KARPAGAM ACADEMY OF HIGHER EDUCATION
(Deemed to be University Established Under Section 3 of UGC Act, 1956)

SEMESTER II

17PHU212 ANALOG SYSTEMS AND APPLICATIONS (PRACTICAL)

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Any 6 experiments

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt`s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.

20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a $1^{st}/2^{nd}$ order differential equation.

REFERENCE BOOKS:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

SYLLABUS

LIST OF PRACTICALS

1. To study V-I characteristics of PN junction diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
4. To design an summing and difference amplifier using Op-amp (741,351) .
5. To design Inverting and non-inverting amplifier using Op-amp (741,351) & study its frequency response
6. To investigate the use of an op-amp as an Integrator and Differentiator.

DIODE CHARACTERSTICS

Aim:

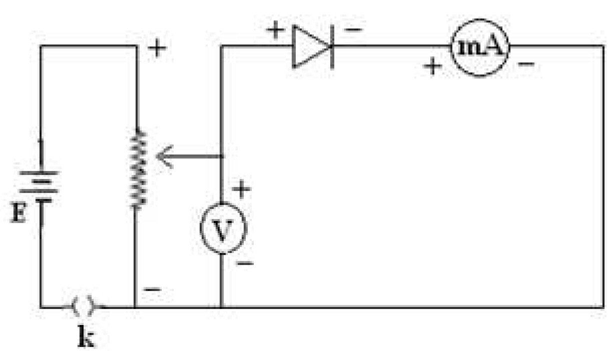
To draw VI characterstics of a PN function diode and find knee voltage and forward resistance.

Apparatus:

- A p-n junction diode
- 3 V battery
- 50 V battery
- High resistance rheostat
- 0-3 V voltmeter
- 0-50 V voltmeter
- 0-100 mA ammeter
- 0-100 μA ammeter
- One way key
- Connecting wires

Procedure:

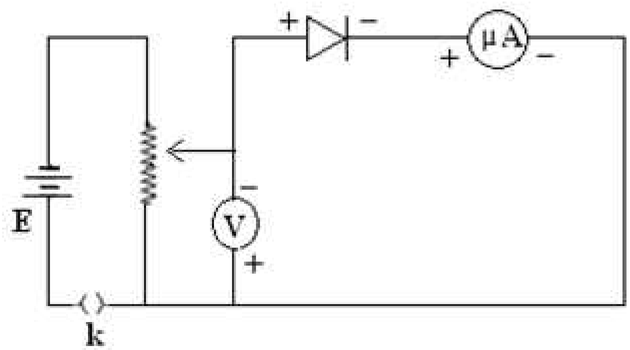
Forward V-I Characteristics :



- Connections are made as per the connection diagram.
- Insert the key. Arrange the sliding contact of the rheostat to minimum.
- Now, gently move the rheostat contact to provide a positive bias voltage.

- Note the voltmeter and milli ammeter readings.
- Repeat the process by increasing the forward current in equal steps by changing the rheostat slider.
- It can be noted that, initially the current increase very slowly. For a certain value of voltage, it shows a sharp increase. The corresponding voltage represents the knee voltage of that diode.
- Plot a graph with forward voltage along X axis and forward current along Y axis. The graph shows the forward V-I characteristics of the given p-n junction diode.

Reverse V-I Characteristics :



- Make the circuit diagram as shown in the figure.
- Insert the key. Arrange the sliding contact of the rheostat to maximum.
- Move the sliding contact of the rheostat to provide a reverse bias voltage.Note the voltmeter and micro ammeter readings.
- Note the voltmeter and micro ammeter readings.
- Repeat the process by changing the reverse voltage in equal steps.
- The current increases slowly in the beginning and then rapidly when the reverse voltage becomes a certain value. This voltage is known as the reverse breakdown voltage.
- Plot a graph with reverse voltage along X axis and reverse current along Y axis. The graph shows the reverse V-I characteristics of the given p-n junction diode.

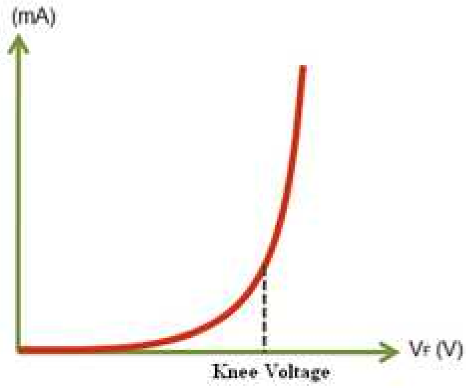
Observations:

Forward V-I Characteristics :

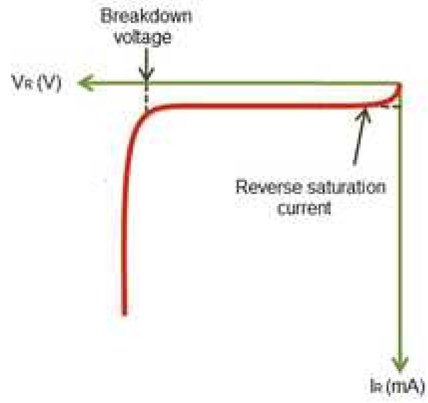
Sl. No.	Forward bias voltage, V_f (V)	Forward current, I_f (mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Reverse V-I Characteristics :

Sl. No.	Reverse bias voltage, V_r (V)	Reverse current, I_r (μA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		



Forward Characteristics



Reverse Characteristics

Result

The forward and reverse characteristics of the given p-n junction diode is drawn.

ZENER DIODE

Aim :

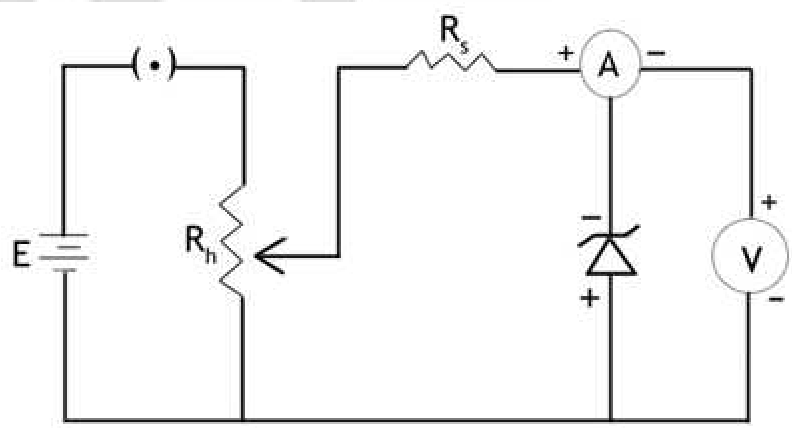
To draw the characterstics of zener diode and determine the breakdown voltage.

Apparatus:

- Battery
- Rheostat
- Small resistance (200 Ω)
- Milliammeter
- Voltmeter
- Key
- Zener diode

Procedure:

- Connections are made as shown in the circuit diagram.



- By adjusting the rheostat, voltmeter reading is increased from 0 and in each time note the corresponding reading in milliammeter.
- The experiment is continued till the milliammeter shows a large deflection while the voltmeter reading remains a constant, indicating the break down voltage.
- Plot the reverse characteristic curve by taking reverse voltage along –ve X-axis and reverse current along –ve Y-axis.

- The break down voltage Vz is obtained from the graph as shown below..

Observations:

Least count of voltmeter = ...V

Zero error of voltmeter = ...V

Least count of milli-ammeter = ...mA

Zero error of milli-ammeter = ...mA

Trial No.	Reverse Voltage (V)	Reverse Current (mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Result:

- The reverse characteristic curve of the Zener diode is obtained.

- The reverse breakdown voltage of the Zener diode, V = …………V

TRANSISTOR CHARACTERISTICS

Aim:

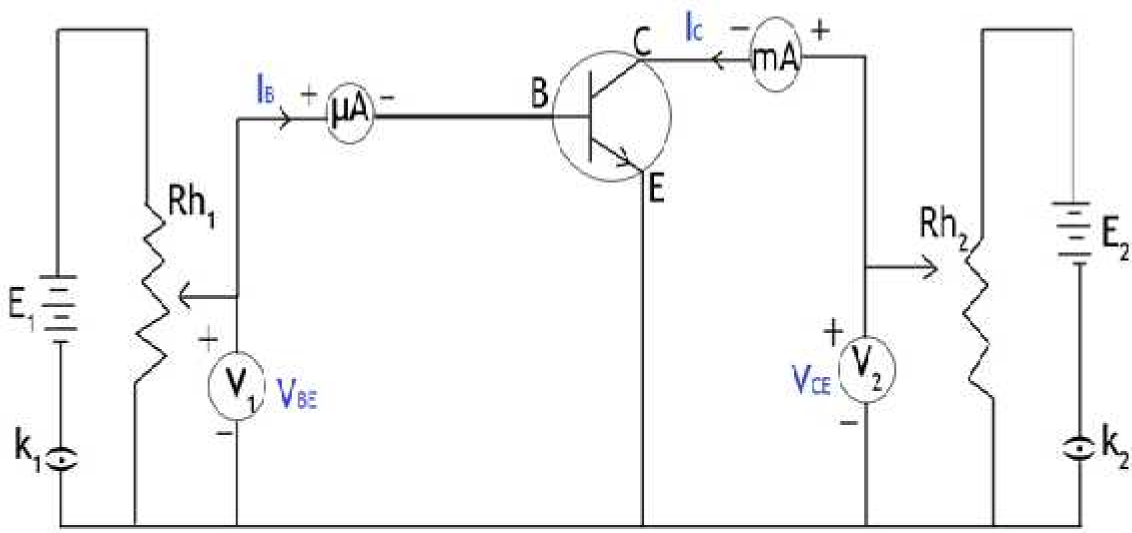
Draw input and output characterstics of NPN transistor in common emitter configuration.

Apparatus:

- Rheostat
- Voltmeter
- Ammeter
- Battery
- One way key
- Transistor
- Bread board

Procedure:

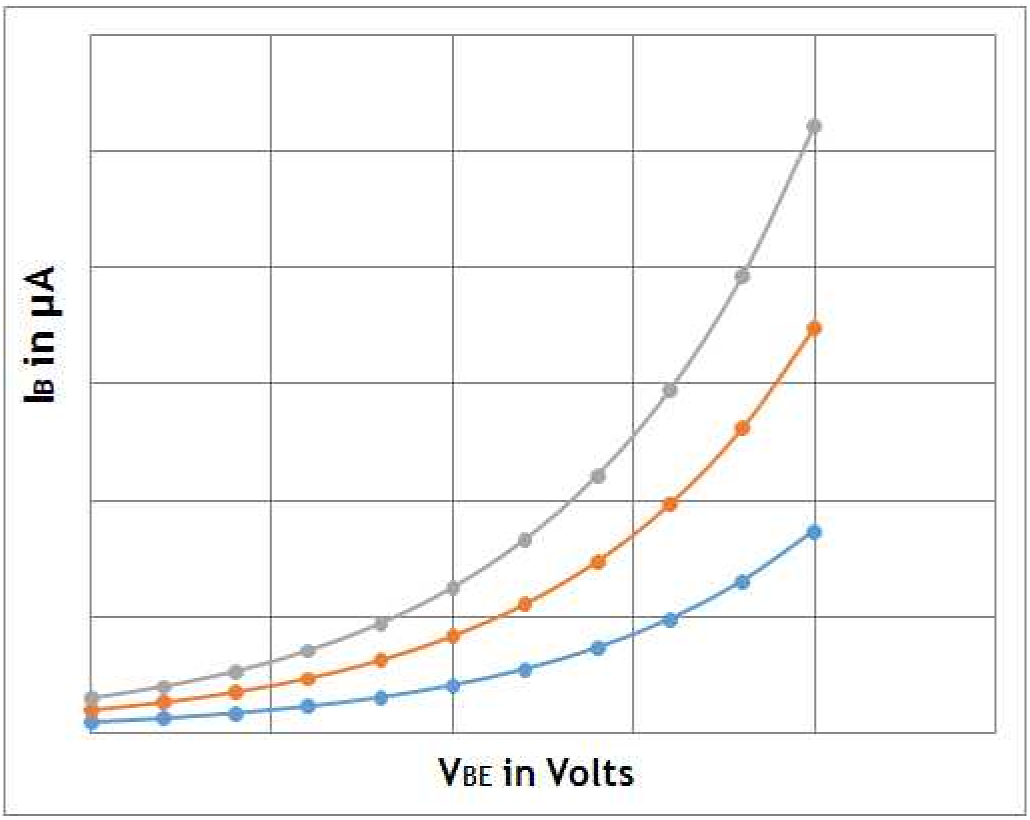
- Connections are made as shown in the circuit diagram.



- The rheostat Rh_1 is used to vary base voltage (input voltage) V_{BE} and it is read from voltmeter V_1. The base current (input current) I_B is measured using a microammeter (μA). The collector voltage (output voltage) V_{CE} is varied using the rheostat Rh_2 and readings are noted from voltmeter V_2. The collector current (output current) I_C is measured by the milliammeter (mA).

Input Characteristics

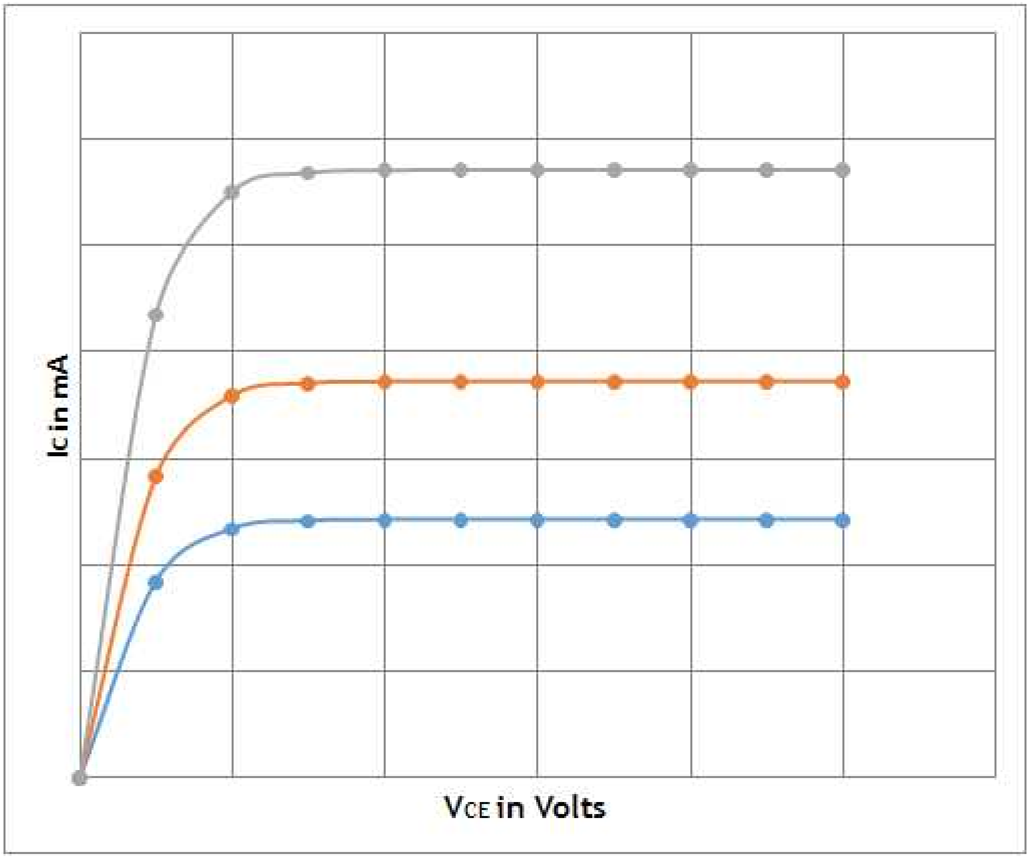
- The collector voltage V_{CE} is kept constant (eg. 1V) by adjusting the rheostat Rh_2.
- The base voltage V_{BE} is varied from zero by adjusting the rheostat Rh_1.
- The base current I_B is noted in each step.
- A graph is drawn with V_{BE} along X-axis and I_B along Y-axis.
- The experiment is repeated with V_{CE} kept constant say 2V, 3V, 4V etc. and corresponding graphs are plotted.



Output characteristics

- The base current I_B is kept constant (eg. 20μA) by adjusting the rheostat Rh_1.
- Now the collector voltage is increased by adjusting the rheostat Rh_2.
- The corresponding collector current I_C is noted.

- A graph is drawn with V_{CE} along X-axis and I_C along Y-axis.
- The experiment is repeated with keeping IB constant, say 40µA, 60µA, 80µA etc and similar graphs are plotted.



Observations:

Input characteristics

V_{CE} (1V)	V_{BE} (V)			
	I_B (µA)			
V_{CE} (2V)				
V_{CE} (3V)				
V_{CE} (4 V)				

Output characteristics

I_B (μA)	V_{CE} (V)			
	I_C (mA)			
I_B (μA)				
I_B (μA)				
I_B (μA)				

Results:

The graphs shows the input and output characteristics of a transistor.

INVERTING AND NON-INVERTING AMPLIFIER

Aim:

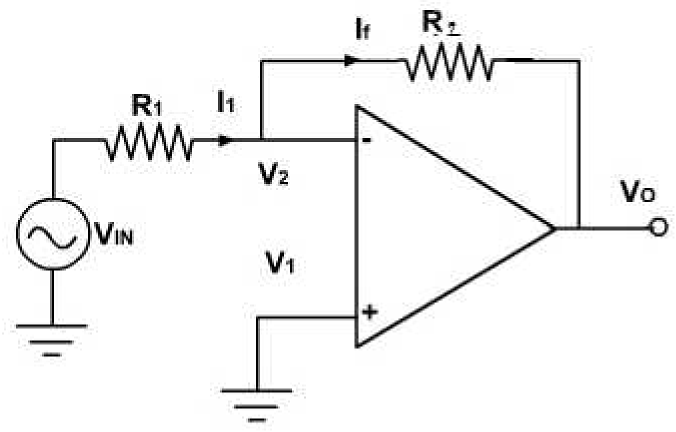
TO construct an inverting voltage amplifier and non-inverting amplifier using IC741 and to find the closed loop voltage gain.

Apparatus

Function generator, CRO, Regulated Power supply, resistor, capacitor, 741 IC, connecting wires.

Theory:

An inverting-amplifier circuit is built by grounding the positive input of the operational amplifier and connecting resistors R1 and R2, called the feedback networks, between the inverting input and the signal source and amplifier output node, respectively. With assumption that reverse-transfer parameter is negligibly small, open-circuit voltage gain Av, input resistance Zin and output resistance Zo can be calculated.

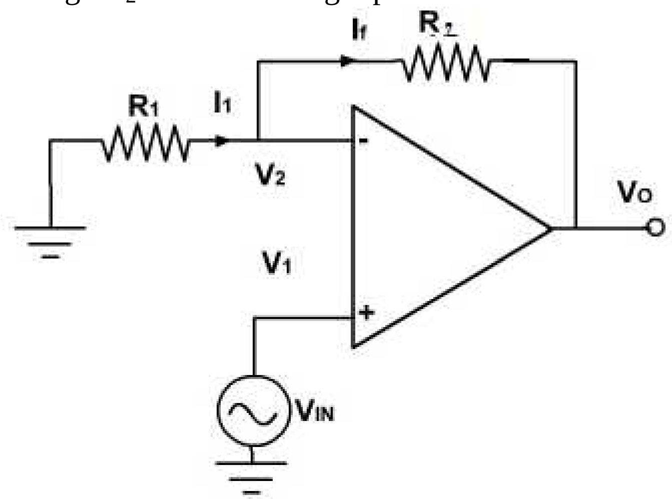


Inverting Amplifier configuration of an op-amp

Non Inverting Amplifier:

The operational amplifier can also be used to construct a non-inverting amplifier with the circuit indicated below. The input signal is applied to the positive or non-inverting input terminal of the operational amplifier, and a portion of the output signal is fed back to the negative input terminal. Analysis of the circuit is performed by relating the voltage at V_2 to both the input voltage V_{in} and the output voltage V_o.
The output is applied back to the inverting (-) input through the feedback circuit (closed loop)

formed by the input resistor R_1 and the feedback resistor R_2. This creates ve feedback as follows. Resistors R_1 and R_2 form a voltage-divider circuit, which reduces V_o and connects the reduced voltage V_2 to the inverting input.



Procedure:

Inverting Amplifier:

1. Connect the circuit as shown in the circuit diagram.
2. Give the input signal as specified.
3. Switch on the power supply.
4. Note down the outputs from the CRO
5. Draw the necessary waveforms on the graph sheet.

Non inverting Amplifier:

1. Connect the circuit as shown in the circuit diagram.
2. Measure the input and output voltage from the input and output waveform in the CRO.
3. Switch on the power supply.
4. Note down the outputs from the CRO
5. Draw the necessary waveforms on the graph sheet

Formula:

Inverting Amplifier:

$$V_o = -\frac{R_2}{R_1} V_{in}$$

Non inverting Amplifier:

$$V_o = (1 + \frac{R_2}{R_1})V_{in}$$

Observation:

Inverting Amplifier

Input voltage Vi(v)	Ri (Ω)	Rf (Ω)	Output voltage (Vo)	Gain (Vo/Vi)	Rf/Ri

Non inverting Amplifier

Input voltage Vi(v)	Ri (Ω)	Rf (Ω)	Output voltage (Vo)	Gain (Vo/Vi)	1+(Rf/Ri)

Result:

The inverting and non inverting IC741 is constructed.

Closed loop gain of inverting amplifier=

Closed loop gain of non inverting amplifier=

SUMMING AND DIFFERENCE AMPLIFIER

Aim:

To construct inverting summing and non-inverting amplifiers and subtractor using amplifiers.

Apparatus:

IC 741, constant power supply, regulated power supply, resistors, etc.

Formula:

1) Inverting summing amplifier $V_0 = \frac{Rf}{Ri}(V_1+V_2)$

Where $V_0 = -(V_1+V_2)$

$Rf = Ri$

2) Non-inverting summing amplifier $V_0 = 1 + \frac{Rf}{Ri} * \frac{(V1+V2)}{2}$

If $Rf = Ri$

$V_0 = V1+V2$

3) Subractor $V_0 = V1-V2$

Procedure:

1) Inverting summing amplifier:
   1 Connections are made as shown in the figure.
   2 Input voltages V1 and V2 are given to the inverting terminal Pin 2 of IC 741 through resistor r1 and r2. Non inverting terminal Pin 3 of IC741 is connected to ground. Rf is the feedback resistance. Inverted output is obtained at pin 6 of IC741.

2) Non-inverting summing amplifier:

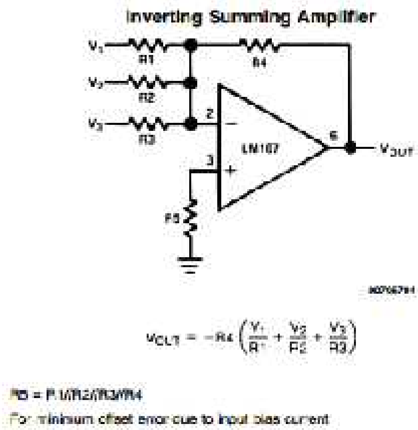
1 Connections are made as shown in the figure.

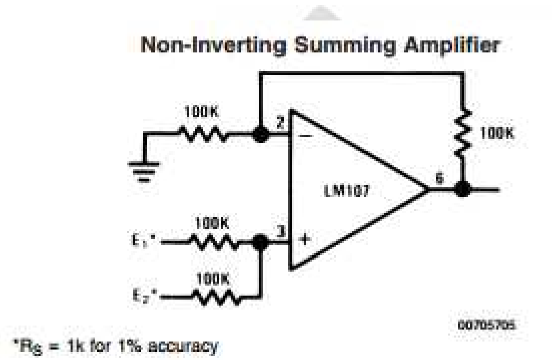
2 Input voltages V1 and V2 are given to the non-inverting terminal Pin 3 of IC 741 through resistor r1 and r2. Inverting terminal Pin 2 of IC741 is connected to ground. Rf is the feedback resistance. Inverted output is obtained at pin 6 of IC741.

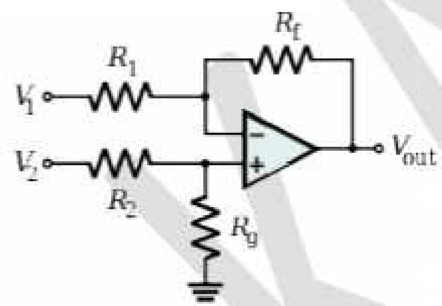
` 3)Subractor:

1 Connections are made as shown in the figure.

2 Input voltages V1 is given to the inverting terminal Pin 2 of IC 741 through resistor r1. The second input voltage is given to non inverting terminal Pin 3 of IC741. Rf is the feedback resistance. Inverted output is obtained at pin 6 of IC741







Observation:

Inverting Amplifier:

V1	V2	$V_0 = -(V_1+V_2)$

Non-inverting amplifier:

V1	V2	V_0 = V1+V2

Subtractor:

V1	V2	V_0 = V2-V1

Result:

The inverting ,non inverting and subtracting amplifiers are constructed using operation amplifiers.

DIFFERENTIATOR AND INTEGRATOR

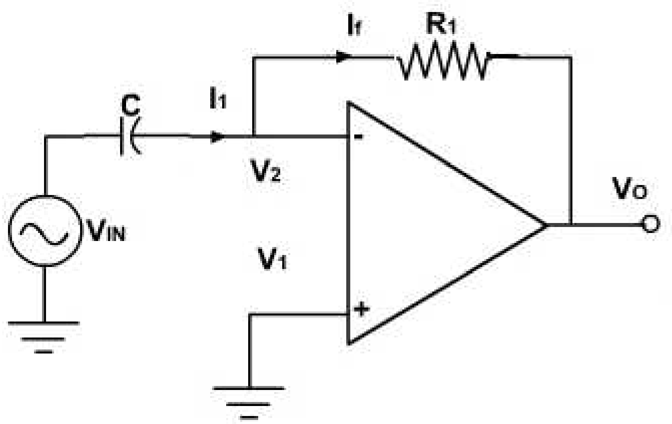
Aim:

To construct a differentiator and integrator using operational amplifiers and verify the output.

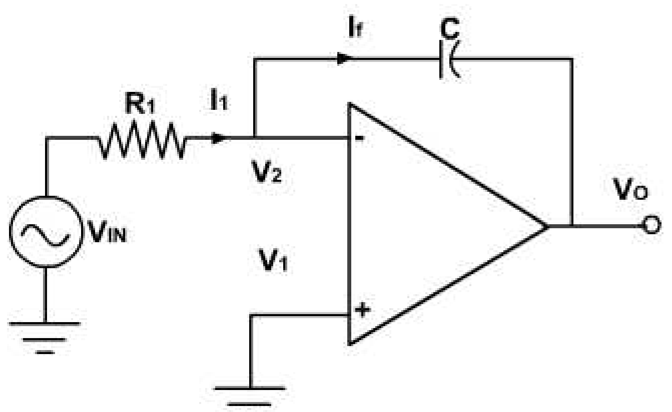
Components required:

Function generator, CRO, Regulated Power supply, resistor, capacitor, 741 IC, connecting wires.

Circuit



The differentiator Circuit



The integrator Circuit

Procedure:

Differentiator:

1. Connect the circuit as shown in the circuit diagram.
2. Give the input signal as specified.
3. Switch on the power supply.

4. Note down the outputs from the CRO
5. Draw the necessary waveforms on the graph sheet.

Integrator:

1. Connect the circuit as shown in the circuit diagram.
2. Give the input signal as specified.
3. Switch on the power supply.
4. Note down the outputs from the CRO
5. Draw the necessary waveforms on the graph sheet.

Result:

The differentiator and integrator are constructed using operational amplifier and output is verified.