Transmission Lines and Antennas, 2012-1
Exercises on Load Matching

1 Pozar, 5.1

The arrangement of two lumped elements, series-shunt or shunt-series receives the name of L-section due to the L-shape these arrangements present. Using the Smith Chart, design lossless L-section matching networks for the following normalized load impedances:

1. $z_L = 1.5 - j2.0$
2. $z_L = 0.5 + j0.3$
3. $z_L = 0.2 - j0.9$
4. $Z_L = 2.0 - j0.3$

Compute actual component values (L, C) if the line impedance is 75Ω and the operation frequency is 7GHz.

2

Repeat exercise 1 using transmission lines of minimum length. Verify your designs using an RF simulation tool.

3

Compare the graphical solution obtained in exercise 1 with the one obtained from these formulas, which allow matching a load with impedance $Z_L = R_L + jX_L$ to a line with impedance Z_0:

- For loads outside the unit conductance circle (i.e. $g < 1$) we use a shunt-series arrangement with these values:

$$B = \frac{X_L \pm \sqrt{R_L/Z_0}\sqrt{R_L^2 + X_L^2 - Z_0 R_L}}{R_L^2 + X_L^2}$$
$$X = \frac{1}{B} + \frac{X_L Z_0}{R_L} - \frac{Z_0}{B R_L}$$

- For loads outside the unit resistance circle (i.e. $r < 1$) we use a series-shunt arrangement with these values:

$$X = \pm\sqrt{R_L(Z_0 - R_L)} - X_L$$
$$B = \pm\frac{\sqrt{(Z_0 - R_L)/R_L}}{Z_0} \tag{1}$$

Note that each of these conditions leads to two different solutions. Furthermore, some loads satisfy both conditions ($g < 1$ and $r < 1$); these admit four different matching networks.

4

Power handling of transmission lines is partly limited by breakdown of the filling dielectric; for this reason, the maximum voltage along the line must be kept below a given value V_{max} related to the dielectric strength of the filling material and the actual geometry of the line. Compare the maximum power a transmission line with rating V_{max} can deliver to a matched load and to an unmatched load (assume a $\Gamma \neq 0$ value). Based on this, dicuss the implications of unmatched loads in terms of system complexity and cost.