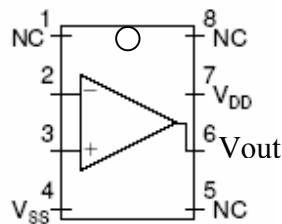# MASSACHUSETTS INSTITUTE OF TECHNOLOGY
6.071 Introduction to Electronics, Signals and Measurement
Spring 2006

Laboratory 21:   Building and testing Op-Amp Circuits

In this short lab we will gain some additional experience with operational amplifiers by building and testing a few fundamental op-amp circuits. We will use the LF356 whose pinout is

Exercise 1

The first thing we are going to do is look at the data sheet describing our device. The data sheet may be found in the class web site.

1. For $V_{DD} = +15V$ and $V_{SS} = -15V$ what is the maximum possible output voltage(Vout)?

2. What is the maximum current that this device can provide?

    What do you think happens when the maximum current is exceeded?

The slew rate (*SR*) of an op-amp is a measure of how fast the device responds to a change in the input signal. *SR* is given in units of V/μs. Since the frequency of a signal represents its time characteristics, there is a maximum operating frequency that an op-amp can handle

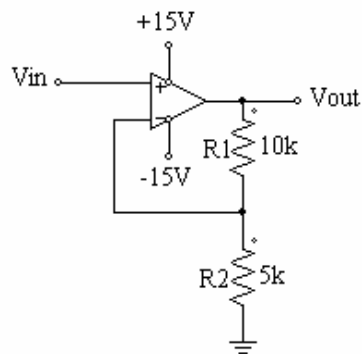$$f_{max} = \frac{SR}{2\pi V_m}$$

Where V_m is the maximum output voltage.
What is the SR for the LF356?

Experiment 1

Non-Inverting Amplifier.

Build the following circuit

How is Vout related to Vin?

With the indicated component values and by using a DC value for Vin, measure the gain (Vout/Vin)

Modify the component values in this circuit for a gain of 10 (Vout = 10Vin). Indicate your changes on the schematic. Test your circuit. Is the gain what you expected?

Next let's use a sinusoidal signal for our input and observe the resulting output. If the input signal is of the form $V_{in} = 0.5\sin(2000\pi t)$, what is the form of the output signal? (Use the oscilloscope for these measurements)

Do you observe any difference in the phase of the two signals?

What is the maximum operating frequency (f_{max}) for this circuit.?
Observe the output for an input signal of frequency $5 f_{max}$

Now let's assume that we are trying to buffer a medium or high output resistance signal source. Run the input through a 100kΩ resistor and observe the resulting output. Do you see any changes?

Experiment 2

Inverting Amplifier

Now let's built the inverting amplifier circuit.
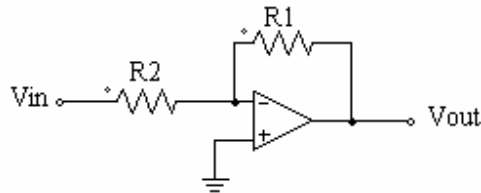
Modify the component values in this circuit for a gain of 10. Test your circuit.

Next let's use a sinusoidal signal for our input and observe the resulting output. Note the inversion of the output signal.
If the input signal is of the form $V_{in} = 0.5\sin(2000\pi t)$, what is the form of the output signal?


What is the difference in the phase of the two signals?

Now let's assume that we are trying to buffer a medium or high impedance load. Run the input through a 100kΩ resistor and see how much does the output changes. How does this compare to the non-inverting configuration?

Exercise 2

Summing amplifier circuit

You would like to add the two signals V1 and V2 resulting in a signal Vout = 2V1 + V2. The following circuit corresponds to a possible solution.
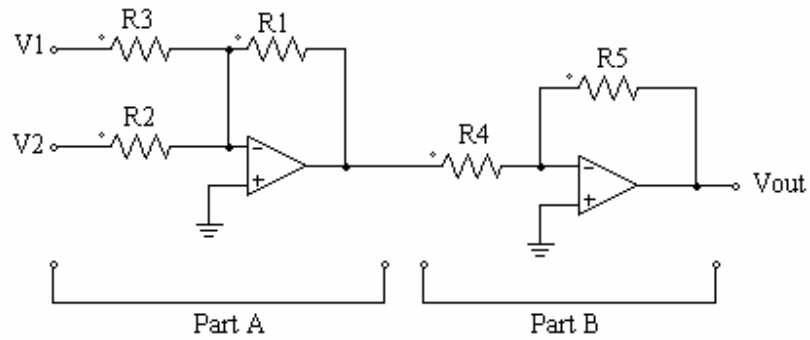
Briefly describe the function of the circuits indicated by Part A and Part B.

What resistor values do you use in order to obtain Vout = 2V1 + V2?

$R1 =$

$R2 =$

$R3 =$

$R4 =$

$R5 =$