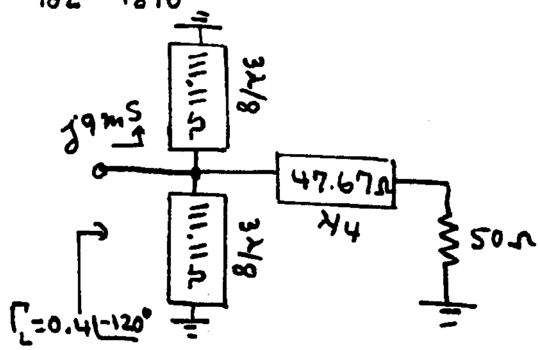
2.24) (a) $\Gamma_L = 0.4\angle{-120^\circ}$, $z_L = 0.538 - j0.444$, $y_L = \frac{1}{z_L} = 1.105 + j0.912$

$$Y_L = \frac{y_L}{50} = 22 + j18 \text{ mS}$$

HENCE: $Z_{01} = \sqrt{50\left(\frac{1}{22\,10^{-3}}\right)} = 47.67\,\Omega$ AND

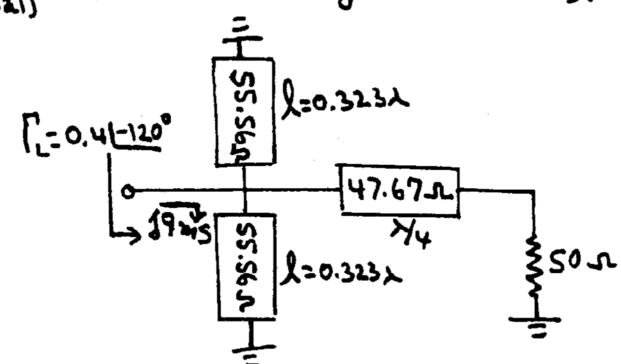
$jY_{02} = j18\text{mS}$ OR $Z_{02} = \frac{1}{Y_{02}} = \frac{1}{18\,10^{-3}} = 55.56\,\Omega$





BALANCE FORM (USE $2Z_{02} = 111.11\,\Omega$)

(b) EACH SIDE OF THE BALANCE STUBS HAS AN ADMITTANCE OF $j9$mS. IF ITS CHARACTERISTIC IMPEDANCE IS $Z_0 = \frac{111.11}{2} = 55.56\,\Omega$, THEN $y_{(bal)} = j9\,10^{-3}(55.56) = j0.5$. HENCE: $l = 0.323\lambda$.



on

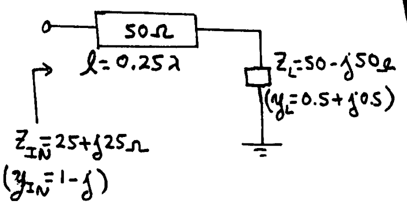
2.29) $z_L = \frac{Z_L}{50} = 1 - j$, $z_{IN} = \frac{Z_{IN}}{50} = 0.5 + j0.5$

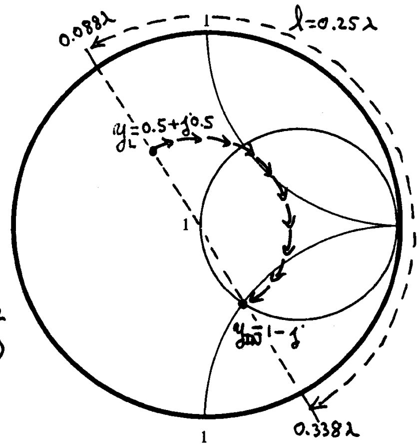
$y_L = \frac{1}{z_L} = 0.5 + j0.5$, $y_{IN} = \frac{1}{z_{IN}} = 1 - j$

y_L AND y_{IN} ARE ON THE SAME CONSTANT $|\Gamma|$ CIRCLE. HENCE, A SERIES TRANSMISSION LINE OF LENGTH:

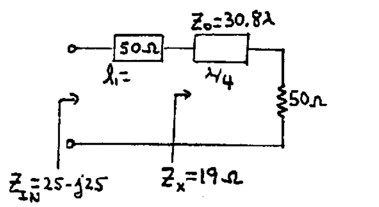
$$\ell = 0.338\lambda - 0.088\lambda = 0.25\lambda$$

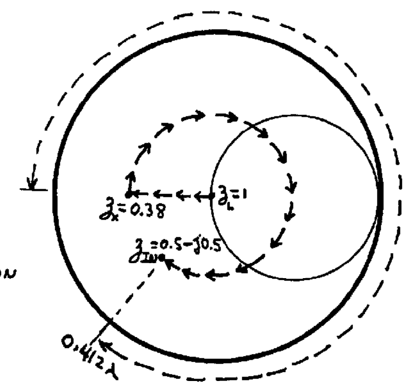
WILL CHANGE y_L TO y_{IN}.





2.33) (a) $z_{IN} = \frac{25-j25}{50} = 0.5 - j0.5$





Z_x AND Z_{IN} MUST BE ON THE SAME CONSTANT $|\Gamma|$ CIRCLE. ONE SOLUTION IS SHOWN ON THE SMITH CHART.

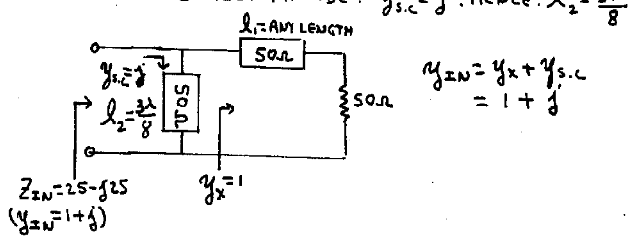
$$Z_x = 50 z_x = 50(0.38) = 19\,\Omega$$

THEN: $Z_o = \sqrt{Z_L Z_x} = \sqrt{50(19)} = 30.8\,\Omega$

AND $\ell_1 = 0.412\lambda$

(b) $z_{IN} = 0.5 - j0.5$, $y_{IN} = \frac{1}{z_{IN}} = 1 + j$

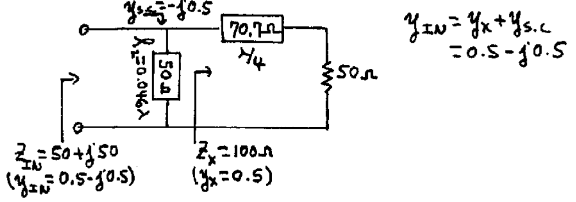
LETTING $Z_o = 50\,\Omega$ AND ℓ_1 = ANY LENGTH, THE ADMITTANCE $y_x = 1$. THEN, THE SHUNT STUB MUST PROVIDE: $y_{s.c} = j$. HENCE: $\ell_2 = \frac{3\lambda}{8}$.



$$y_{IN} = y_x + y_{s.c} = 1 + j$$

(c) $z_{IN} = \frac{50+j50}{50} = 1 + j$, $y_{IN} = 0.5 - j0.5$, $Y_{IN} = 10 - j10$ mS

$\therefore$ $Z_o = \sqrt{Z_L Z_x} = \sqrt{50\left(\frac{1}{10\,10^{-3}}\right)} = 70.7\,\Omega$. THE STUB ADMITTANCE MUST BE: $y_{s.c} = -j0.5$. HENCE: $\ell_2 = 0.426\lambda$



$$y_{IN} = y_x + y_{s.c} = 0.5 - j0.5$$

2.37) (a) FROM (2.8.3), WITH $\Gamma_\ell = \Gamma_{IN}^* = 0.545\angle 77.7^\circ$, WE OBTAIN $|\Gamma_a| = 0$.

THEN, USING (2.8.1), $(VSWR)_{in} = 1$.

(b) WHEN $\Gamma_\ell = \Gamma_{IN}^*$ WE HAVE $|\Gamma_a| = 0$ OR $\Gamma_a = 0$. HENCE,

$$Z_a = Z_0 = 50\,\Omega$$

(c) $$|\Gamma_a| = \left|\frac{\Gamma_{IN} - \Gamma_\ell^*}{1 - \Gamma_{IN}\Gamma_\ell}\right| = \left|\frac{0.4\angle 45^\circ - 0.545\angle -77.7^\circ}{1 - 0.4\angle 45^\circ (0.545\angle 77.7^\circ)}\right| = 0.735$$

$$(VSWR)_{in} = \frac{1+0.735}{1-0.735} = 6.54$$