2.3) \[ Z(d) = Z_0 \frac{Z_L + \frac{1}{2} Z_0 \tan \beta d}{Z_0 + \frac{1}{2} Z_L \tan \beta d} \]

\[ Z(d + \eta d) = Z_0 \frac{Z_L + \frac{1}{2} Z_0 \tan (\beta d + \eta \frac{\beta d}{2})}{Z_0 + \frac{1}{2} Z_L \tan (\beta d + \eta \frac{\beta d}{2})} \]

\[ \tan (\beta d + \eta \frac{\beta d}{2}) = \tan \beta d \]

Hence,
\[ Z(d + \eta \frac{\beta d}{2}) = Z(d) \]
series C: \( Z_C = -j0.4 - j0.8 = j1.2 \)
\( Z_C = 50 \) \( Z_C = j60 \angle \)

shunt L: \( y_L = 0 - j2 = -j2 \)
\( Z_L = \frac{50}{j} = j25 \angle \)

\[
\begin{align*}
Z &= 50 + j81 \\
&= \frac{10 + j40}{10} \\
&= 10 + j40
\end{align*}
\]
2.11. \[ y_L = \frac{Y_L}{Y_0} = Z_0 Y_L = 50(4 - j4)10^{-3} = 0.2 - j0.2 \]

Series C: \[ Y_C = -j2 -j0 = -j2 \]
\[ Z_C = 50 Y_C = -j100 \Omega \]

Shunt L: \[ Y_L = -j0.2 -j0.2 = -j0.4 \]
\[ Z_L = 50 Y_L = -j83.3 \Omega \]

At \( f = 700 \text{ MHz} \):
\[ Z_L = j \omega L = j83.3 \]
\[ L = \frac{83.3}{2 \pi 70010^6} = 18.9 \text{ nH} \]
\[ Z_C = \frac{1}{j \omega C} = -j100 \]
\[ C = \frac{1}{100(2 \pi 70010^6)} = 2.27 \text{ pF} \]

2.13. \[ Z_L = j \omega L = j10^9 50 10^9 = j50 \]
\[ Z_C = \frac{1}{j \omega C} = \frac{1}{j10^9 10^{-12}} = -j100 \text{ or } \frac{1}{j \omega C} = \frac{1}{j100 50} = -j^2 \]

\[ Z_{IN} = 50(1 + j2) \]
\[ Z_{IN} = 50(1 + j100) \]
\[ Z_{IN} = 50 j \text{IN} = 50 + j100 \Omega \]
2.15) (a) \[ Z_L = \frac{50}{50} = 1 \]
\[ Z_{IN} = \frac{20 + j^{20}}{50} = 0.4 + j0.4 \]

Draw the \( Q = 5 \) circles (see Fig. 2.4.16)

The motion from A to B -- series \( L_1 \):
At A: \( Z_B = 1 + j3 \)
\[ Z_{L1} = j3 \] or \( Z_{L1} = j3(50) = j150 \)

The motion from B to C -- shunt C:
At B: \( y_B = 0.1 - j0.3 \)
At C: \( y_C = 0.1 + j0.5 \)
\[ y_C = 0.5 - j0.3 = j0.8 \]
\[ Z_C = \frac{50}{j0.8} = -j62.5 \]

The motion from C to D -- series \( L_2 \):
At C: \( Z_C = 0.4 + j1.9 \)
At D: \( Z_D = 0.4 + j0.4 \)
\[ Z_{L2} = 0.4 - j1.9 = j2.3 \]
\[ Z_{L2} = 50(j2.3) = j115 \]

(b) \( \beta = 1 \) and \( \beta_{ZV} = 0.5 \)
At B: \( y_B = 1 \)
At C: \( y_C = 2 - j1.4 \)
\[ Z_C = 50(j0.3)n \]
\[ Z_{C'} = 50(j0.3) = -j16.5 \]

Series \( C_1 \):
\[ Z_{C1} = 0.25 - j0.335 \]
\[ Z_{C1} = 50(j0.12) = -j6.5 \]

Shunt \( C_2 \):
\[ y_C = 0 - j3.4 = j3.4 \]
\[ Z_{C2} = \frac{50}{j3.4} = -j14.7 \]

\[ Z_{ZV} = 25j \]
2.19) (a) \[ z_{in} = z_{in} = 2 + j2 \]
\[ y_{in} = \frac{1}{z_{in}} = 0.25 + j0.25 \]
\[ l_1 = 0.339\lambda - 0.25\lambda = 0.089\lambda \]
\[ l_2 = 0.042 + (0.52 - 0.32\lambda) = 0.219\lambda \]

(b) If \( l_1 \) is an open-circuited stub, then
\[ l_1 = 0.25\lambda + 0.089\lambda = 0.339\lambda \]

(c) For \( z_{in} = z_{in} = 2 + j2 \), one answer is:
\[ z = 100 + j100 \]

If \( l_1 \) is an open-circuited stub, then
\[ l_1 = 0.25\lambda + 0.089\lambda = 0.339\lambda \]
2.21) (a) \( Y_{IN} = G_{IN} + j\beta B_{IN} = 50 + j40 \text{ mS} \) 
\( R_{IN} = \frac{1}{G_{IN}} = \frac{1}{50} = 0.02 \text{ \Omega} \)
\( Z_{01} = \sqrt{Z_L R_{IN}} = \sqrt{50 \times 0.02} = 7.07 \text{ \Omega} \)

**In a short-circuited \( \frac{3\lambda}{8} \) stub:** \( Y_{SC} = \frac{j}{Y_{02}} \) **hence,** \( jY_{02} = \frac{j}{Y_{SC}} = j40 \text{ mS} \)

\( R_{02} = \frac{1}{Y_{02}} = 25 \text{ \Omega} \)

(b) \( Y_{IN} = G_{IN} - j\beta B_{IN} = 50 - j40 \text{ mS} \) 
\( R_{IN} = \frac{1}{G_{IN}} = \frac{1}{50} = 0.02 \text{ \Omega} \)

**Then,** \( Z_{01} = \sqrt{50 \times 0.02} = 7.07 \text{ \Omega} \) **in a short-circuited \( \frac{1}{8} \) stub:**

\( Y_{SC} = -\frac{j}{Y_{02}} \). **Hence,** \( Y_{02} = 40 \text{ mS} \) **or** \( Z_{02} = \frac{1}{40\times 0.02} = 25 \text{ \Omega} \)

(c) \( Y_{IN} = G_{IN} + j\beta B_{IN} = 10 + j20 \text{ mS} \) 
\( R_{IN} = \frac{1}{G_{IN}} = \frac{1}{10} = 0.1 \text{ \Omega} \)

**Then,** \( Z_{01} = \sqrt{50 \times 0.1} = 7.07 \text{ \Omega} \) **in an open-circuited \( \frac{1}{8} \) stub:**

\( Y_{OC} = \frac{j}{Y_{02}} \). **Hence,** \( Y_{02} = 20 \text{ mS} \) **or** \( Z_{02} = \frac{1}{20\times 0.02} = 50 \text{ \Omega} \)

(d) \( Y_{IN} = 10 - j20 \text{ mS} \) **hence:** \( Z_{01} = \sqrt{50 \times 0.02} = 7.07 \text{ \Omega} \)

**In an open-circuited \( \frac{3\lambda}{8} \) stub:** \( Y_{OC} = \frac{j}{Y_{02}} \). **Hence,** \( Z_{02} = \frac{1}{40\times 0.02} = 25 \text{ \Omega} \)

2.22) (a) \( \lambda = 0.5 \lambda_0^0, \beta = 0.6 + j0.8 \)

\( \therefore \ y_0 = \frac{1}{\beta} = 0.6 - j0.8 \)

**From the Smith chart:**
\( \lambda_1 = \frac{1.136}{0.156}, \lambda_2 = 0.375 - 0.166 \lambda = 0.209 \lambda \)

**In Fig. P.22(b):**
\( Y = \frac{0.6 - j0.8}{50} = 12 - j16 \text{ mS} \)

\( \therefore \ Z_{01} = \sqrt{50 \times \frac{1}{12.16}} = 64.5 \text{ \Omega} \)

**Using a \( \frac{3\lambda}{8} \) open-circuited stub:**
\( -jY_{02} = -j16 \text{ mS, or} Y_{02} = 16 \text{ mS} \)

\( Z_{02} = \frac{1}{62.5} = 62.5 \text{ \Omega} \)

(b) **Balanced form of the stubs.**

For Fig. P.22(a): \( \frac{d}{2} = 0.575 \Rightarrow l_{(6\lambda_0)} = 0.083 \lambda \)

For Fig. P.22(b): \( Z_{02} = 2(62.5) = 125 \text{ \Omega} \)
2.24) (a) \( \Gamma_L = 0.4 - 120^\circ \), \( \beta_L = 0.538 - j0.444 \), \( \gamma_L = \frac{1}{\beta_L} = 1.105 + j0.912 \)

\[ Y_L = \frac{\beta_L}{50} = 22 + j18 \, \text{mS} \]

Hence: \[ Z_{01} = \sqrt{\frac{50}{\frac{1}{22.1}}} = 47.67 \, \Omega \] and

\[ y_{02} = 18 \, \text{mS} \text{ or } Z_{02} = \frac{1}{y_{02}} = \frac{1}{1810^3} = 55.56 \, \Omega \]

(b) Each side of the balance stubs has an admittance of \( 19 \, \text{mS} \). If its characteristic impedance is \( Z_0 = \frac{111.1}{l} \), then \( \gamma_{(6.1)} = 19 \times 10^{-3} \times 55.56 = 1.05 \). Hence: \( l = 0.323 \, \lambda \).

2.29) \( \beta_L = \frac{Z_L}{50} = 1 - j \), \( \beta_{in} = \frac{Z_{in}}{50} = 0.5 + j0.5 \)

\[ y_L = \frac{1}{\beta_L} = 0.5 + j0.5 \text{, } y_{in} = \frac{1}{\beta_{in}} = 1 - j \]
$y_d$ and $y_{2u}$ are on the same constant [1] circle. Hence, a series transmission line of length:

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

will change $y_d$ to $y_{2u}$.

$$Z_{2u} = 25 + j25 \lambda$$

$$y_{2u} = 1 - \frac{j}{\lambda}$$

2.33) (a) $Z_{2u} = 25 + j25 = 0.5 - j0.5$

Z sub 2 and $Z_{2u}$ must be on the same constant [1] circle. One solution is shown on the Smith chart.

$$Z_2 = 50 \lambda^2 = 50(0.38) = 19 \lambda$$

Then:

$$Z_0 = \sqrt{Z_{2u} Z_2} = 50 \lambda^2 = 30.9 \lambda$$

and $\lambda = 0.412 \lambda$

(b) $Z_{2u} = 0.5 - j0.5$, $y_{2u} = \frac{1}{Z_{2u}} = 1 + \frac{j}{\lambda}$

Letting $Z_0 = 50 \lambda$ and $\lambda$ any length, the admittance $y_d$.

Then the short stub must provide: $y_d = \frac{j}{\lambda}$, hence: $\lambda = \frac{\lambda}{\lambda}$.

$$y_d = \frac{1}{Z_{2u}} = 1 + \frac{j}{\lambda}$$

$$Z_{2u} = 15 + j15$$

(c) $Z_{2u} = 50 + j50 = 1 + j$, $y_{2u} = 0.5 - j0.5$, $\lambda = 10 - j10 \text{ in } 5$

\[Z = \sqrt{Z_{2u} Z_2} = \sqrt{50 \lambda \cdot 50 \lambda} = 70 \lambda \text{ in.} \]

The stub admittance must be: $y_d = -j0.5$, hence: $\lambda = 0.426 \lambda$

$$y_{2u} = y_d + y_{2u}$$

$$Z_{2u} = 100 \lambda$$

$$y_{2u} = \frac{1}{Z_{2u}} = 1 + \frac{j}{\lambda}$$
2.37) (a) From (2.8.3), with \( \Gamma_a = \Gamma_{xN} = 0.545 \angle 77.7^\circ \), we obtain \( |\Gamma_a| = 0 \).

Then, using (2.8.1), \( (VSWR)_{ch} = 1 \).

(b) When \( \Gamma_a = \Gamma_{xN}^* \) we have \( |\Gamma_a| = 0 \) or \( \Gamma_a = 0 \). Hence,

\[ Z_a = Z_o = 50 \ \Omega \]

(c) \[ |\Gamma_a| = \left| \frac{\Gamma_{xN} - \Gamma_{xN}^*}{1 - \Gamma_{xN} \Gamma_{xN}^*} \right| = \left| \frac{0.41450 - 0.545 \angle 77.7^\circ}{1 - 0.41450(0.545 \angle 77.7^\circ)} \right| = 0.735 \]

\[ (VSWR)_{ch} = \frac{1 + 0.735}{1 - 0.735} = 6.54 \]