

ECE 457- Microwave Devices and Circuits

Fall 2026

Homework #4- Smith Chart and Lumped Matching Network

Due: Monday Oct 5th

1. Passive loads have reflection coefficient with $|\Gamma| \leq 1$ so most of the time we only need to use a Smith Chart with radius of one. Active devices (like amplifiers), however, can be represented as having a *negative* resistance and may thus have $|\Gamma| > 1$. Draw an “extended” Smith Chart of radius 3 that shows contours of constant normalized conductance (g) for $g = -3, -2, -1, 0$, and 1, and constant normalized susceptance (b) for $b = -2, -1, 0, 1$, and 2. Note: all of these contours will be either lines or circles and you may use this fact to make it easier to plot them.

2. (Poza 2.16)

The transmission line circuit in the accompanying figure has $V_g = 15$ V rms, $Z_g = 75 \Omega$, $Z_0 = 75 \Omega$, $Z_L = 60 - j40 \Omega$, and $\ell = 0.7\lambda$. Compute the power delivered to the load using three different techniques:

- (a) Find Γ and compute

$$P_L = \left(\frac{V_g}{2} \right)^2 \frac{1}{Z_0} (1 - |\Gamma|^2);$$

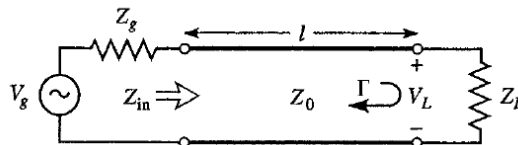
- (b) find Z_{in} and compute

$$P_L = \left| \frac{V_g}{Z_g + Z_{in}} \right|^2 \operatorname{Re} \{ Z_{in} \};$$

- (c) find V_L and compute

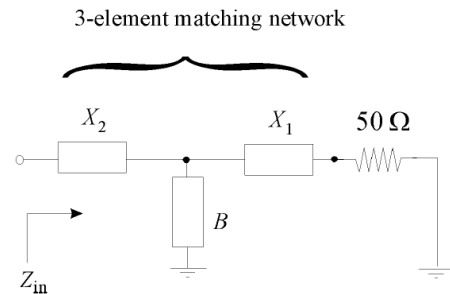
$$P_L = \left| \frac{V_L}{Z_L} \right|^2 \operatorname{Re} \{ Z_L \}.$$

Discuss the rationale for each of these methods. Which of these methods can be used if the line is not lossless?



3. A lossless transmission line of length ℓ has a characteristic impedance of 50Ω . The terminating load impedance has a resistive part of 25Ω and an inductive reactive part whose value is unknown. The velocity of propagation on the transmission line is 3×10^8 m/s and the frequency is 100 MHz. The standing wave ratio is found to be 3. With the help of the Smith Chart, determine :
 - (a) the magnitude of the load reflection coefficient, $|\Gamma_0|$,
 - (b) the phase angle of the load reflection coefficient, and
 - (c) the reactive part of the load impedance.
 - (d) If the first maximum of the voltage standing wave occurs at the input terminals of the transmission line, find the length ℓ of the transmission line.
 - (e) What is the value of the input admittance to the transmission line (Y_{in})?

4. (Pozar 5.1) Design two lossless L -section matching circuits to match each of the following loads to a $100\ \Omega$ generator at 3 GHz. (a) $Z_L = 150 - j200\ \Omega$ and (b) $Z_L = 20 - j90\ \Omega$.
5. The simple, lumped-element matching circuits described in class that consist of two reactive circuit elements do not have enough degrees of freedom to allow control over Q and, consequently, the bandwidth of the match. However, by adding additional reactive elements (as shown below), we can adjust the Q of the matching network.



Consider the matching network shown above that consists of three lumped reactive elements. On a Smith Chart, plot the contour of $Q_s = 5$. Design a matching network (based on this circuit) that transforms a load impedance of $50\ \Omega$ to $10 - j15\ \Omega$ with $Q_s = 5$. (To do this, you need to adjust the values of X_1 and B to bring the $50\ \Omega$ load to the $Q_s = 5$ circle. Note that this needs to be done in such a way that the final element (X_2) can be adjusted to bring the locus to the desired point on the Smith Chart.)