EXPERIMENT 4
BASIC APPLICATIONS OF OPERATIONAL AMPLIFIERS

4.1 Objectives:

Basic applications of operational amplifiers (op-amp) are introduced.

4.2 Equipment List:

- Oscillator,
- Cadet
- Op-Amp (μA741),
- Resistors (1.2kΩ, 3.3kΩ, 10kΩ, 12kΩ, 2x33kΩ, 2x100kΩ),

4.3 Theoretical Backgroud – Ideal Op-Amp:

This experiment introduces operational amplifiers (op-amps). Op-amps can be used in various types of circuits such as voltage comparators, differential amplifiers, integrators, etc. Circuit symbol for an op-amp is shown in Figure 1.

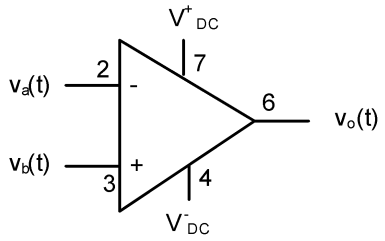


Figure 1

Here $V_a(t)$ and $V_b(t)$ are the inputs, and $V_o(t)$ is the output voltage. Op-amps are generally in the form of 8-pin Dual-in-line package (DIP) Integrated Circuits (IC), meaning their pins are distributed on the two sides of the IC, as shown in Figure 2

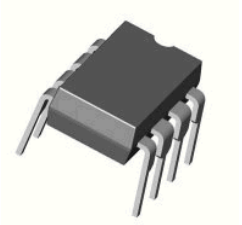


Figure 2

The numbers written around the op-amp in Figure 1 indicate the pin numbers of the IC, as shown in Figure 3.

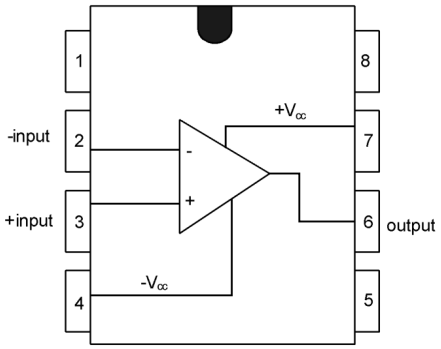


Figure 3

The properties that we are going to use in our ***ideal*** op-amp model are as follows:

- Input impedances are infinite. Therefore, there is no current on pins 2 and 3.
- The voltage at pin 3 is equal to the voltage at pin 2.

4.4 Preliminary Work:

Assume that the op-amps are ideal.

1) Find the expression relating the output voltage to the input voltage, where $v_{in}(t)=3\sin 1000\pi t$ V, and plot $v_o(t)$ versus $v_{in}(t)$ for each of the following circuits.

a.

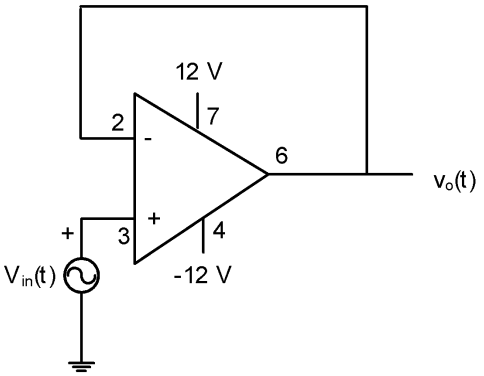


Figure 4

b.

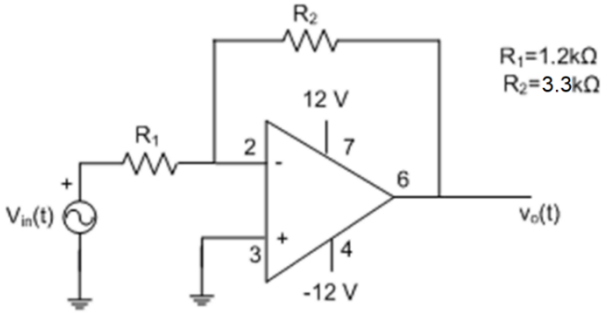


Figure 5

c.

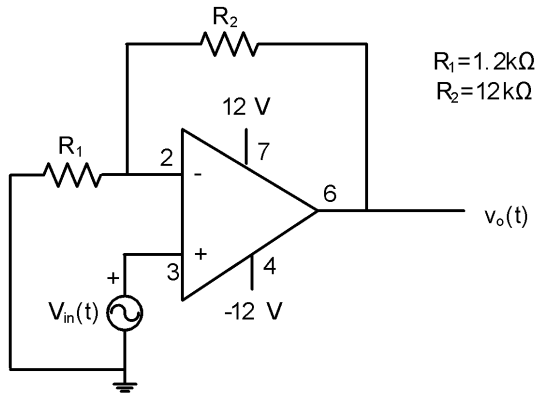


Figure 6

2) Find the expression relating $V_o(t)$ to $V_a(t)$ and $V_b(t)$, where $V_a(t)=2V_b(t)=4\sin(1000\pi t)V$, and plot $V_o(t)$ for the following circuits. Comment on the function of each circuit considering the relations between input voltages and the output voltage.

a.

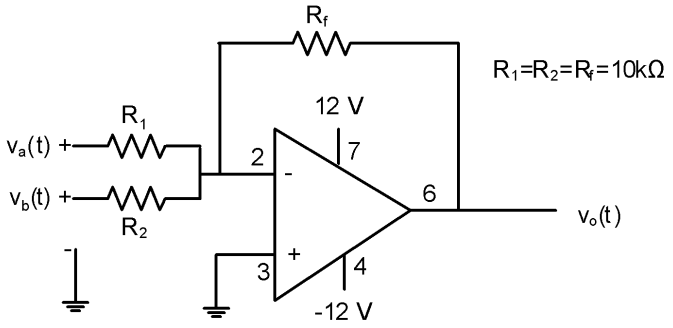


Figure 7

b.

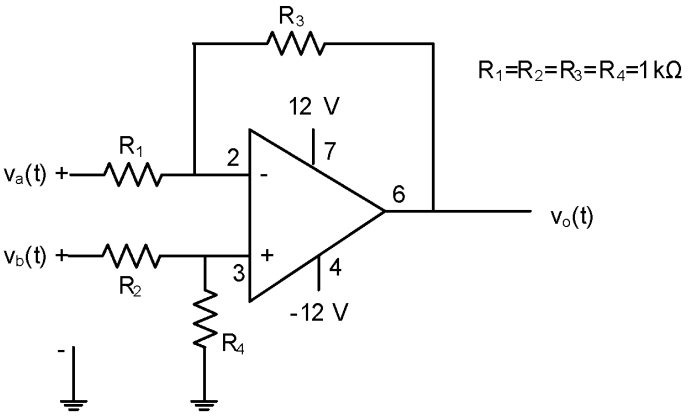


Figure 8

3) Express $V_o(t)$ in terms of $V_{in}(t)$ for the circuit below.

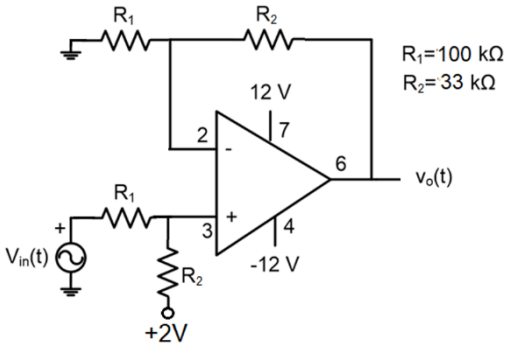


Figure 9

4.5 Experimental Work:

1)

a.) Set up the circuits in **Figure 5** and **Figure 10**. Observe $v_{in}(t)=3\sin(1000\pi t)$ and $v_o(t)$ on the oscilloscope screen at the same time. Obtain and plot v_o versus v_{in} on your report sheets. Indicate time and voltage scales clearly. State briefly and comment on the function of this circuit.

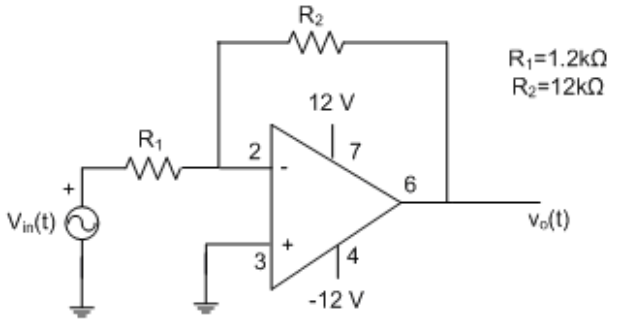


Figure 10

b.) Set up the circuits in **Figure 6**. Observe $v_{in}(t)=3\sin(1000\pi t)$ and $v_o(t)$ on the oscilloscope screen at the same time. Obtain and plot v_o versus v_{in} on your report sheets. Indicate time and voltage scales clearly. State briefly and comment on the function of this circuit.

2) Set up the circuit in **Figure 9**. Apply a ***sinusoidal*** input voltage of 2V peak-to-peak with f=500Hz. Observe $v_{in}(t)$ and $v_o(t)$ on the oscilloscope screen simultaneously. Comment on the shape of the output waveform with respect to the input waveform. Explain the relationship between input and output waveforms.

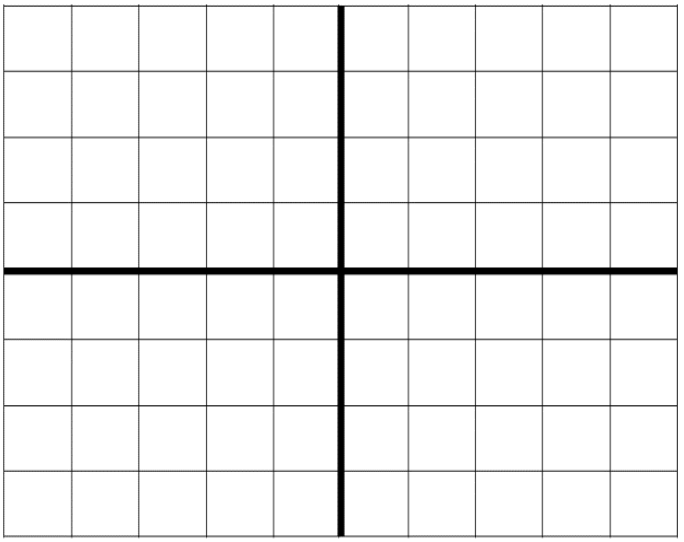
EXPERIMENT 4
REPORT SHEET

Name & Surname :

Date :

Experimental Work:

1) a.)



DSO Settings

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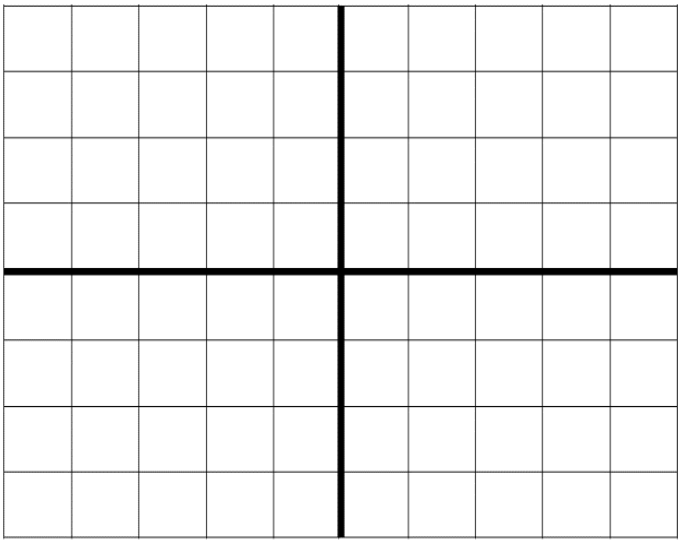

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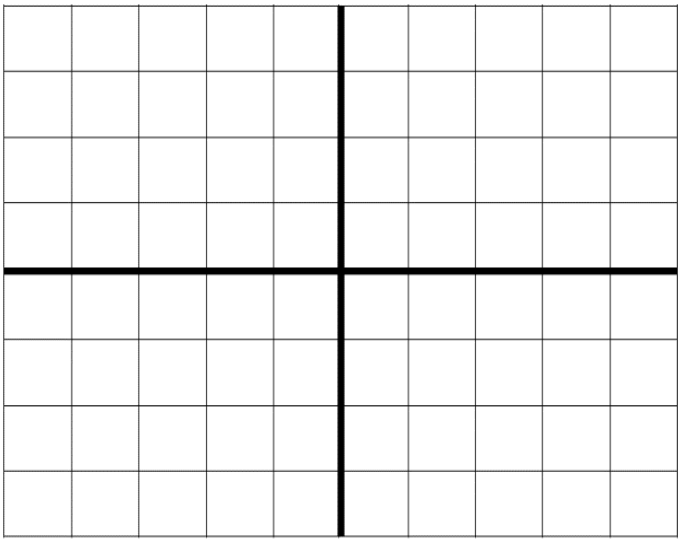
b.)



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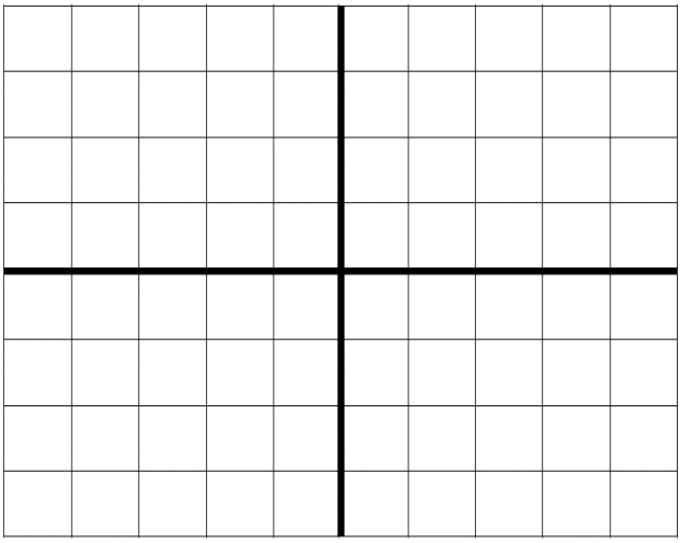

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Comments:

4) Conclusions: