**ECE 2313: Electrical Engineering Science I**

# Laboratory No. 11: PCB Implementation

In this laboratory, you will complete the fabrication of your printed circuit board (PCB) by populating the board, testing it and comparing the results to your Multisim simulation.

**Task 1: Verify Your Implementation**

Populate your PCB with the components you have selected through your design process. Solder the components. Be sure to use an IC socket, which you can obtain from the ECE Shop, for the op-amp IC – do not solder the IC directly to the circuit board because you will damage the chip in the process of heating it.

Power up the circuit, connecting a 1V sinewave at 750 Hz to the input as well as the DC sources for the op-amp using your Digilent board for the signal generation and power supply. Measure voltages at every node in the circuit, starting at the input and proceeding in a step-by-step fashion to the output. Compare the voltages that you measure to the predicted values in Multisim. Be sure to load the exact component values you are using on the PCB into Multisim so that the two results match closely.

**Task 2: Verify The Frequency Response**

Vary the frequency of the input voltage source from 10 Hz to 1500 Hz and plot the output voltage as a function of frequency. Does this match your Multisim plot? Is the peak in the correct location in frequency? Does the measured bandwidth match? (Bandwidth is defined as the difference of the two frequencies at which the frequency response drops 3 dB from the peak value.)

**Task 3: Impulse Response**

Using your MATLAB recording capability, apply a short pulse (1V amplitude, 10 msec duration) to the input of your circuit. Capture the output in MATLAB. Convert the signal to its frequency response using the Fast Fourier Transform function. Plot the magnitude of the frequency response as a function of frequency. Does this match what you observed in Task 2?

Next, increase the duration of the pulse to 1 second. Again, apply this signal to the circuit and digitize the result into MATLAB. Differentiate the signal and convert it to its frequency response. Plot the magnitude as a function of frequency. Does this plot match the plot you obtained in Task 2?

**Task 4: Chirp Signals**

Finally, generate a chirp signal that varies in frequency from 10 Hz to 1500 Hz over 5 seconds. Measure the output from your PCB implementation and plot this waveform as a function of time in MATLAB. Does this match what you observed in the previous tasks?

**Summary:**

In this laboratory, we have demonstrated how to analyze and debug your circuit. We have shown you several ways to measure the frequency response. In your Signal course (ECE 3512), you will learn more about these techniques. However, the most important thing to remember from this lab is to be very systematic in testing your circuits, making sure you do not skip any steps. Make sure you include pictures of your PCB in your lab report.