

UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE 105
Spring 2011

Prof. Pister

Project Intro, Lab #10

Answers to questions 1-4 are due **at the end** of your lab section, week 13

Problem 1: Assuming that you want to make a 100 μ H inductor by winding 23 gauge wire around a circle. The wire has a radius of 0.28mm, and a resistance of around 0.1 Ohms/meter.

Calculate the number of turns you need to get $L=100\mu\text{H}$ if $R=6\text{cm}$, $a=0.28\text{mm}$, and calculate the corresponding resistance of that much wire.

Plot the magnitude of the impedance of your inductor (with wire resistance) over the frequency range from 1 to 100 Mrad/sec.

On the same plot, plot the magnitude of the impedance of a 100pF capacitor.

Problem 2 If you connect the inductor and capacitor in parallel to form an LC tank, what is the resonant frequency in radians/sec and Hz?

What is the impedance of the inductor at the resonant frequency of the tank? What is the impedance of the capacitor at the resonant frequency of the tank?

What is the Q of the inductor (the impedance at resonant frequency divided by the wire resistance)?

What impedance do you expect for the tank at resonance?

Problem 3: When you build your inductor, it will not be exactly the magnitude you expect. Sketch the magnitude and phase of a high-pass LR filter with a 100 μ H inductor and a 1kOhm resistor. Thinking about this plot, how would you make measurements in the lab to estimate the inductance of a coil that you built?

Problem 4: Similarly, your LC tank will not be at the exact frequency you expect. Sketch the magnitude and phase of a band-pass filter using your tank in series with a 1kOhm resistor. Use spice to verify your sketch. Thinking about this plot, how would you make measurements in the lab to estimate the center frequency of your tank? Is 1kOhm the right resistance to use?

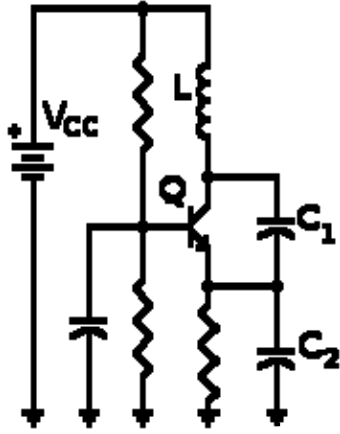
Lab:

1. Wind your inductor. Include a center tap.
2. Strip and solder the ends of all three leads of the inductor.
3. Build one or more circuits to measure the magnitude and phase of your inductor's impedance vs. frequency, near 1MHz.
4. Make an LC tank with your inductor and a 100pF capacitor. Build one or more circuits to measure the magnitude and phase of the tank impedance. Make sure that your data includes measurements at least one decade below and one decade above the tank resonant frequency. Estimate the tank resonant frequency, the impedance at resonance, the 3dB bandwidth, and the Q of the resonance.
5. If you have time, make an oscillator using your tank. There are many on the web to choose from. Try the Colpitts, or a negative transimpedance amplifier.

Turn in descriptions of all of the circuits that you built, all of your measurements/plots, and your conclusions about your inductance, series resistance, tank frequency, impedance at resonance, Q, 3dB bandwidth, etc.

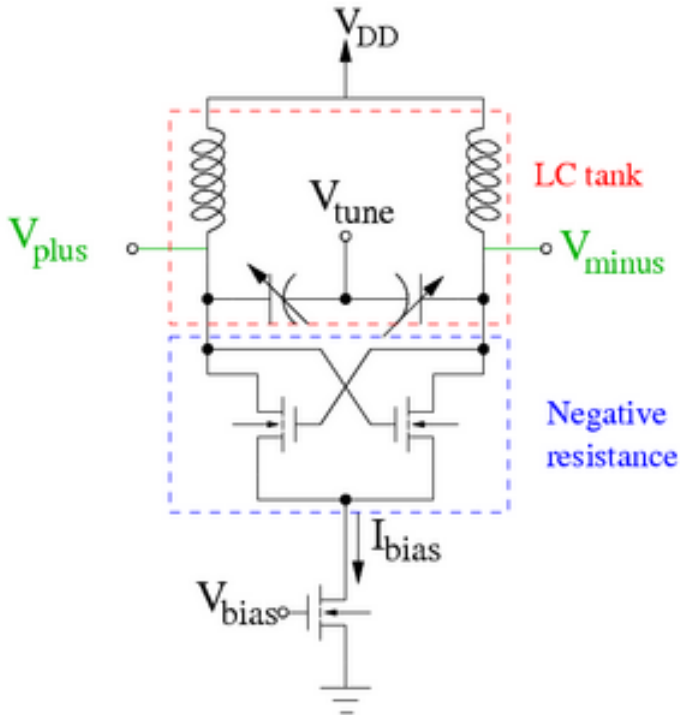
All of this should be turned in as a **powerpoint** (or equivalent) document emailed to pister@eecs with subject line "ee105 lab10". Email due by 5pm Thursday 4/28/11. One powerpoint from each lab team. This is the beginning of your final project report, so put some effort into it!

Oscillator examples:
Colpitts



From http://www.play-hookey.com/oscillators/colpitts_oscillator.html

MOS negative differential transconductance (use the center tap on your inductor; replace the two series tunable capacitors with your 100pF cap; and build with NPN BJTs):



From http://bmf.ece.queensu.ca/mediawiki/index.php/Differential_Negative-gm_VCOs