Scope:

Study basic OP-AMP circuits:

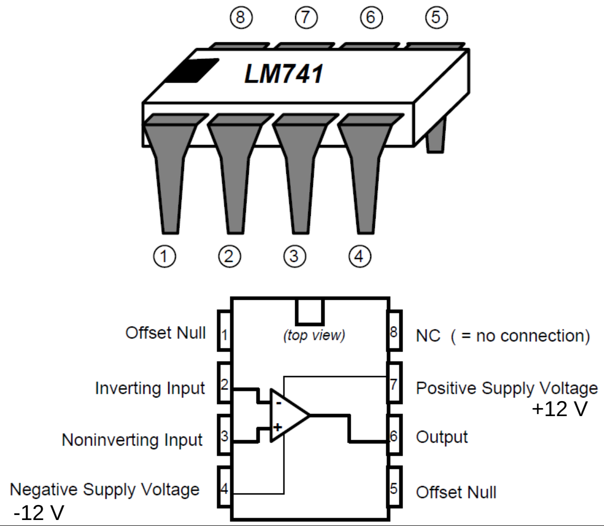
- Voltage dividers
- Voltage follower
- Inverting configuration
- Summing circuits

Fig. 8.1 shows the 8-DIP package of a type 741 OP-AMP with its terminals labeled.

Note that there is no “ground” pin on the op amp package. The op amp’s differential inputs “float” with respect to ground.

The offset null (pins 1 and 5) will not be used in this experiment. Those pins must be left unconnected.

Fig. 8.1: Op Amp



Home preparation:

- Review Hambley Ch 14
- Complete the pre-lab column in each table assuming the ideal op amp model.

Laboratory Experiments:

1.) Using the DMM, carefully adjust the bench DC power supply to produce +12V and -12V with respect to a common ground.

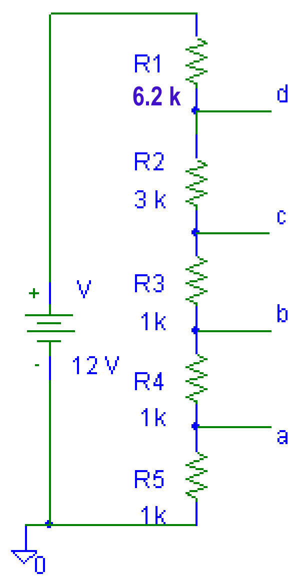
2.) Build the circuit shown in Fig. 8.2 on your breadboard. Choose resistors with value close to the nominal values listed. This is a *voltage divider*, assuming all of the resistors conduct the same current. You will use this circuit to create several voltages to use in the rest of the experiment. Measure and record the voltages in column 2 below.

3.) If current is drawn from any of the nodes *a*, *b*, *c*, or *d*, the corresponding node voltages will change due to the change in the overall current. Try this by temporarily connecting a 1 kΩ resistor between node *b* and ground. Re-measure the node voltages and record them in column 3 below.

	Pre-lab predicted voltage	Measured in lab (part 2)	Measured with 1kΩ resistor from *b* to ground (part 3)
V_a			
V_b			
V_c			
V_d			

When done with step 3, <u>remove the 1kΩ resistor you attached between node *b* and ground</u>.

Fig. 8.2: Voltage Divider



4.) TURN OFF THE BENCH SUPPLY and carefully assemble a *voltage follower* circuit using one of the op amps from your kit. The voltage follower, or *voltage buffer*, is shown in Figure 8.3.

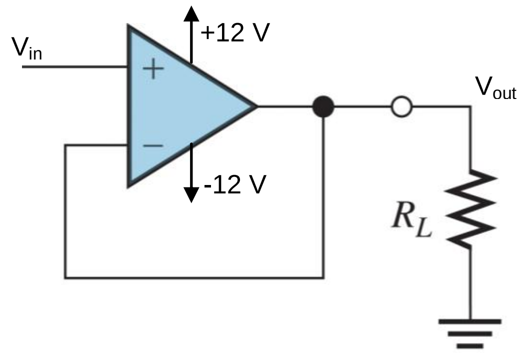


Fig. 8.3: Voltage Follower

5.) Connect a 1kΩ resistor from the op amp's V_{out} terminal to ground.

6.) Turn on the ±12 volt bench supply, and record V_{out} when V_{in} is connected one by one to nodes *a*, *b*, *c*, *d* of the voltage divider.

With V_{in} connected to:	**Pre-lab** predicted voltage	V_{out} measured from op amp voltage follower (part 6)
a		
b		
c		
d		

- Note that the voltage follower draws negligible current from the voltage divider, but provides sufficient current to drive the 1kΩ load.
- Comment on this result compared to attaching the 1kΩ load directly to the divider circuit.

7.) Turn OFF the bench supply, select another op amp chip from your kit, and breadboard the circuit shown in Fig. 8.4. Don't forget the power supply connections! This is called an *inverting amplifier* configuration.

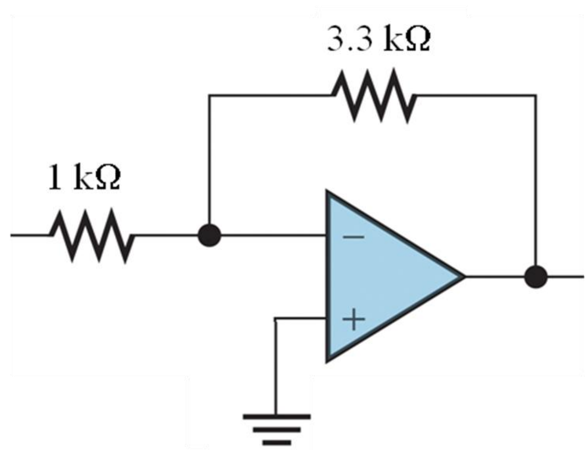


Fig. 8.4: Inverting Amplifier

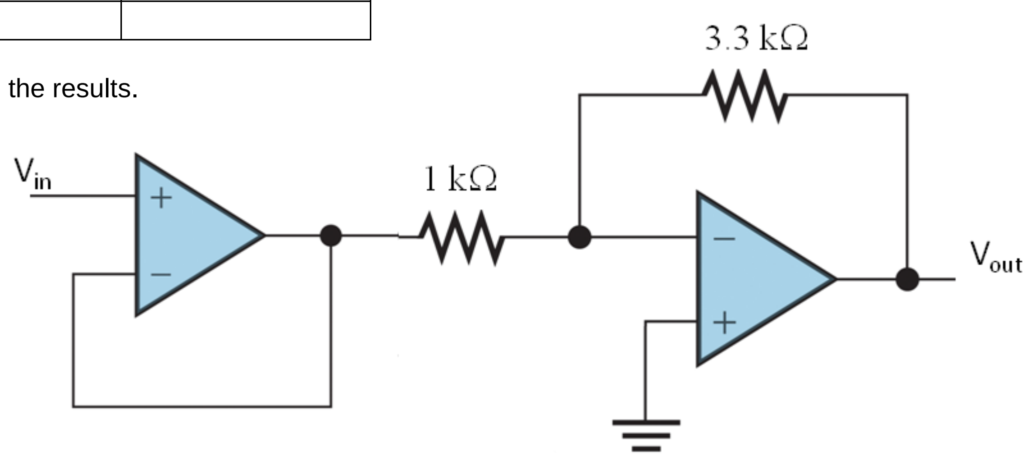
8.) Connect the V_{out} of the voltage follower circuit to be "V_{in}" for the inverting amplifier, as shown in Fig. 8.5.

9.) Turn on the bench supply and record V_{out} when V_{in} is connected one by one to nodes *a*, *b*, *c*, *d* of the voltage divider.

With V_{in} connected to:	**Pre-lab** predicted voltage	V_{out} measured from inverting amp (part 9)
a		
b		
c		
d		

- Comment on the results.

Fig. 8.5: Voltage follower driving the inverting amplifier



10.) Turn off the bench power supply and breadboard the circuit shown in Fig. 8.6. Remember the power supply connections! This is called a *non-inverting* amplifier configuration.

11.) Turn on the bench supply and record V_{out} when V_{in} is connected one by one to nodes *a*, *b*, *c*, *d* of the voltage divider.

With V_{in} connected to:	**Pre-lab** predicted voltage	V_{out} measured from non-inverting amp (part 10)
a		
b		
c		
d		

- Why isn't the voltage follower needed in this case?
- Comment on the results.

Fig. 8.6: Non-inverting amplifier configuration