EC244 **Experiment #1** **Spring 2012**

Pre-Lab

Op-Amps Behaving Badly

1. Look up the datasheet for the LM741 operational amplifier to determine the connection diagram, output voltage swing, output short circuit current, slew rate, unity-gain bandwidth ("bandwidth" in the datasheets), input bias current, input offset current, and input offset voltage. Assume the 741 will be powered by +/- 15 V.
2. Design a non- inverting op-amp circuit with a nominal gain of 10 using resistors > 1 kΩ.
3. Now consider the limits of the op-amp's operation:
    a. What is the bandwidth for this amplifier?
    b. For a frequency of 1 kHz and a load, R_L = 1 kΩ, what peak output voltage is possible without distortion?
    c. For a frequency of 1 kHz and a load, R_L = 100 Ω, what peak output voltage is possible without distortion?
    d. For a frequency of 50 kHz and a load, R_L = 1 kΩ, what peak output voltage is possible without distortion?
4. If you neglect the bias-current-effect-canceling resistor in the design of the inverting op-amp, what is the worst case DC output voltage that you would expect to see when the input is set to zero?
5. Modify your design to include the bias-current-effect-canceling resistor. Now what do you expect the worst-case DC output voltage to be (in the case where the input is set to zero)?

Digital to Analog Conversion

6. Adapt a summing amplifier circuit to implement a 4-bit digital-to-analog converter (DAC) which accepts 4 input voltages (tied either to ground for '0' or to 5 V for '1') and produces an output voltage ranging from 0 to –14 V. Create a table of all of the possible input combinations and the expected resulting output voltage for this DAC. (Use additional resources i.e. the web for help).
7. Simulate your design in Multisim to confirm its operation.

Laboratory Work

1. Build the non-inverting amplifier you designed in the pre-lab, without the bias current compensating resistor. Check that the amplifier is performing properly by using a 1V peak, 1 kHz sine wave as an input and observing the input and output on the oscilloscope.
2. Set the input to ground and measure the worst case DC output voltage that results from the DC imperfections. Then add in the bias current compensating resistor and repeat the measurement.
3. Measure all of the operating limits that you considered in question 3 of the pre-lab.
4. Build your DAC that you designed in the pre-lab and measure its output for all possible input combinations. Check that it matches what you expected from the pre-lab. Explain any discrepancies.