Lab 9 More Op-Amp Applications & Active Filters

Current boosters

For a given input voltage, the load current of an amplifier depends on the load resistance. The smaller the load resistance, the larger the current. A typical op amp like the 741 cannot drive very small load resistances because its maximum output current is 25 mA. When a load requires more current than this, a current booster can be added to the output of the op amp. Power transistors are often used to deliver current to the load when the current requirements exceed the original circuit.

a. Build a voltage divider to supply the non-inverting input of a 741 op-amp (you must pick the 741 in Multisim) about +1.5V DC voltage. You only have two fixed DC power sources: $VCC = 15V, VEE = -15V$. Measure input voltage at pin 3 (+). Show your circuit schematics and simulation below.

b. Use this 741 to build a voltage follower (buffer). Connect a load resistor RL to its output. Measure the load current I_L and voltage V_L of various RL. $R_L = 1\Omega, 5\Omega \sim 100\Omega$ with a step size of 10Ω; $R_L = 100\Omega \sim 1000\Omega$ with a step size of 200Ω; Explain your data. What is the maximum output current (short circuit current) of a 741? Show your circuit schematics and simulations. *Do make a table to record your data.*

c. Add a current booster (emitter follower) to the voltage follower. Use the transistor MJ15024G in Multisim. What's the difference between a 2N3904 (the transistor we used in lab 5 & 6) and an MJ15024G? Can we use a 2N3904 here? Why? Show your circuit schematics.

d. Repeat step b - Measure the load current I_L and voltage V_L of various RL. $R_L = 1\Omega, 5\Omega \sim 100\Omega$ with a step size of 10Ω; $R_L = 100\Omega \sim 1000\Omega$ with a step size of 200Ω. Show your circuit and simulations. What was learned about an op-am circuit when used without a current booster? With a current booster? *Do make a table to record your data.*

e. Disconnect the wires and the voltage divider to input pin 3 (+). Now supply pin 3 with an ac input signal with $v_{peak} < 5V$. Measure the input and output (load) voltage. Do the waveforms make sense to you? Explain. Show your circuit schematics and simulation graph.

80 POINTS IN TOTAL. LAB IN THE WEEK 4/6. DUE AT 2PM 4/16.

Active Filters

a. Build the active filter your designed in Homework 9 – iv -a. Set the input voltage less than $1V_{peak-to-peak}$. Keep the op amp as a 741. Supply this 741 with rail voltages of $\pm 15V$, same as our previous setup. Show your circuit schematics below.

b. Calculate voltage gain A_V and the cutoff frequency f_c. Measure the output peak-to-peak voltage by varying input voltage from $v_{in} = 0Hz \sim 1MHz$ with step sizes of your own choice – make sure you have enough data to make a Bode plot. Make a table and do a Bode plot. Show your simulation graph at f_c below.

c. Do an AC sweep with Multisim. Does Multisim's Bode plot agree with yours? Show both plots side to side below.

- *We will do integrator and differentiator simulations next week.*