General Sir John Kotelawala Defense University
Faculty of Computing
Department of Computer Engineering

2.2

BSc (Hons) in Computer Engineering
Laboratory Practical
ET1102- Basic Electronics

Experiment #2 Operational Amplifiers

Name:
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Index No
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Intake
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Date
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Instructor Name and Signature:
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Comments ……

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Grade

Objective: To introduce students to the analog IC, the operational amplifier, and to identify some of its uses.

Outcome:

After successfully completing this experiment you would be able to,

a) Implement an opamp inverting amplifier
b) Implement an opamp inverter
c) Implement a non-inverting amplifier

d) Identify an opamp comparator
e) Identify an opamp integrator
f) Identify an opamp differentiator

Equipment Required:
Audio Signal Generator
Oscilloscope
±5V/500mA DC power supply

Components Required:
741 Opamp
Resistors:– a collection
Capacitors:- a collection

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a) Implementing the inverting amplifier

Operational Amplifier, Opamp in short, is a high gain amplifier in IC form which can be used to provide a gain determined by the external components. The pin configuration of the common opamp 741 is shown in Fig:5.1.

An inverting amplifier gives an amplified output which is inverted. The inverting amplifier configuration is shown in Fig:5.2.

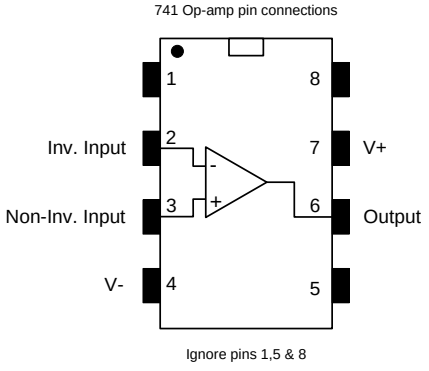

Fig: 5.1

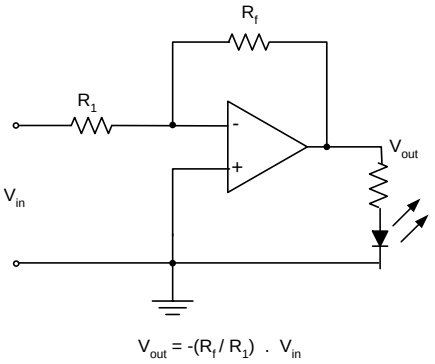

Fig: 5.2

- Implement the circuit shown in Fig:5.2 on the protoboard using the opamp 741. Use R_1=10kΩ and R_f=100kΩ.
- Apply +5V to pin number 7 and -5V to pin number 4 of the opamp.
- Connect the audio signal generator across V_{IN} terminal and ground. Select a sinusoidal signal of amplitude 400mV and frequency 10kHzand apply the signal to the opamp circuit. Observe the input signal on the CRO.

- Observe the input and output waveforms on the dual trace CRO by connecting the two CRO probes to the input and output of the circuit. Draw the observed waveforms in the space provided below and indicate their peak values.

X axis: time Y axis: voltage	

- What is the measured voltage gain, V_{OUT}(peak)/V_{IN} (peak)? = ...……
- What is the theoretical voltage gain, (R_f/R_1)? =……
- What is the phase relationship between the input and output?

……

- Change the R_f to 1MΩ and repeat the above procedure.
- What is the measured voltage gain = V_{OUT}(peak)/V_{IN} (peak)? ……
- Calculatethe theoretical voltage gain (R_f/R_1)…….……

- Compare the theoretical and experimental gains and complete the table below.

	Theoretical Gain	Measured Gain
R_1 = 10 kΩ, R_f = 100 kΩ		
R_1 = 10 kΩ, R_f = 1 MΩ		

b) Opamp inverter

In the inverting amplifier shown in Fig:5.2, if R_1=$R_f$the circuit will produce unity gain with an inverted output. This inverting amplifier configuration is known as an 'inverter'.

- In the inverting amplifier circuit in Fig:5.2, make R_1=R_f=10kΩ.

- Apply a sinusoidal signal of peak amplitude 400mV and frequency 10 kHz as before to the V_{IN} terminal.
- Apply +5V and -5V at the relevant supply terminals of the operational amplifier as before.
- Observe the input and output waveforms on the CRO.
- Draw the observed waveforms in the space provided below.

X axis: time Y axis: voltage	

What is the measured voltage gain, V_{OUT}(peak)/V_{IN}(peak)?……

What is the phase relationship between input and output? ……

c) Implementing a non-inverting amplifier

Opamp can also be used to provide amplified but non-inverted signals. Such a configuration is known as a non-inverting amplifier. In this configuration, the signal to be amplified is applied to the non-inverting input of the op-amp as shown in Fig: 5.3.

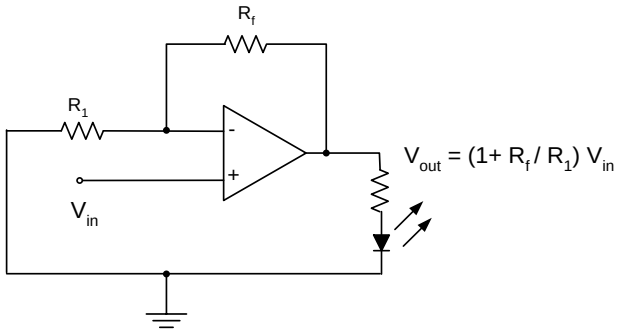

Fig: 5.3

- Build the circuit in Fig: 5.3 on the protoboard using the 741opamp, R_1=100kΩ and R_2=10kΩ and apply +5V and -5V DC power to the relevant pins of the opamp.
- Connect the signal generator across the non-inverting input, V_{IN}, and ground and apply a sinusoidal signal of 400mV peak value and frequency 10kHzas before.

- Draw the observed input and output signals in the space provided below indicating their peak values.

X axis: time Y axis: voltage	

What is the measured voltage gain, V_{OUT} (peak)/V_{IN}(peak)?.....……
What is the theoretical voltage gain, $(1+R_1/R_2)$?……...
What is the phase relationship between input and the output ?……..

(d) Implement an opamp comparator

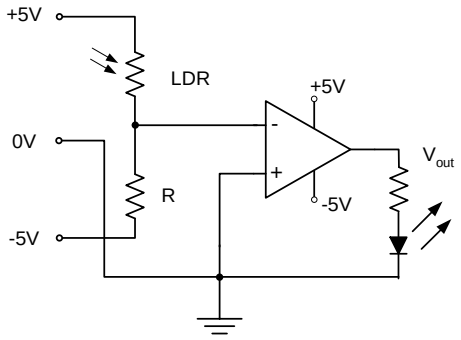

Fig:5.4

- Implement the circuit of Fig:5.4 with an LDR and a resistor R = 10K, as a potential divider.
- When the LDR is exposed to light, is the LED ON or OFF? ……..
- What is the voltage at the output? ……..…….
- When the LDR is in the dark, is the LED ON or OFF? ……....
- What is the voltage at the output? ……..…….
- Give a brief explanation of the circuit behavior as a comparator/switch.

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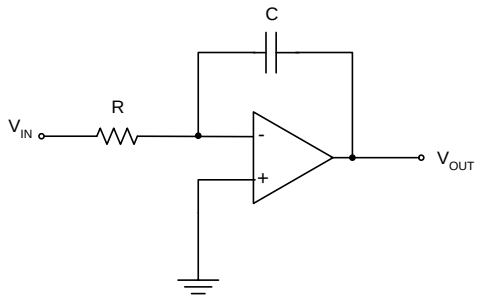
(e) Implementing an op amp integrator

The opamp can be used to integrate a voltage. The integrator circuit uses resistors and capacitors.



$$V_{OUT} = -\frac{1}{RC}\int V_{IN}\,dt + C$$

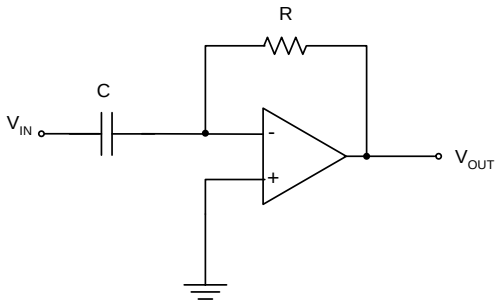
Fig: 5.5

- Build the circuit of Fig: 5.5 on the protoboard with R=100kΩ and C=220μF with the necessary dc power to the chip.
- Connect the signal generator across the inverting input and ground selecting a square waveform of 400mV peak value and 10kHz in frequency.
- Draw the observed input and output signals in the space provided below indicating their peak values. Notice that the output voltage is the integrated value of the input voltage.

X axis: time Y axis: voltage	

(f) Implementing an op amp differentiator

The opamp can also be used to produce a differentiator. The circuit can take a voltage and produce the derivative of that voltage. Once again, the circuit uses resistors and capacitors as shown in Fig: 5.6.



$$V_{OUT} = -RC\frac{dV_{IN}}{dt}$$

Fig: 5.6

- Build the circuit in Fig: 5.6 on the protoboard using 741opamp with R=100kΩ and C=220μF and apply the necessary dc power to operate the opamp, as before.

- Connect the signal generator as the input and select triangular waveform of peak value 400mV, and frequency 10kHz.
- Draw the observed input and output signals in the space provided below indicating their peak values. Notice that the output voltage is the differential of the input voltage.

X axis: time Y axis: voltage	

(g) Answer the following questions:-

1. In an inverting amplifier, if R_f=100kΩ and R_1=50kΩ, what is the voltage gain of the amplifier?
   ……

2. How would you convert an inverting amplifier to an inverter?
   ……

3. In a non- inverting amplifier circuit, if R_1=20kΩ and R_2=5kΩ, what is the voltage gain of the amplifier?
   ……

4. Draw an opamp circuit diagram which will take a DC signal of magnitude 20V and give an output of 5V.

Performance Evaluation

Experiment: Combinational and Sequential Logic Circuit

	Evaluation Aspect	Marks
1	Preparation	
2	Neatness of Work	
3	Familiarity with Lab Equipment	
4	Completion of Work	
5	Capability	
6	Accuracy of Readings/ Observations	
7	Answers given to Questions	
8	Discipline	
	Total	

Marks are awarded on a 0-10 scale for each aspect

Excellent	Very Good	Good	Fair	Poor	Very Poor
10	9 – 8	7 – 6	5 – 4	3 – 2	1 – 0

Name of the Instructor: ……

Signature: …….

Date: …….