Islamic University of Technology (IUT)
Organisation of Islamic Cooperation (OIC)
Department of Electrical and Electronic Engineering (EEE)

Student ID. : ……………

Date & Year: …………………... Working table no.: ……. Section: …….. Group:..……….…

Course: EEE 4484

Experiment no.: 03 (Digital Electronics and Pulse Techniques Lab)

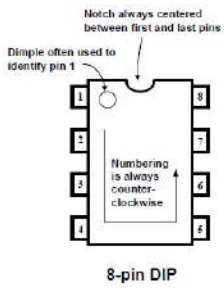
Name of the experiment: Study of Operational Amplifier as an Inverter, Inverting Amplifier, Adder, Integrator, Differentiator, Non-inverting Amplifier.

Objective:

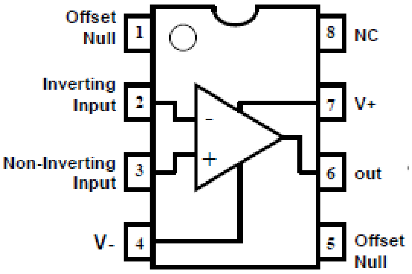
1. To study the basic use of an Op-Amplifier.
2. To observe the non-inverting amplifier operation of an Op-Amp.
3. To observe the inverting operation of an Op-Amp.
4. To observe the inverting amplifier operation of an Op-Amp.
5. To observe the adder operation of an Op-Amp.
6. To observe the integrator operation of an Op-Amp.
7. To observe the differentiator operation of an Op-Amp.

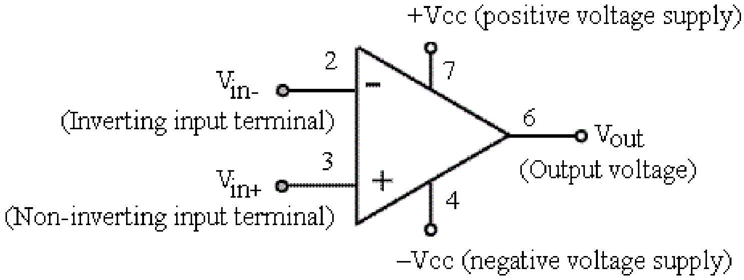
Task 1: To study the basic use of an Op-Amplifier

An operational amplifier or op-amp is a linear device that has all the properties required for nearly ideal DC-coupled voltage amplification and are therefore used extensively in signal conditioning, filtering or to perform mathematical operations such as addition, subtraction, integration and differentiation. The different types of Op-Amp IC's are LM741, LM747, LM358, LM339, LM324, TL071, TL082, CA3140. The most popular op-amp IC is the LM741, which comes in a standard eight-pin DIP package. Here are the pin connections for an LM741 op amp.

 Pin 1: Offset null Pin 2: V_{in-} (Inverting input terminal) Pin 3: V_{in+} (Non-inverting input terminal) **Pin 4: $-V_{CC}$** (Negative voltage supply) Pin 5: Offset null Pin 6: V_{out} (Output voltage) **Pin 7: $+V_{CC}$** (Positive voltage supply) Pin 8: NC (No Connection)	Look at the package closely and try to find out IC number in horizontal direction as shown in figure below. Then the lower left most pin is the Pin 1.  	Look at the package closely, you will find a notch at one end or a dot in one corner. This tells us how to find Pin 1: the dot is located next to Pin 1 and the notch is located between Pins 1 and 8. The rest of the pins are numbered like this: 

Pin 8 is not connected (NC). Pins 1 and 5 are used to eliminate the offset voltage. We won't be using this feature, so don't connect anything to these pins.

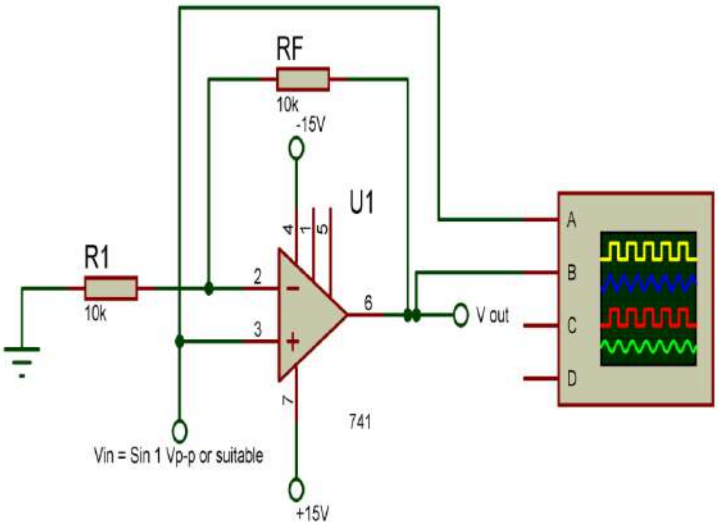


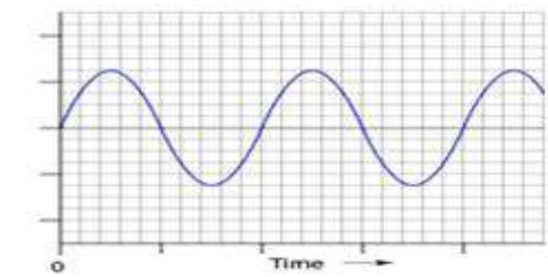


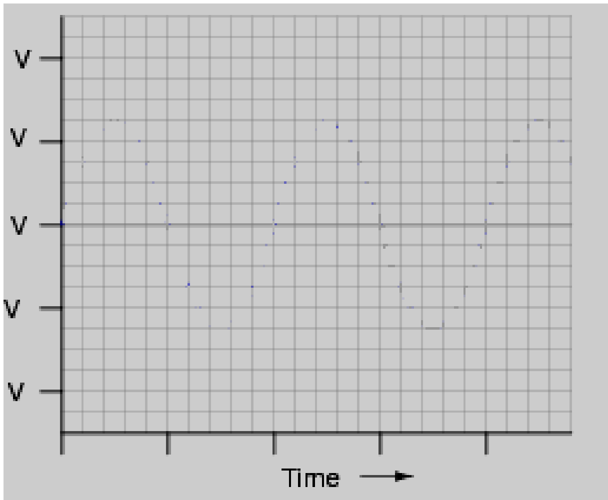
In order to function, the op-amp must be connected to an external power supply. Since we want to produce both positive and negative output voltages, we need apply both positive and negative voltages from an external power supply. V_{CC} is usually in the range from 12 to 15 volts. For a LM741, the nominal values are $+V_{CC}$ **=15 V (Pin 7) and** $-V_{CC}$ **= -15 V (Pin 4)**. If negative output voltage is not required, we can apply $-V_{CC}$ = 0 V/Ground (Pin 4).

Task 2: To observe the non-inverting amplifier operation of an op-amp.

Construct a non-inverter circuit using $R_i = R_f$ =10 kΩ. Set the function generator to produce a 1 V_{P-P}, 10kHz sine wave and apply that signal in V$_{in}$ (pin 3). Observe the output in Pin 6 and draw output wave shape.





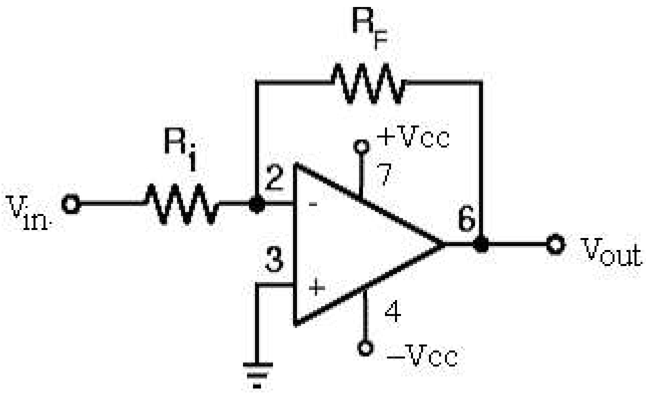


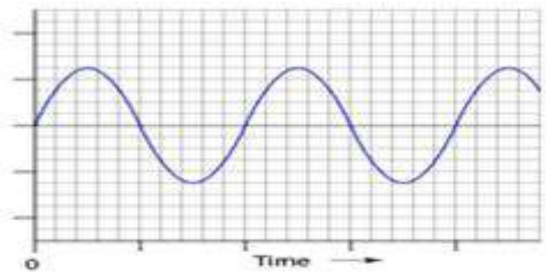
Measure the voltage gain, $A_v = \dfrac{V_{out}}{V_{in}} = \dots\dots\dots$

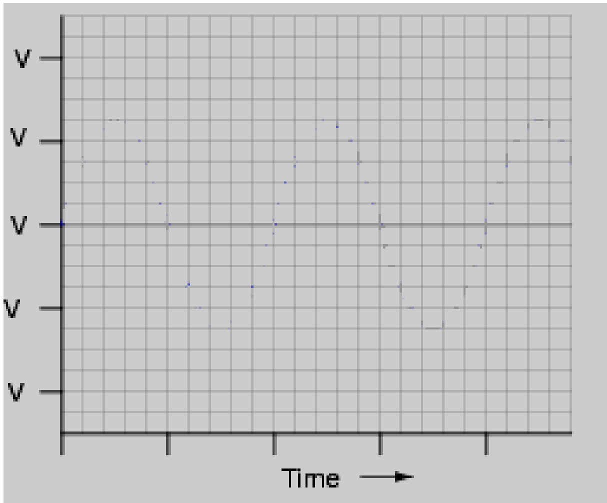
Write the output voltage equation of a non-inverting amplifier, $V_{out} = \dots\dots\dots\dots\dots\dots$

Task 3: To observe the inverting operation of an Op-Amp.

Construct a inverter circuit using $R_i = R_f$ =10 kΩ. Set the function generator to produce a 1 V_{P-P} ,10kHz sine wave and apply that signal in V_{in}. Observe the output in Pin 6 and draw output wave shape.







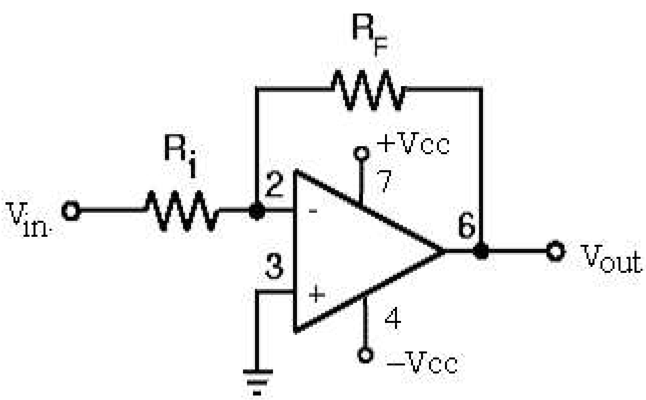
Measure the voltage gain,

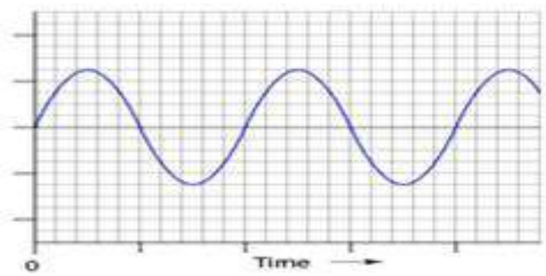
$$A_v = \frac{V_{out}}{V_{in}} = ...$$

In particular, note that the output is inverted with respect to the input.

Task 4: To observe the inverting amplifier operation of an Op-Amp.

Construct an inverting amplifier circuit using R_i =10 kΩ and R_f =20 kΩ. Set the function generator to produce a 1 V_{P-P} ,10kHz sine wave and apply that signal in V_{in}. Observe the output in Pin 6 and draw output wave shape.



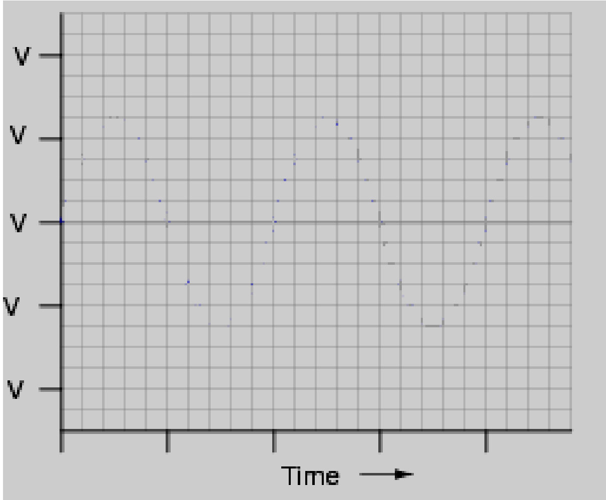


Measure the voltage gain,

$$A_v = \frac{V_{out}}{V_{in}} = ...$$

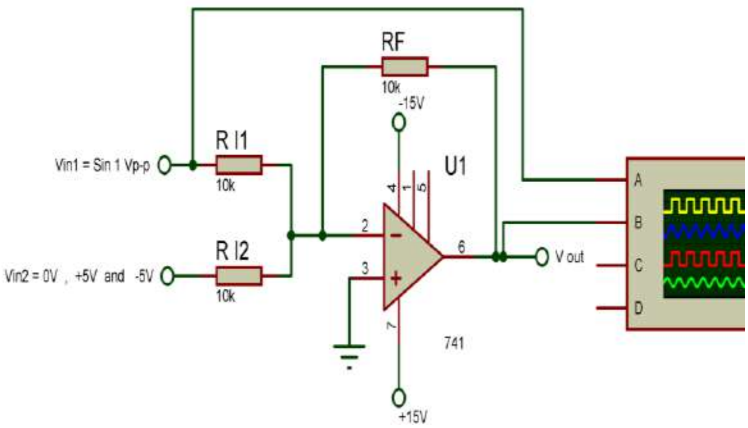
Write the output voltage equation of a inverting amplifier, $V_{out} = \ldots\ldots\ldots\ldots\ldots\ldots$

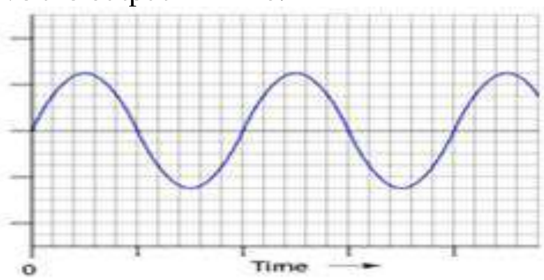
****Increase the input amplitude until output clipping occurs. Note the output clipping levels.**



Task 5: To observe the adder operation of an op-amp.

Step 1: Construct an adder circuit using $R_i = R_f$ =10 kΩ. Set the function generator to produce a $1V_{P-P}$, 10kHz sine wave and apply it in V_{in1}. Apply V_{in2} =0V. Observe the output in Pin 6.



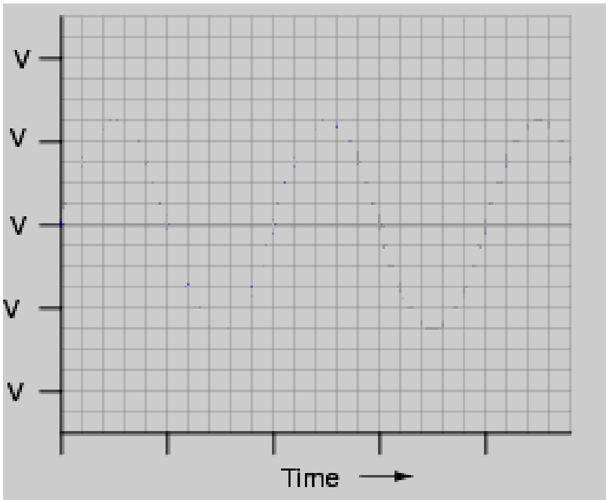


Step 2: Apply V_{in2} =+5V. Observe the output in Pin 6. Draw Output Signal.

Step 3: Apply V_{in2} =-5V. Observe the output in Pin 6.

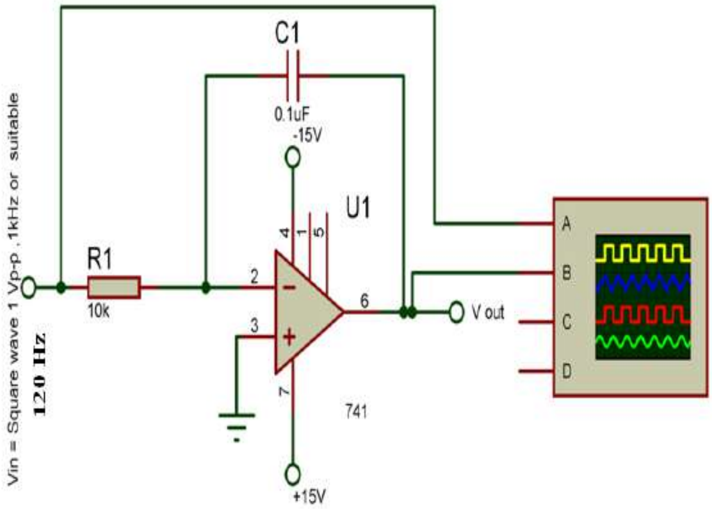
Write the output voltage equation of inverting adder amplifier,

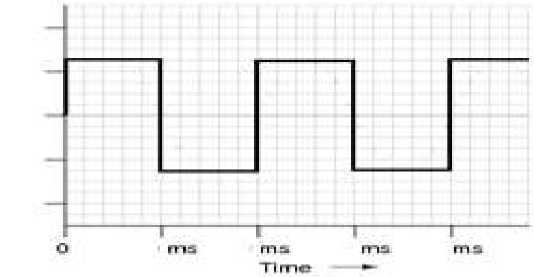
$V_{out} = \ldots\ldots\ldots\ldots\ldots\ldots$

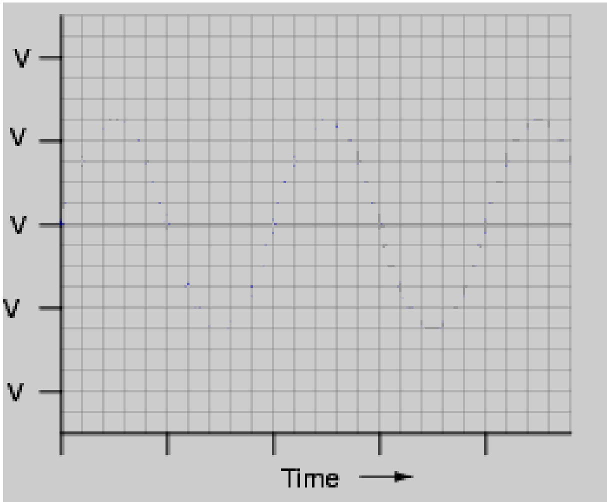


Task 6: To observe the integrator operation of an op-amp.

Construct an integrator circuit using R =10 kΩ and C =0.1μf. Set the function generator to produce a 1 V_{P-P}, 120Hz square wave and apply that signal in V_{in}. Observe the output at Pin 6 and draw output wave shape.





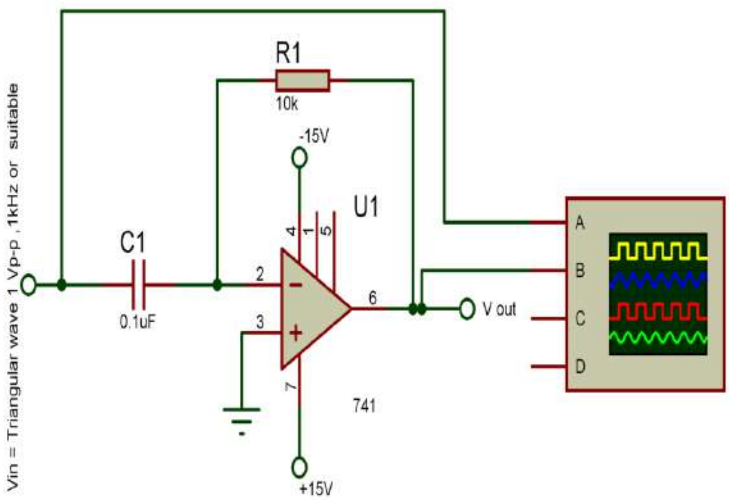


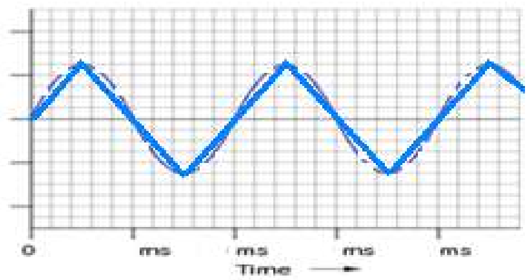
Write the output voltage equation of an integrator,

$$V_{out} = \dots\dots\dots\dots\dots\dots$$

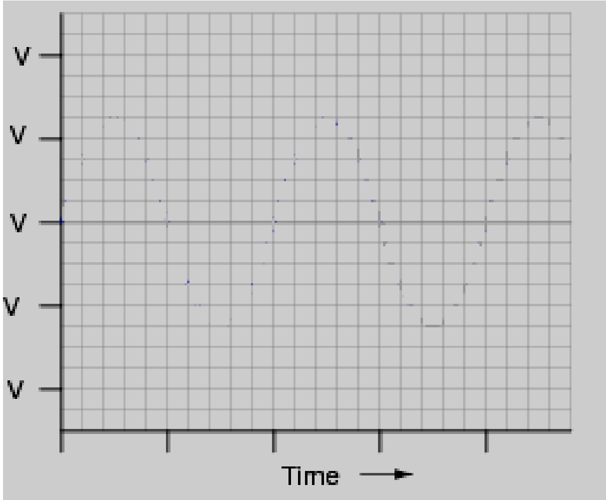
Task 7: To observe the differentiator operation of an op-amp.

Construct a differentiator circuit using C =0.1μf and R =10 kΩ. Set the function generator to produce a 1 V_{P-P}, 120Hz triangular wave and apply that signal in V_{in}. Observe the output at Pin 6 and draw output wave shape.





Write the output voltage equation of a differentiator, $V_{out} =$ ………………



Assignment:

- Construct all the circuits in different tasks in PSIM