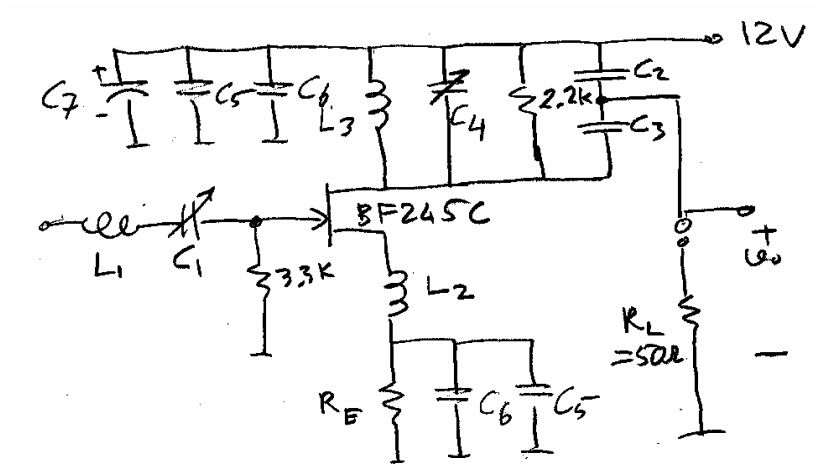
EEE411/511 LAB #4
Low Noise Amplifier (LNA)

Preliminary work:

A Low Noise Amplifier (LNA) is to be designed and tested. The input impedance is 50 ohms. The frequency band of operation is 55-56 MHz.

1. Start the design of the amplifier by choosing the bias resistor R_1 to obtain the maximum possible gain.
2. Continue the design the amplifier by finding the values of L_1 and L_2 assuming they are ideal. Design the inductors L_1 and L_2 as air cored inductors. Calculate their Q's by taking into account the skin effect at those frequencies. Use standard enamelled wire for inductors (0.75 mm), (Take care that the Q of the inductor is not below 30). Tune L_1 with the capacitor C_1 by choosing a larger than needed inductance.
3. Now calculate the impedance presented by the transistor circuit at point A at the center frequency by again assuming that L_2 is ideal and the Q of L_1 is 40 at that frequency. Assume the Q values of capacitors are very large.
4. Try to make the drain load as much as possible to get the maximum power gain. For this purpose choose appropriate values for L_3, C_2, C_3 and C_4. While doing the term project, you are going to match the impedance of the following stage.
5. Verify your design using SPICE. Plot the power gain and the input impedance as a function of frequency. Calculate the average power dissipated in the transistor. Calculate the junction temperature by using the junction-to-air thermal resistance of the transistor.
6. Finally choose suitable values for C_5, C_6 and C_7 to create good AC ground at the supply and over R_E.



The spice model for BF245C is given below:

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.MODEL BF245C/PLP NJF
+ VTO = -5.0014E+000
+ BETA = 5.43157E-004
+ LAMBDA = 2.71505E-002
+ RD = 1.20869E+001
+ RS = 1.20869E+001
+ IS = 3.64346E-016
+ CGS = 2.00000E-012
+ CGD = 2.00000E-012
+ PB = 1.24659E+000
+ FC = 5.00000E-001
.ENDS
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Lab Work:

1. Check your decoupling capacitors by using network analyser. Try to see the difference between short-leaded and long-leaded capacitors. Compare resonance frequencies of the decoupling capacitor you plan to use before and after cutting its leads.
2. You will be given a circuit diagram which was tested before. Construct your circuit according to this circuit.
3. Construct your inductors L_1 and L_2 and measure their Q's using the network analyzer. Also measure the Q using the LCR meter. Explain the differences.
4. Connect the circuit of the preliminary work on bare PC board.
5. Check DC biases of your circuit.
6. Measure the bandwidth and the gain of the LNA. The noise figure of the amplifier will not be measured at this stage. Rather, the noise figure of the whole receiver will be measured during the term project.
7. Plot the frequency response and the input voltage of the amplifier as a function of the frequency to get an indication of the change in the input impedance as the frequency changes. (To do this part, you can use the Labview program you developed for Experiment # 2. Please have this Labview program with you during the lab).
8. Calculate the power gain of the amplifier and comment on it.
9. Measure the input impedance and the gain of the amplifier using the network analyzer. Adjust your amplifier while doing the measurement to get maximum gain and input impedance nearest to 50 ohms (during the adjustment split the screen into two to be able to see them both simultaneously).
10. Compare your results with your simulations. Comment on the differences.