2.12) ONLY CIRCUIT (b) CAN MATCH $Y_L = 8-j12$ MS TO $Z_{IN} = 50\,\Omega$.

**Series C:**
- $Z_c = 50\,\Omega$
- $Z_c = 50 \times \frac{1}{j1.52} = -j78.15\,\Omega$
- $C = \frac{1}{\omega(78)} = \frac{1}{2\pi \times 10^9 \times 78} = 2.04\,\mu F$

**Shunt L:**
- $Y_L = 0-j0.52\,\Omega$
- $Z_L = 50 - j96.15\,\Omega$
- $L = \frac{96.15}{\omega} = \frac{96.15}{2\pi \times 10^9} = 15.3\,\mu H$

\[ Y_L = \begin{cases} 8-j12 & \text{MS} \\ \end{cases} \]

\[ Z_{IN} = 50\,\Omega \]

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: $Y_C = 0.1 + j0.5$
- $Y_C = 0.5 - j0.3 = j0.8$
- $Z_C = \frac{50}{j0.8} = -j62.5\,\Omega$

**The motion from C to D -- Series $L_2$:**
- At C: $Z_C = 0.4 - j1.9$
- At D: $Z_D = 0.4 + j0.4$
- $Z_L_2 = 10.4 - j1.9 = j8.3$
- $Z_L_2 = 50(j8.3) = j115\,\Omega$

\[ Z_{IN} = 50\,\Omega \]

\[ Z_{IN} = 20 + j20\,\Omega \]
(b) $Z_L = 1$ and $Z_{IN} = 0.5$

At B: $y_B = 1 - j1.6, Z_b = 0.13 + j0.335$

At C: $y_c = 2 - j3.4, Z_c = 20.13 + j0.215$

At D: $y_d = 2, Z_d = 2, Z_{IN} = 0.5$

Shunt L: $y_L = -j2.6$

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

Series C: $Z_C = j0.215 - j0.335 = j0.12$

$Z_{C1} = 50(j0.12) = j6 \Omega$

Shunt C: $y_{C2} = 0 - (j3.4) = j3.4$

$Z_{C2} = \frac{50}{j3.4} = -j14.7 \Omega$

$Z_{IN} = 25 \Omega$

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

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

In a short-circuited $\frac{1}{B}$ stub: $Y_{sc} = jY_{O2}$. Hence, $jY_{O2} = jB_{IN} = j40 \text{ mS}$ or $Y_{O2} = 40 \text{ mS}$, $Z_{O2} = \frac{1}{Y_{O2}} = 25 \Omega$

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

Then, $Z_{01} = \sqrt{50(20)} = 31.62 \Omega$. In a short-circuited $\frac{1}{B}$ stub:

$Y_{sc} = -jY_{O2}$. Hence, $Y_{O2} = 40 \text{ mS}$ or $Z_{O2} = \frac{1}{40^{10^3}} = 25 \Omega$.

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

Then, $Z_{01} = \sqrt{50(100)} = 70.7 \Omega$. In an open-circuited $\frac{1}{B}$ stub:

$Y_{sc} = jY_{O2}$. Hence, $Y_{O2} = 20 \text{ mS}$ or $Z_{O2} = \frac{1}{20^{10^3}} = 50 \Omega$.

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

In an open-circuited $\frac{1}{B}$ stub: $Y_{sc} = -jY_{O2}$. Hence, $Z_{O2} = \frac{1}{Y_{O2}} = \frac{1}{20^{10^3}} = 50 \Omega$. 

2.24) (a) \( \Gamma_L = 0.4 - 120^\circ \), \( Z_L = 0.538 - 0.444 \), \( Y_L = \frac{1}{Z_L} = 1.105 + j0.912 \)

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

Hence:

\[ Z_{o1} = \sqrt{50 \left( \frac{1}{22 + j18} \right)} = 47.67 \, \Omega \quad \text{and} \]

\[ jY_{o2} = j18 \, \text{mS} \quad \text{or} \quad Z_{o2} = \frac{1}{Y_{o2}} = \frac{1}{18 \times 10^{-3}} = 55.56 \, \Omega \]

(b) Each side of the balance stubs has an admittance of \( 9 \, \text{mS} \). If its characteristic impedance is \( Z_0 = 111.11 = 55.56 \, \Omega \), then \( \gamma = j9 \times 10^{-3} \times 55.56 = j0.5 \). Hence:

\[ l = 0.323 \, \text{m} \]