EEE411/EEE511 LAB # 7

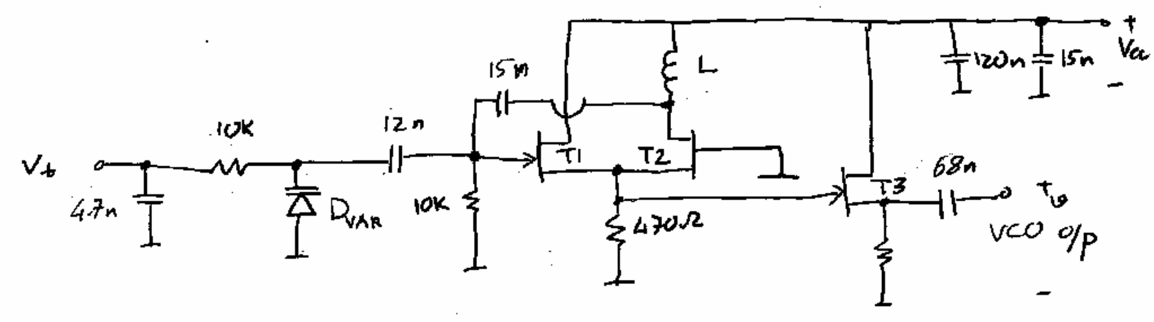
Voltage Controlled Oscillator (VCO)

Preliminary Work:

In this experiment you will design and construct a voltage controlled oscillator (VCO) with an output buffer. The oscillator output frequency is controlled by the value of V_t (V_{tune}). This accomplished by changing the capacitance of D_{var} (Varactor diode) through changing its voltage (Please note that varactor diodes are specially manufactured diodes. Their reverse biased junction capacitance which varies with reverse bias voltage is used to obtain a voltage controlled capacitance). The resonance frequency of the tank circuit formed by the capacitance of Dvar and L determines the frequency of operation. The differential pair (T_1 and T_2) serve as the gain block. The buffer transistor T_3 isolates the circuit from the effects of the output load.

The output frequency range of this oscillator must cover the necessary range to be able to convert the RF input frequency range of the project receiver. The input frequency range of your receiver is 55+/-1 MHz. Your mixer is going to convert the input signal from the lower side (i.e. the frequency of the mixer is lower than the frequency of the signal). Since your IF frequency is 10.7 MHz.

1. Please find the value of L to satisfy this condition. T_1, T_2 and T_3 are BF245C transistors, and the varactor diode is BB106. The varactor diode capacitance changes in the range 4-20pF for the voltage range of 0-20V. Vcc is 12 Volts.
2. Calculate the output frequency as a function of the capacitance of D_{var} for a number of capacitance values.
3. Check your design using SPICE in transient analysis for a number of varactor capacitance values (The same vaules as in step 2). For the simulation, use simple capacitor model to represent D_{var}.
4. Please bring the following instruments to the lab:
    a. A soldering iron with a sharp, pointed soldering iron tip suitable for mounting SMD components.
    b. A tweezer suitable for SMD mounting.



The circuit diagram of the VCO

Lab Work:

1. In this experiment you are going to construct your circuit on a pre made PCB using surface mount components. The SMD components and the layout of the circuit will be given to you during the experiment. Do not forget to connect power supply decoupling capacitors to the DC power supplies. Measure the oscillation frequency range and amplitudes at a number of frequencies.

2. Plot o/p frequency vs. V_t.

3. Calculate and plot VCO gain which is also called modulation sensitivity (dfreq/dVbias) versus V_t.

4. Connect your VCO to the LO drive of the Mixer. Adjust the frequency of your VCO using a potentiometer. Connect the signal generator to the RF input. Adjust the frequency to 30MHz. Observe the o/p on the scope at the IF output before the 10.7 MHz filter by adjusting the VCO frequency using the potentiometer.

5. Take the scope to FFT mode (Math Menu). Scan the VCO frequency at the given frequency band. Observe the mixer o/p spectrum at that range.

Discussion:
Compare your experimental results with your estimations and spice simulations. Comment on the results.

SPICE Model of BF245C:

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.MODEL BF245C  NJF(Beta=1.5m Betatce=-.5 Rd=1 Rs=1 Lambda=3.8m Vto=-3.099
+               Vtotc=-2.5m Is=33.57f Isr=322.4f N=1 Nr=2 Xti=3 Alpha=311.7u
+               Vk=243.6 Cgd=3.35p M=.3622 Pb=1 Fc=.5 Cgs=3.736p Kf=13.56E-18
+               Af=1)
```

Note: You can use a different SPICE model file which you obtained from the web yourselves.