University of Pennsylvania
Department of Electrical and Systems Engineering
ESE319

Laboratory Experiment – Colpitts Oscillator

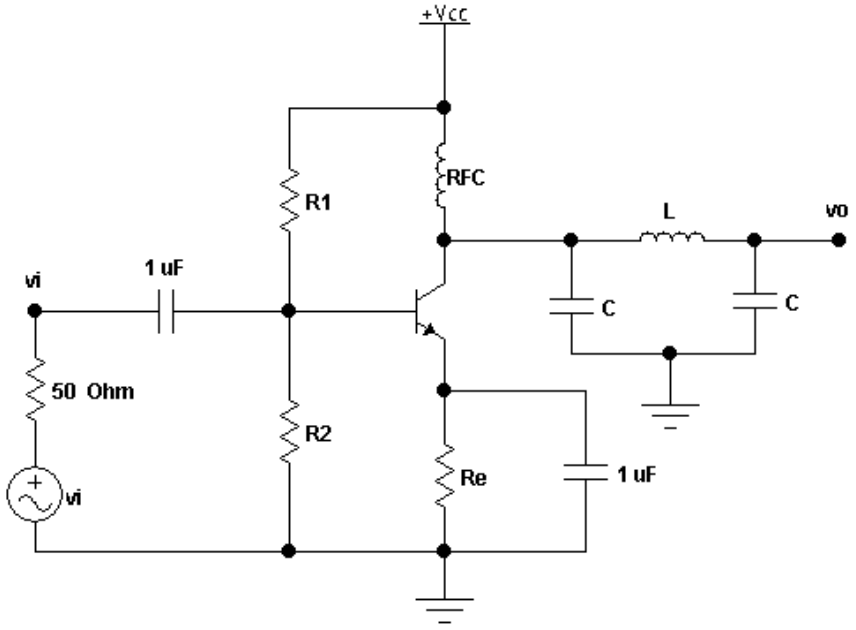

Figure l Colpitts Oscillator Circuit – Feedback Loop Opened

Shown in Figure 1 is the Colpitts oscillator circuit with an open feedback loop. The Colpitts oscillator is widely used in communications systems. Some advantages of this circuit are: good frequency selectivity, higher oscillation frequency, and self-limiting behavior.

Biasing: Select values of R_l, R_2, and R_e such that I_C equals l mA dc. (Hint: Use low values of resistance and make $I_{R1} = 4\ I_B$.)
RF: Using available inductors and capacitors, select L & C so that the oscillation frequency is close 0.5 MHz. Use Vcc = 12 volts. The selection of the unspecified components is left as a design problem.

Simulate both the open-loop and closed-loop circuits using Multisim. You should measure the circuit gain and phase at frequencies near the calculated oscillation frequency. It may be helpful to simulate the closed loop (oscillator) first to get an accurate estimate of the frequencies around which you should measure open-loop gain and phase.

Construct the open-loop circuit and verify the biasing. Next, connect a function generator to node v_i through a 1 μF capacitor and display v_o and v_i on your scope. Measure and plot their amplitude ratio and phase over the frequency range 100 kHz < f < l MHz and confirm that self oscillation will occur, i. e., that the gain from input to output is greater than 1 where the phase shift is 0 degrees. (Note that the output must be in phase with the input for oscillation.)

Then close the loop through the 1 μF input capacitor (remove the function generator and connect v_o to v_i through the capacitor) and display v_{bg} and v_{cg} on the scope. Record the waveforms and discuss their shape. Compare the experimental oscillation frequency with the calculated one. Now reduce R_2 until I_C = 0.1 mA and display and graph v_{bg} and v_{cg}. How far can you reduce R_2 before oscillations are extinguished?

Very Important: To design the circuit, first choose one of the values for L given below and then calculate the value of capacitance C to be used in the Colpitts oscillator. One of the inductors will serve as RFC, the "RF Choke." RFC should have a reactance that is much higher than the impedance of the frequency-determining elements in the circuit.

Available Inductors: 68 uH, 100 uH, 10 mH, 100 mH
Available Capacitors: 470 pF**,** 1 nF, 2.2 nF, 4.7 nF (among others).