3.18 (a) \( G_{t_{\text{max}}} = \frac{1}{1 - (0.5)^2} = 1.33 \) or 1.25 dB, \( G_{v_{\text{max}}} = \frac{1}{1 - (0.6)^2} = 1.563 \) or 1.94 dB

\[ G_0 = \frac{1}{2} \begin{vmatrix} 1 \end{vmatrix}^2 = 25 \text{ or } 13.98 \text{ dB}, \quad G_{t_{\text{max}}} = 1.25 + 13.98 + 1.94 = 17.2 \text{ dB} \]

(b) A matching network design at 900 MHz is:

At 900 MHz: \( \lambda = \frac{310}{900} = 33.3 \text{ cm}, \ l_1 = 0.135 \lambda = 4.496 \text{ cm}, \)

\( l_2 = 0.024 \lambda = 0.933 \text{ cm}, l_3 = 0.156 \lambda = 5.195 \text{ cm}, l_4 = 0.192 \lambda = 6.394 \text{ cm} \)

(c) \( g_L = \frac{G_L}{G_{t_{\text{max}}}} = \frac{1.259}{1.563} = 0.805 \)

From (3.4.11) and (3.4.12):

\( C = 0.519 \quad 95^\circ \)

\( T = 0.304 \)

(d) Let \( \lambda' = \frac{\lambda}{f} \) where \( f = 1 \text{ GHz} \)

And \( \lambda = \frac{\lambda}{f} \) where \( f = 900 \text{ MHz} \)

\[ \lambda' = \frac{\lambda}{f} \quad \text{or} \quad \lambda = \frac{\lambda'}{f} = \frac{10.2}{900} = \frac{10.2}{100} = 0.102 \lambda \]

\[ l_1 = 0.135 \lambda = 0.135 (1.11 \lambda) = 0.152 \lambda, \quad l_2 = 0.024 (1.11 \lambda) = 0.028 \lambda, \]

\[ l_3 = 0.156 (1.11 \lambda) = 0.173 \lambda, \quad l_4 = 0.192 (1.11 \lambda) = 0.213 \lambda \]

\[ y_3 = \frac{1}{y_4}, \quad y_4 = 0.28 + 0.72, \quad \gamma = 0.693 \quad 124^\circ \]

\[ G_{t_{\text{u}}} = \frac{1 - (0.55)^2}{1 - 0.48 (1.37 \times 0.55 - 1.44)^2} = 31.97 \text{ or } 15.05 \text{ dB} \]
3.28) **Output Stability Circle:**

\[ |\Gamma_L - C_L|^2 = V_L^2 \]

\[ |\Gamma_L|^2 - \Gamma_L C_L^* - \Gamma_L^* C_L + |C_L|^2 = V_L^2 \]

(1) Intersects the Smith Chart when \(|\Gamma_L| = 1\); then

\[ 1 - \Gamma_L C_L^* - \Gamma_L^* C_L + |C_L|^2 = V_L^2 \]

Let \( \Gamma_L = U_L + jV_L \) and \( C_L = \text{Re}[C_L] + j\text{Im}[C_L] \):

\[ -(U_L + jV_L)(\text{Re}[C_L] - j\text{Im}[C_L]) - (U_L - jV_L)(\text{Re}[C_L] + j\text{Im}[C_L]) = V_L^2 - |C_L|^2 - 1 \]

\[ 2U_L \text{Re}[C_L] + 2V_L \text{Im}[C_L] = 1 + |C_L|^2 - V_L^2 \]

Or

\[ V_L = \frac{-\text{Re}[C_L]}{2\text{Im}[C_L]} U_L + \frac{1 + |C_L|^2 - V_L^2}{2\text{Im}[C_L]} \]

(2) is the equation of a straight line with slope \( m_L = -\frac{\text{Re}[C_L]}{\text{Im}[C_L]} \) and intercept \( b_L = \frac{1 + |C_L|^2 - V_L^2}{2\text{Im}[C_L]} \). This line intersects the Smith Chart (i.e., \(|\Gamma_L| = 1\)) at two points.

Similarly, the power gain circle intersects \(|\Gamma_L| = 1\) at two points determined by:

\[ V_L = \frac{-\text{Re}[C_p]}{2\text{Im}[C_p]} U_L + \frac{1 + |C_p|^2 - V_L^2}{2\text{Im}[C_p]} \]

The points of intersection determined by (2) and (3) are equal if \( m_L = m_p \) and \( b_L = b_p \).

\[ m_L = \frac{-\text{Re}[C_L]}{\text{Im}[C_L]} = \frac{-\text{Re}[S^*_L - \Delta S^*_L]}{\text{Im}[S^*_L - \Delta S^*_L]} \]

\[ m_p = \frac{-\text{Re}[C_p]}{\text{Im}[C_p]} = \frac{-\text{Re}[C^*_p]}{\text{Im}[C^*_p]} = \frac{-\text{Re}[S^*_L - \Delta S^*_L]}{\text{Im}[S^*_L - \Delta S^*_L]} \]

\[ \therefore m_L = m_p \]

It also follows that \( b_L = b_p \).
3.29 (a) \( K = 1.032, \Delta = 1.69 \frac{[78.1]}{180} \) : POTENTIALLY UNSTABLE

From (3.3.9) to (3.3.10):
-\( \text{INPUT STABILITY CIRCLE} \quad C_L = 0.295 \frac{-166.1}{\gamma_L = 0.65} \)
-\( \text{OUTPUT STABILITY CIRCLE} \quad C_P = 0.315 \frac{-161.0}{\gamma_P = 0.627} \)

(b) From (3.2.3) with \( n = 0 \): (and \( r_{20} = s_{11} \) when \( n = 0 \))
\[
G_P = \frac{15.5}{1 - 15.5} = \frac{4}{1 - 0.5^2} = 21.33 \text{ or } 13.3 \text{ dB}
\]

(c) \( G_P \) CAN BE INFINITE, BECAUSE IT IS POTENTIALLY UNSTABLE. As \( \gamma_P \) APPROXIMATES THE STABILITY CIRCLE, \( G_P \to \infty \).

3.31 (a) \( K = 1.344, \Delta = 2.156 \frac{-16.6}{16} \) : POTENTIALLY UNSTABLE

(b) OUTPUT STABILITY CIRCLE: \( C_L = 0.261 \frac{-36.3}{\gamma_L = 0.409} \)

(c) FROM (3.6.4) (USING THE + SIGN): \( \Gamma_{ML} = 0.319 \frac{-36.3}{\gamma_L} \)

(d) \( G_{P, min} = G_T, min = 44.82 \text{ or } 16.51 \text{ dB} \)

(e) \[
\begin{array}{c|c|c}
G_P & \text{CENTER} & \text{RADIUS} \\
\hline
18 \text{ dB} & C_P = 0.31 - 36.3^\circ & \gamma_P = 0.234 \\
21 \text{ dB} & C_P = 0.28 - 36.3^\circ & \gamma_P = 0.34 \\
26 \text{ dB} & C_P = 0.266 - 36.3^\circ & \gamma_P = 0.39 \\
36 \text{ dB} & C_P = 0.261 - 36.3^\circ & \gamma_P = 0.407 \\
\end{array}
\]


(f) INPUT STABILITY CIRCLE: \( C_L = 0.102 \frac{-107.4}{\gamma_L = 0.44} \)

From (3.6.5) (USING THE + SIGN): \( \Gamma_{ML} = 0.127 \frac{-107.4}{\gamma_L} \)

(g) \( (VSWR)_{in} = (VSWR)_{out} = 1 \).