

# **Basic Op-Amp. Circuits**

Sayed Taher Zewari

ECE 334- 201

Lab No. 4

02/21/01

# Basic Op-Amp. Circuits

## I. Introduction

The purpose of this part of the lab is to investigate the characteristics of a comparator circuit build using an Operational Amplifier.

## II. Background Information

### Operational Amplifier:

An amplifier is a device, which magnifies signals. The ideal operational amplifier ( Op Amp), under optimum conditions, would theoretically have infinite gain, and infinite bandwidth. These ideals cannot be realized in practice, but many operational amplifiers have very high input impedance (they draw almost no current and hence almost no power), very low output impedance, extremely high gain and large bandwidth.

### Comparator Circuit:

It is a circuit which compares two input voltages and produces an output in which indicates the greater than or less than relationship of the inputs.

### Inverting Amplifier:

An inverting amplifier is any amplifier that produces a 180-degree phase shift in the process of amplification.

### Integrator Circuit:

Integrating Amplifier is a circuit that generates the integral, with respect to time, of a waveform. In other words, it produces an inverted output which approximates the area under the curve of the input function. When the input amplitude to an integrator is constant-that is, a direct current-the output constantly increases. If the input is zero, the output is zero. When the input amplitude changes alternately toward the positive and the negative, the output reflects the integral of the waveform.

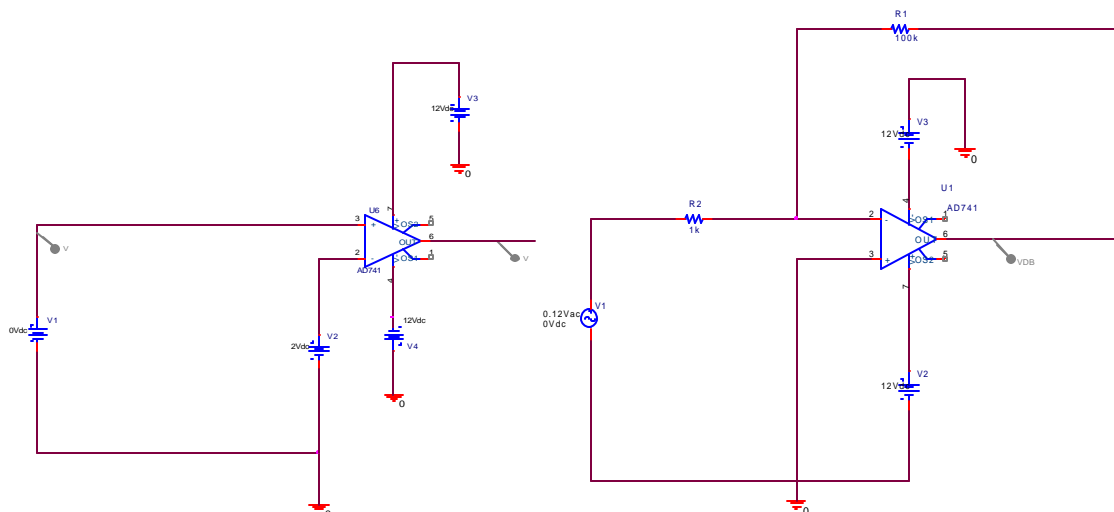
## III. Materials Used

The following materials were used in this lab: resistors of 1 k $\Omega$ , 100 k $\Omega$  resistance, function generator, capacitor of value 10 nF, oscilloscope, and the bread board on the Heathkit Trainer.

## IV. Procedure

### Comparator Circuit:

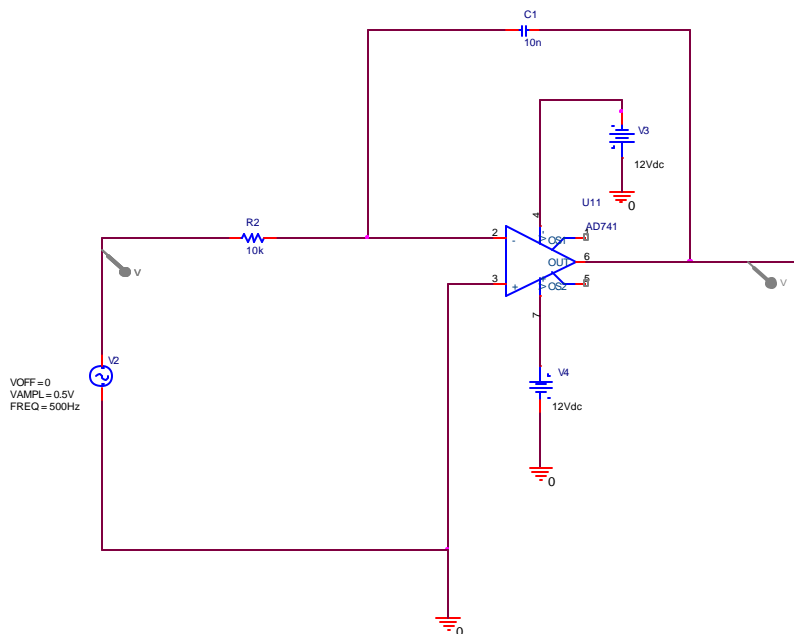
1. Setup the following circuit:



1. Connect the negative outlet of the voltage source to the ground as indicated above.
2. Connect the positive outlet of the voltage source to the pin number 3 ( $V_+$ ).
3. Connect the pin number 7 to the positive voltage source (12 V).
4. Connect the pin number 4 to the negative voltage source (-12 V).
5. Increase the voltage in increments of 1 up to 5 volts and measure the output at pin number 6 ( $V_o$ ).
6. Connect the positive outlet of the voltage source to the ground.
7. Connect the negative outlet of the voltage source to the pin number 3 ( $V_+$ ).
8. Connect the pin number 7 to the positive voltage source (12 V).
9. Connect the pin number 4 to the negative voltage source (-12 V).
10. Increase the voltage in increments of -1 up to -5 volts and measure the output at pin number 6 ( $V_o$ ).
11. Supply a voltage of 2 V to the pin number 2 ( $V_-$ ) of the Op amp.
12. Repeat the steps 1 to 10 and record the output.

### Inverting Amplifier:

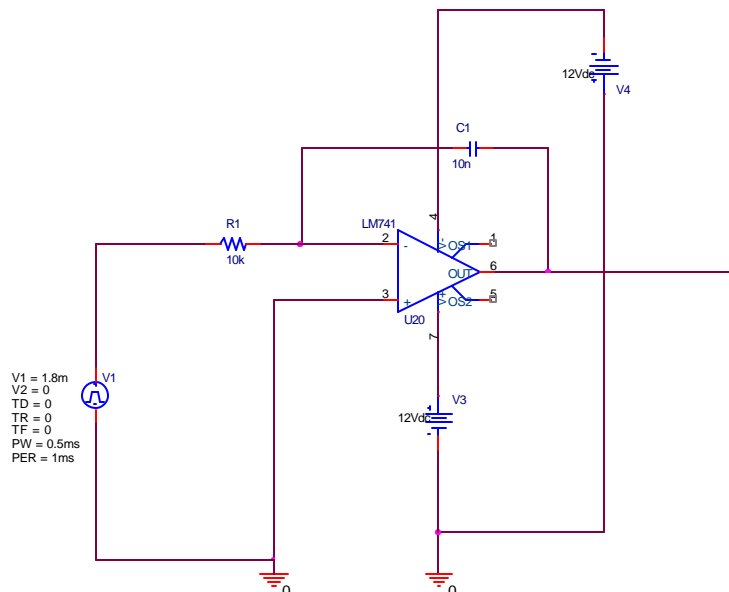
1. Setup the following circuit:



2. Connect the pin number 2 to the function generator and put a resistor of 1 k $\Omega$  between them.
3. Connect the pin number 3 to the ground.
4. Connect the output, pin 6, to the input which is pin 2 and put a resistor of 100 k $\Omega$  between them.

### Integrator Circuit:

1. Setup the following circuit:



2. Connect the pin number 2 to the function generator and put a resistor of 10 k $\Omega$  between them.
3. Connect the pin number 3 to the ground.
5. Connect the output, pin 6, to the input, which is pin 2 and put a capacitor of 10 nF between them.
6. Using the function generator, display both input and output on the oscilloscope. If the input is sine wave, the output should be cosine wave.
7. Change the shape of input wave, from sinusoid to square and observe the output. The output should now be of triangular form.
8. Change the shape of input wave, from square to triangular and observe the output. The output should now be of sinusoid wave.

## V. Results

### Comparator Circuit:

$V_+$ (V)	$V_-$ (V)	$V_{out}$ (V)	$V_-$ (V)	$V_+$ (V)	$V_{out}$ (V)
0	-5	-10.08	2	-5	-10.08
	-4	-10.08		-4	-10.08
	-3	-10.08		-3	-10.08
	-2	-10.08		-2	-10.08
	-1	-10.08		-1	-10.08
	0	-10.08		0	-10.08
	1	11.37		1	11.37
	2	11.37		2	11.37
	3	11.37		3	11.37
	4	11.37		4	11.37
	5	11.37		5	11.37

Inverting Amplifier:

$V_{in}$	$V_{out}$	Gain
1 V		
1		
1		
1		
1		
1		
1		

Integrator Circuit:

Read the conclusion for Integrator

## VI. Conclusion

Comparator Circuit:

A voltage comparator circuit is the circuit that tests voltage level and indicates if signals are matched. Usually, the yes is a high state, and the no is a low state. In the two experiments, in part a, it can be seen that the voltage comparator changes from  $-12\text{ V}$  to  $12\text{ V}$  when the voltage of  $2\text{ V}$  is connected to the pin 2. When the voltage at pin 2 is  $0\text{ V}$  the output voltage changes from  $12\text{ V}$  to  $-12\text{ V}$ .

Inverting Amplifier:

An inverting Op Amp functions to generate an inverted and scaled copy of the input. This can be clearly seen by comparing the input and outputs. The output of an amplifier is usually amplified to a certain level after which the amplification does not occur. This can clearly be seen in part Ai and part Aii. In both part Ai and Aii, we can see that there is an amplified output for an input of zero. That is because; the amplifier is so sensitive producing an output even for the noise. From all the above data results, we can conclude that an inverting amplifier not only amplifies a signal but also inverts the signal.

Integrator Circuit:

An integrator circuit generates the integral of a waveform. When the input amplitude to this circuit is constant, the output constantly increases. As we see from the above data results, the input voltage is constant. As a result, the output,  $V_{out}$ , increase. If the input voltage,  $V_{IN}$ , were zero, the output would have been zero too. Also the integrator circuit's output reflects the changes in the input's amplitude. If the input amplitude changes toward positive and the negative, the output reflects these changes. This is also evident from the graphs of the three waveforms in the following attached pages.

Further more, when the input to an integrator amplifier is sine, the output waveform will be cosine. When the input is square, the output waveform is triangular. When the input is triangular, the output waveform is sinusoid.