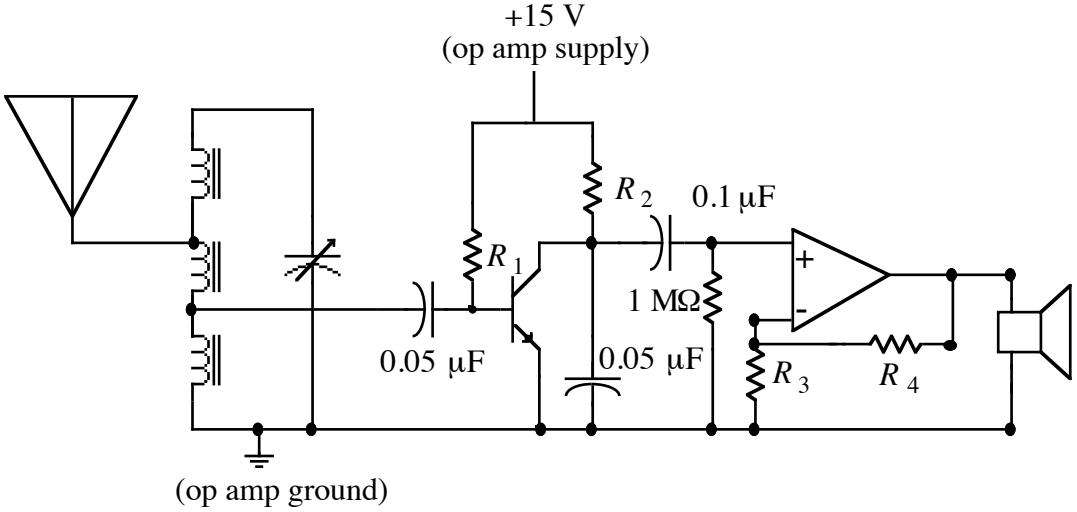
Physics 4700 Experiment 6
Operational Amplifiers

1) Measure the voltage gain vs. frequency for a non-inverting amplifier with a gain of 0, 20, and 60 dB. Scan the frequency range 10 Hz (or as low as you can go) to 100 kHz. Plot all measurements on one Bode plot together with the open loop gain from the op amp's spec sheet (see next page). Measure the input impedance of the amp for 0 and 20 dB by measuring the input voltage vs. current at several frequencies, starting at high frequency and go down until the current is not small to be measured. For the 20 dB measurement, the input voltage should be small to avoid saturating the amp. Tabulate your results, including your measured voltages/currents.

2) Do one of the following:
a) Build an inverting amp with a gain of 40 dB. Measure the gain vs. frequency over the range 10 Hz -100 kHz. Compare your result with the theoretical expectation. Measure the input impedance at several frequencies and tabulate the results as in part 1).
b) Build a summing amplifier. The input voltages can be DC. Summarize your result in a table for various combinations of input voltages.
c) Build a difference amplifier with gain of 20 dB.

3a) Build a circuit to perform integration of a 1 kHz square wave, sine wave, and triangular wave. Capture using the input and output waveforms and compare the amplitude of each waveform with what is expected for the integrals of each waveform. Start with the square wave. Read the discussion in the Student Manual for the Art of Electronics (Hayes and Horowitz) on P185 before you start.

3b) Return of the Radio from Hell:
In the previous lab you built a 3-stage AM radio. The last two stages of the radio amplified the signal so that it would be audible. Replace the last two transistors with a non-inverting amplifier of gain 40 dB. See the circuit below. Pick R_1 and R_2 in the same fashion that they were chosen for the AM radio lab. Pick R_3 and R_4 to give a gain of 40 dB. Compare this version of the radio with the 3-stage version (i.e. which works better). Capture a picture of the input and output waveforms of each amplifier. For the first amplifier, set the time scale to be 50 ns/division for the base and 250 μs/division for the collector. For the second amplifier, set the time scale to be 250 μs/division (2 waveforms/picture). Discuss what you see.



Note: *All circuits use a 741 (or equivalent) op amp and the op amp breadboard.*

Open loop gain for 741: The op-amps used in the lab were fabricated by TI. Unfortunately we cannot find the spec sheet for the open loop gain. We will use the gain below from Analog Devices which should be a good approximation:

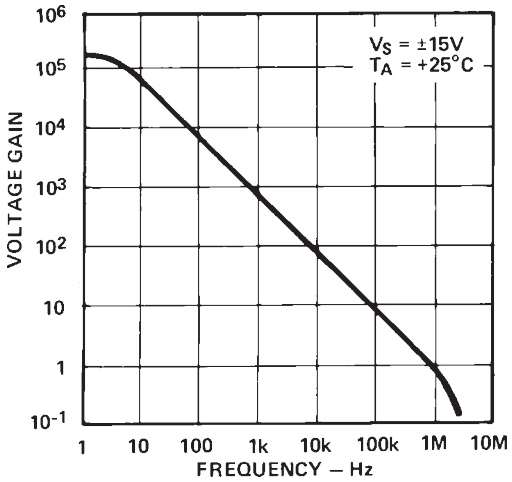


Figure 3. Open-Loop Gain vs. Frequency