Lab Experiment
DIFFERENTIAL AMPLIFIERS - OPERATIONAL AMPLIFIERS
AND ACTIVE FILTERS

OBJECTIVE

After the completion of this unit, the student should be able to compute values, voltages, currents, voltage gain, slew rate, and common mode rejection ratio in differential amps and operational amplifier. The student should also be able to construct the operational amplifier and make accurate voltage measurements. The student will determine the operation of the operational amplifier using proper test equipment, operational amplifier specification book and demonstrate the knowledge obtained in the classroom. Compute, construct and measure voltages in active high pass, low pass and band pass filters.

REFERENCE

1. 2nd Semester Text book and notes
2. 3rd Semester Notes

EQUIPMENT AND MATERIALS

1. Oscilloscope as assigned
2. DVM
3. Audio sweep/function generator
4. DC supply
5. 741 operational amplifier
6. Diodes, Zener diodes, resistors, and capacitors as needed
7. MPQ3904 or THAT300 NPN transistors

SPECIFIC OBJECTIVES

**Write an explanation of the circuit operation for each circuit investigated. **

1. Calculate, construct, measure and compare a transistor differential amplifier including all DC values, voltage gain, and waveforms for single input, common mode, and differential modes of operation. (see schematic Figure 4-1 page 3)

2. Replace the tail resistor with a constant current source and compare the differential and common mode gains with the previous circuit. **Verify your circuit with your instructor (1)**

3. Calculate and construct a differential amplifier with the same gains as the circuit in step 1 above using an Op-amp. Compare the common mode and differential mode gains with the previous circuit and the CMRR specifications.

4. Write in your lab book the two rules for an Op-Amp. Describe voltage gain (open loop) and voltage gain (closed loop) and show how to calculate voltage gain (closed loop) for an op-amp. List the slew rate and CMRR found in the spec book. Show in your lab book how to test and measure slew rate, and then measure the slew rate of your part and verify with your instructor (2).

5. Build the circuit below (Figure 4-2)
    - Measure the output voltage and record it in a table.
    - Calculate the balancing resistor that the circuit should have and replace the Rb resistor and measure and record the output in the table.
    - Properly connect the offset null pins for zeroing the op amp. Adjust so that you have a perfect zero volt output of your Op-amp. Document in your lab book what zeroing is and what you learned.

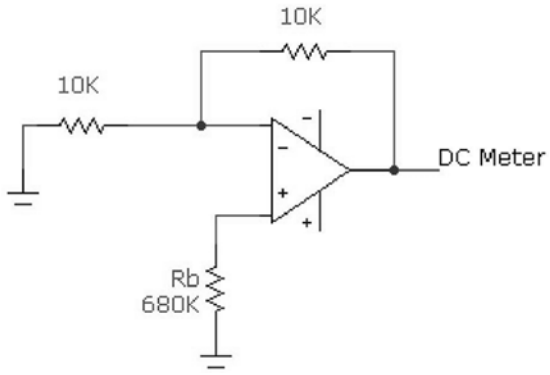

Figure 4-2 – Op Amp Null Circuit

6) Build a 3 stage amplifier out of Op-amps with the following specs.

- Must have 1 non inverting amp, 1 inverting amp and one voltage follower
- Zin must be 50Ω
- The load (RL) is 10Ω
- Total voltage gain of the circuit is 425.
- Set your generator to 60mVp unloaded (before you connect it to your circuit)

Show all calculations for your design. Calculate and measure the High Critical frequency of the circuit. **Verify your circuit with your instructor (3**).

7) Build a voltage Bounding circuit (Figure 4-3) that will let the output signal vary but not let the output signal go above (?) **assigned by your instructor** to a 2.2K load.

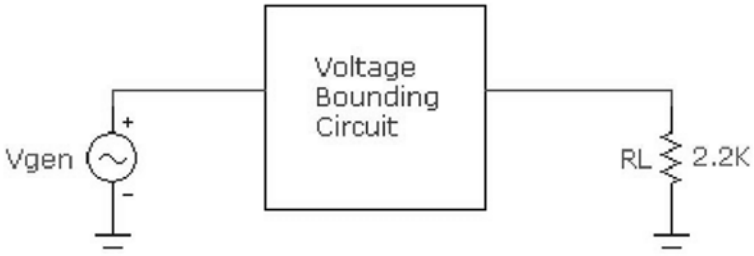

Figure 4-2 – Op Amp Null Circuit

8) Build a 3-bit D/A converter (DAC) using an op-amp. Connect the input of the DAC to the output of a Mod-8 counter. Observe and document the output on the scope in your lab book. **Verify your circuit with your instructor (4**).

9) Design a circuit using Op-amp comparators to light one LED requiring 10 mA, if a 5V power supply goes above 6.0V or below 3.9V. **Verify your circuit with your instructor (5)**

** Write an explanation of the circuit operation for each circuit. ** Pick critical frequencies for your circuits to be between 5KHz and 30KHz ** Calculate frequency and voltage at the critical frequency (Fc) and the one decade point of the frequency response curve, and draw the bode plot for each.**Measure frequency and voltage on circuits at four points:

- Mid Band
- Fc
- -6dB Point and
- one decade point

10) Compute the resistor values, construct and measure the following circuits;

- -20db/decade Butterworth low pass filter
- -40db/decade Butterworth low pass filter
- -20db/decade Butterworth high pass filter
- -40db/decade Butterworth high pass filter

11) Construct and measure an active -40db high pass filter circuit that is adjustable to produce a Butterworth, Chebyshev, and Bessel response. with the sweep generator. **Verify your circuit with your instructor (6)**

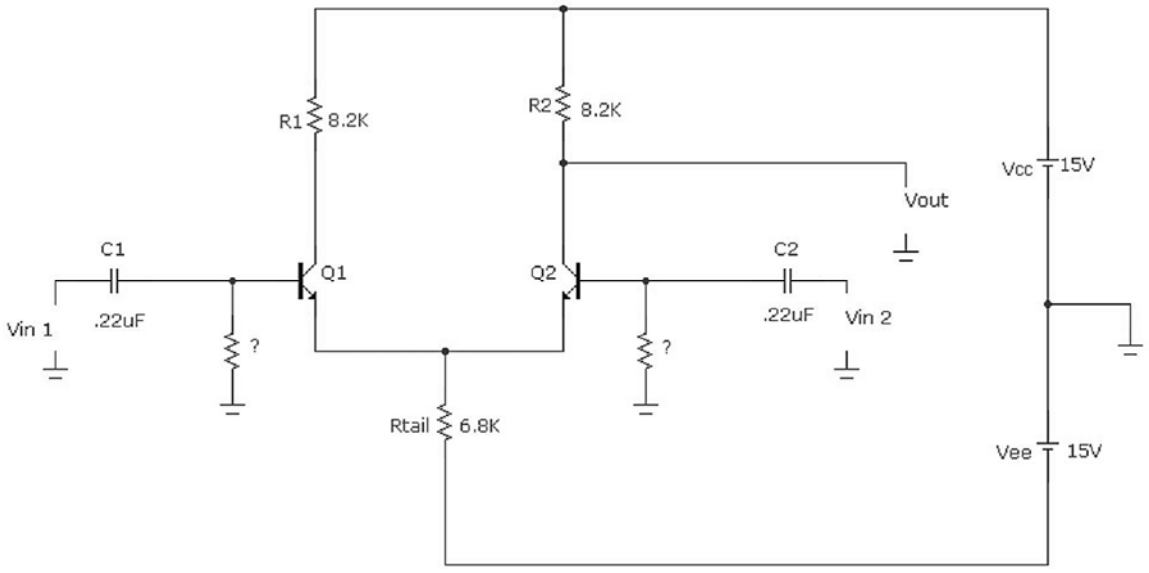

Figure 4-1 – Differential Amplifier for Specific Objective 1