# Practice problems for ECE 432/532 – part 2 (HW-2) – Sp2016

For HW#2 in ECE 432/532 do 6 of the problems listed below. The more you do the more proficient you will become. A dropbox will be provided on D2L for submissions. Several areas are covered:

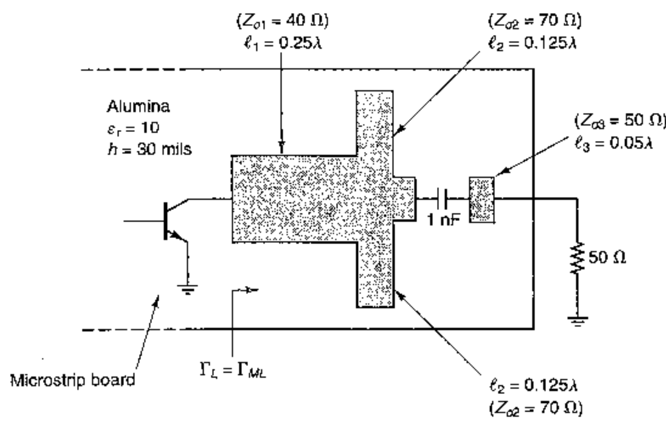
a) Designing amps using unilateral devices or unilateral approximation
    a. Amplifier design for maximum gain
    b. Amplifier design for specific gain
b) Working with operating and available gains
c) Designing low-noise amplifiers

Here are some problems from Pozar ($4^{th}$ edition): **12.9, 12.12, 12.15, 12.16**.

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

1. Problem 3.21: Design a microwave transistor amplifier for $G_{T,max}$ using a transistor with S parameters (50 Ohm system): $S_{11} = 0.277\angle -59°$ , $S_{12} = 0.078\angle 93°$ , $S_{21} = 1.94\angle 64°$ , $S_{22} = 0.848\angle -31°$ .

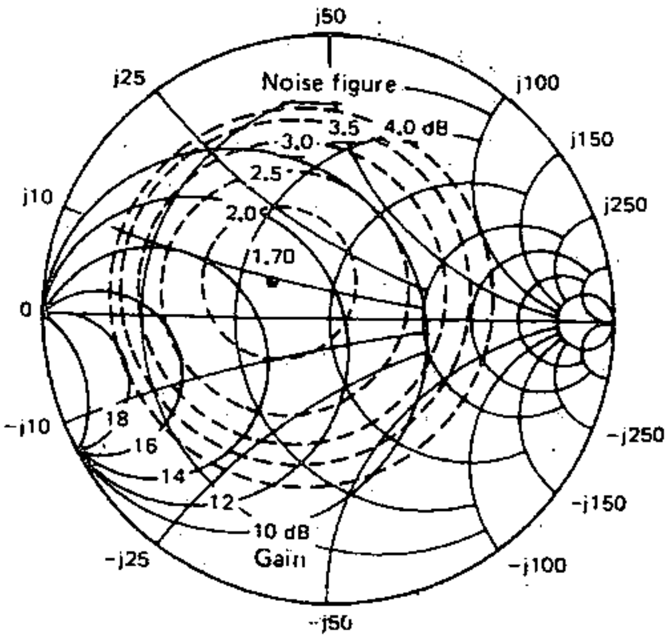
2. Prob. 3.22: The output matching network shown below was designed at 2 GHz for a simultaneous conjugate match. (a) Determine $\Gamma_{ML}$. (b) If the microstrip is alumina ($\varepsilon_r = 10$) and h = 30 mils, determine the length of the 0.25 $\lambda$ line.




3. Prob. 3.25: Design a microwave transistor amplifier at f = 750 MHz to have $G_p$ = 10 dB using: $S_{11} = 0.277\angle -59°$ , $S_{12} = 0.078\angle 93°$ , $S_{21} = 1.94\angle 64°$ , $S_{22} = 0.848\angle -31°$ .
4. Prob. 3.26. At 2 GHz, a GaAs FET has the following S parameters: $S_{11} = 0.7\angle -65°$ , $S_{12} = 0.03\angle 60°$ , $S_{21} = 3.2\angle 110°$ , $S_{22} = 0.8\angle -30°$ . Determine the stability and design an amplifier with $G_p$= 10 dB.
5. Prob. 4.4. The S parameters and noise parameters are: $S_{11} = 0.6\angle -170°$ , $S_{12} = 0.05\angle 16°$ , $S_{21} = 2\angle 30°$ , $S_{22} = 0.5\angle -95°$, $F_{min}$ = 2.5 dB, $\Gamma_{opt}$= 0.5 $\angle 145°$ , $R_n$ = 5 Ohm. Determine:
    a. Is the transistor unconditionally stable
    b. What is $G_{A,max}$
    c. Draw constant available power gain circle which is 3 dB less than $G_{A,max}$
    d. Determine the noise figure if the transistor is used in an amplifier designed for $G_{A,max}$.

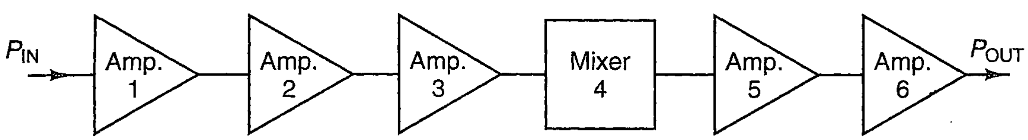
6. Prob. 4.8. Design an LNA for minimum noise figure for a transistor with $S_{11} = 0.8\angle -51.9°$ , $S_{12} = 0.045\angle 54.6°$ , $S_{21} = 2.15\angle 128.3°$ , $S_{22} = 0.73\angle -30.5°$, $F_{min} = 1.25$ dB, $\Gamma_{opt}= 0.73 \angle 60°$ , $R_n = 19.4$ Ohm.

7. Prob. 4.3. For the transistor with $S_{11} = 0.646\angle -172°$ , $S_{12} = 0.051\angle 13.5°$ , $S_{21} = 3.042\angle 47.9°$ , $S_{22} = 0.642\angle -64°$ : What are the noise parameters given the figure below? Find the value of $\Gamma_S$ that produces an available power gain of 14 dB and a noise figure of 2 dB. Find which value of $\Gamma_L$ produces $VSWR_{out}$ =1.




Frequency = 2 GHz, 10 V, 5 mA

8. Prob. 4.13: Consider the LNB below. Calculate the total noise figure and the available gain.




$F_1 = 0.5$ dB $F_2 = 0.9$ dB $F_3 = 1.1$ dB $F_4 = 7.5$ dB $F_5 = 4.5$ dB $F_6 = 4.5$ dB
$G_{A1} = 14$ dB $G_{A2} = 14$ dB $G_{A3} = 14$ dB $G_{A4} = -7.5$ dB $G_{A5} = 16$ dB $G_{A6} = 16$ dB

You should also be quite familiar with all the examples given in the notes. Pozar has one example of power amplifier design: example 12.9 on p. 600. For LNA design, check out his example 12.5 (unilateral design).