Practice problems for ECE 432/532 – Sp2016

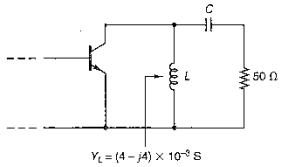
Several areas are covered:

a) Matching problems using lumped elements and microstrip components
b) Transistor/amplifier stability

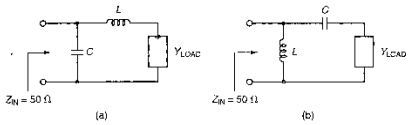
Here are some problems from Pozar (4th edition): 12.1, 12.2, 12.3, 12.5, 12.6,

The following problems are taken (some are modified) from 2nd edition of Gonzalez' book:

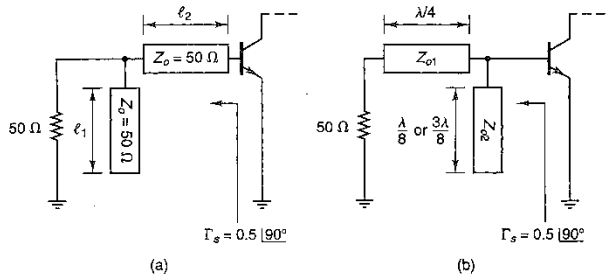
1. Prob . 2.2 a) and c).
    a. Show that impedances having a negative real part (i.e., z = -r + jx) have a reflection coefficient whose magnitude is greater than 1
2. Prob. 2.11. Design the matching network in figure below that provides YL = (4 - j4) X 10^{-3} S to the transistor. Find the element values at 700 MHz.



3. Prob. 2.12. Two types of Ell matching networks are shown below. Select one that can match the load Y_{LOAD} = (8 - j12) X 10^{-3} S to a 50 Ohm transmission line. Find the element values at f= 1 GHz.

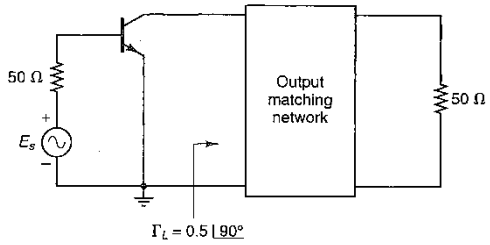


4. Prob. 2.22. Design the matching networks shown below to produce the source reflection coefficient $\Gamma_S = 0.5 \angle 90°$. In part b) of the figure, the appropriate length for the short-circuited stub must be selected (i.e., λ/8 or 3λ/8). In addition, try to design a balanced version of the shunt stubs. (Warning: figure b) that has λ/4 line in it is a little bit different than the "usual" matching circuits we used. However, you should be able to figure out how to do this on your own).

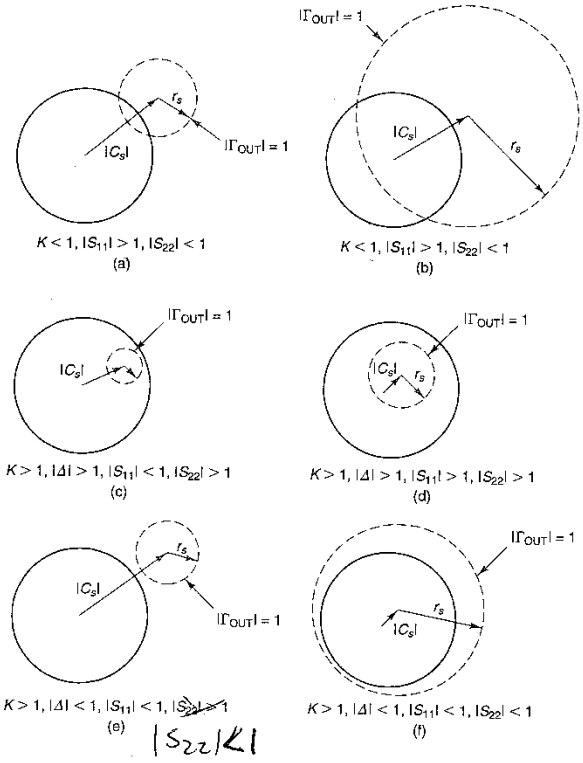


5. Prob. 3.3. A microwave amplifier diagram is shown below. Determine G_T, G_A, and G_p if $\Gamma_S = 0.49\angle -150°$, $\Gamma_L = 0.56\angle 90°$, and the S parameters of the transistor are: $S_{11} = 0.54\angle 165°$, $S_{12} = 0.09\angle 20°$, $S_{21} = 2\angle 30°$, $S_{22} = 0.5\angle -80°$. Calculate P_{AVS}, P_{IN}, P_{AVN}, and P_L if source voltage $E_1 = 10\angle 30°$, source impedance Z_1=50 Ohm and load impedance Z_2= 50 Ohm.

6. Prob. 3.4: The S parameters of transistor are: $S_{11} = 0.7\angle 30°$, $S_{12} = 0$, $S_{21} = 4\angle 90°$, $S_{22} = 0.5\angle 0°$. Amplifier is shown in figure below where output matching network produces $\Gamma_L = 0.5\ \angle 90°$. Determine the values of G_T, G_p and G_A.



7. Prob. 3.5. In each of the stability circles shown below indicate clearly the possible locations for stable Γ_S (source reflection coeff.)



8. Prob. 3.7.: The scattering parameters for three different transistors are given below. Determine the stability in each case and in a potentially unstable case, draw the input and output stability circles.
   a. $S_{11} = 0.674\angle -152°$, $S_{12} = 0.075\angle 6.2°$, $S_{21} = 1.74\angle 36.4°$, $S_{22} = 0.6\angle -92.6°$
   b. $S_{11} = 0.385\angle -55°$, $S_{12} = 0.045\angle 90°$, $S_{21} = 2.7\angle 78°$, $S_{22} = 0.89\angle -26.5°$
   c. $S_{11} = 0.7\angle -50°$, $S_{12} = 0.27\angle 75°$, $S_{21} = 5\angle 120°$, $S_{22} = 0.6\angle 80°$
9. Prob. 3.14: Show how resistive loading can stabilize a transistor whose S parameters at f=750 MHz are: $S_{11} = 0.69\angle -78°$, $S_{12} = 0.033\angle 41.4°$, $S_{21} = 5.67\angle 123°$, $S_{22} = 0.84\angle -25°$.

You should also be quite familiar with all the examples given in the notes. For LNA design, check out his example 12.5 (unilateral design).