EXPERIMENT 12: NON-LINEAR OP AMP CIRCUITS 11/23/02

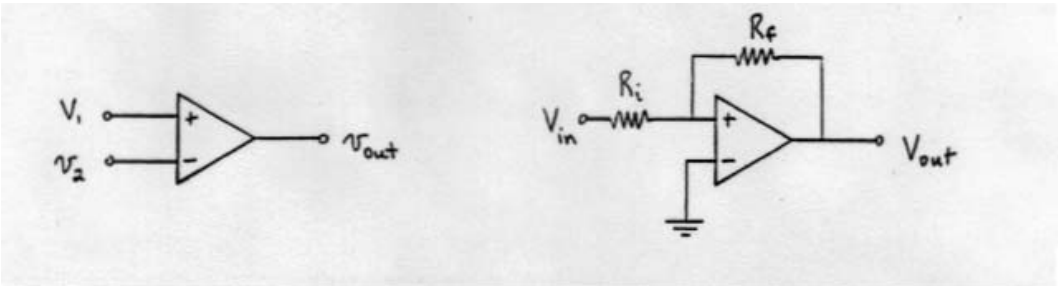
In this experiment we will examine some applications of operational amplifiers in non-linear circuits.

We will use the same μA741 operational amplifier board as in Experiment 11. Please note that it is possible to burn out the op amp by applying an input voltage that exceeds the voltage of the power supply.

1. Construct the voltage comparator circuit shown below. For v_2, use sine waves with an amplitude of about 4 V peak-to-peak.. Keep f $\leq$ 200 Hz. Use the ±5 V power supply for V_1. Observe what happens to V_{out} as you adjust V_1 up and down. Write a brief explanation of what the comparator circuit does. For some value of V_1 (say V_1 = 1.5 V) make a sketch showing the input voltages and V_{out}.

2. Construct the latch circuit shown below with R_i = 1 kW and R_f = 25 kW. Use the ±5 V power supply for V_{in}. Describe what happens to V_{out} as you adjust V_{in} up and down. Determine the values of V_{in} at which the latch switches states. The latch circuit "remembers" the polarity of the last input pulse by "latching" to either the positive or negative saturation voltage. Explain what the resistor R_f does in this circuit.

comparator **latch**



3. The circuit diagram of a logarithmic amplifier is shown below. The output voltage from this amplifier should be given by:

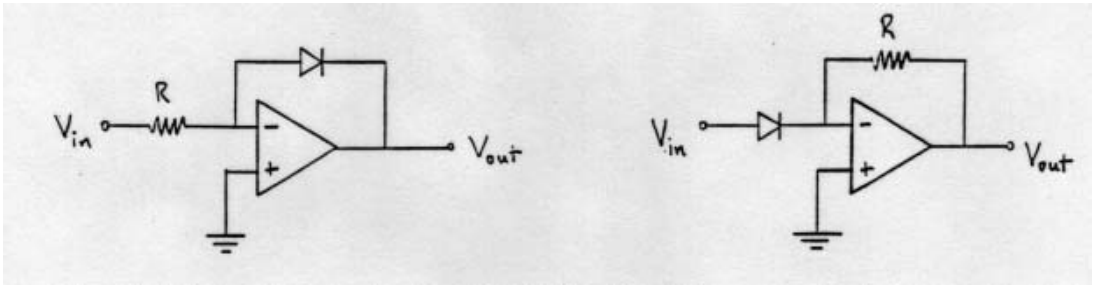
$$V_{out} = -\alpha \ln(V_{in} / I_0 R) .$$

Before you begin, set up the linear amplifier shown on p. 11-1 and carefully adjust the zero offset of the op amp. Then construct the log amp circuit using a silicon diode and a 10 kΩ resistor. Using the ±5 V power supply and two DMM's, measure and tabulate V_{out} as a function of V_{in}.

Start at V_{in} = 5 mV and work up to V_{in} = 5 V, increasing V_{in} by roughly a factor of 2 at each step. Make a plot of V_{out} vs V_{in} on semi-log paper. Over what range is the amplifier logarithmic? What value do you get for α from your graph?

4. For the exponential amplifier shown below the output voltage should be given by:

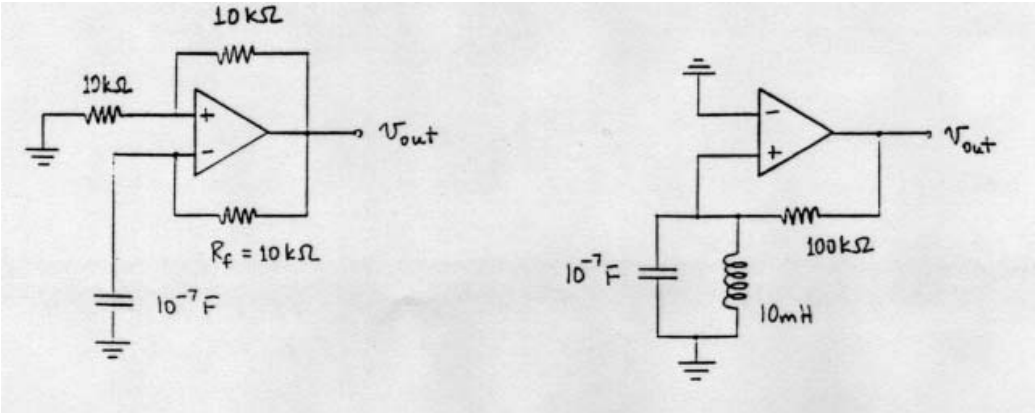
$$V_{out} = -I_0 R \exp(V_{in} / \alpha) .$$



Logarithmic Amplifier **Exponential Amplifier**

Construct the amplifier using a silicon diode and a 20 kΩ resistor. Measure and tabulate V_{out} as a function of V_{in} starting at V_{in} = 0.3 V and going up in 0.025 V steps until V_{out} reaches saturation. Plot the results on semi-log paper and extract a value for α. How does the result compare with the value of α you obtained in step 3 ?

5. Construct the two oscillator circuits shown below. For each circuit sketch V_{out} and V_C (the capacitor voltage). Measure the period for each and compare your results with the expected values ($T = 2.2\ R_f C$ for the relaxation oscillator and $T = 2\pi\sqrt{LC}$ for the resonant oscillator). Write a brief explanation of how each oscillator works.



Relaxation Oscillator **Resonant Oscillator**