GOVT CO-ED POLYTECHNIC

BYRON BAZAR RAIPUR (C.G.)

LAB MANUAL

Branch : Electrical Engineering

Year & Semester : 2nd Year / 3rd Semester

2025364(025) – Basic Electronics (Lab)

CONTENTS

Experiment No: 1

AIM: To plot V-I Characteristics of Silicon based PN Junction diodes

Components Required:

Components:

Name	Quantity
Diodes 1N4007(Si)	1
Diodes DR-25(Ge)	1
Resistor 1KΩ	1

Equipment:

Name	Range	Quantity
Bread board		1
Regulated power supply	0-30V	1
Digital Ammeter	0-200µA/200mA	1
Digital Voltmeter	0-20V	1
Connecting Wires		

Theory

Donor impurities (pentavalent) are introduced into one-side and acceptor impurities into the other side of a single crystal of an intrinsic semiconductor to form a p-n diode with a junction called depletion region (this region is depleted off the charge carriers). This region gives rise to a potential barrier called Cut-in Voltage. This is the voltage across the diode at which it starts conducting. The P-N junction can conduct beyond this potential.

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected the cathode. Then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage. Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current from n-side (injected minority current – due to holes crossing the junction and entering P- side of the diode). Assuming current flowing through the diode to be very large, the diode can be approximated as short- circuited switch.

If –ve terminal of the input supply is connected to anode (p-side) and +ve terminal of the input supply is connected to cathode (n-side) then the diode is said to be reverse biased. In this condition an amount equal to reverse biasing voltage increases the height of the potential barrier at the junction. Both the holes on P-side and electrons on N-side tend to move away from the junction there by increasing the depleted region. However, the process cannot continue indefinitely, thus a small current called reverse saturation current continues to flow in the diode. This current is negligible hence the diode can be approximated as an open circuited switch.

The volt-ampere characteristics of a diode explained by the following equations:

$$I = I_0 \left(e^{\frac{V_D}{\eta \, V_T}} - 1 \right)$$

Where I = current flowing in the diode, I_0 = reverse saturation current
V_D = Voltage applied to the diode,
V_T = volt- equivalent of temperature = k T/q = T/ 11,600 = 26mV (@ room temp)
η = 1(for Ge) and 2 (for Si)

It is observed that Ge diodes has smaller cut-in-voltage when compared to Si diode. The reverse saturation current in Ge diode is larger in magnitude when compared to silicon diode.

Circuit Diagram:

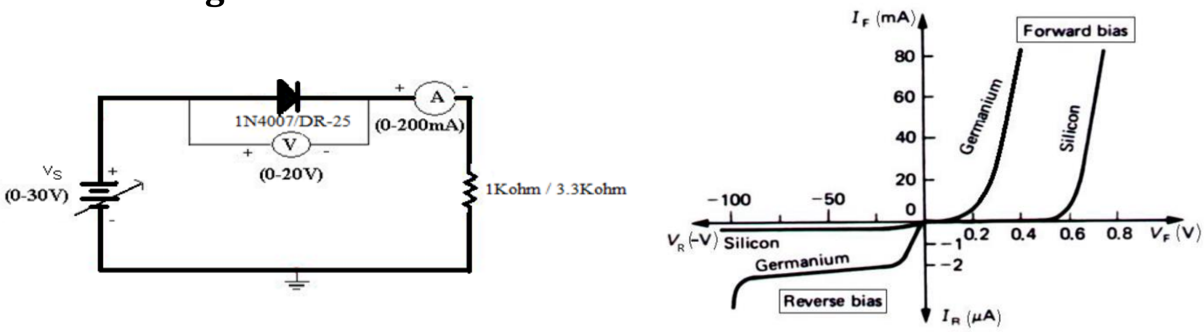


Fig. 1.1: Circuit diagram showing PN Junction under forward biased Connection & its VI Characteristics

Procedure:

- Connect the components as shown in the Fig.1.1.
- Vary the supply voltage such that the voltage across the Silicon diode varies from 0 to 0.6 V in steps of 0.1 V and in steps of 0.02 V from 0.6 to 0.76 V. In each step record the current flowing through the diode as I.
- Repeat the above but with the diode under reverse biased configuration & plot the VI characteristics based on the reading noted in previous steps.

Observation Table:

S.No.	Forward Voltage across the diode V_d (Volt)	Forward Current through the diode I_d (mA)

Precautions:

1. While doing the experiment do not exceed the readings of the diode. This may lead to damaging of the diode.
2. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Result:

Cut in voltage = ____ V

Static Forward Resistance = ______

Dynamic Forward Resistance = ______

Static Reverse Resistance = ______

Dynamic Reverse Resistance = ______

Thus, the V-I Characteristics of Silicon P-N Junction Diode has been studied successfully.

Viva-Voce:

Q 1. What are trivalent and pentavalent impurities?

Q 2. How PN junction diode does acts as a switch?

Q 3. What is the value of Vt at room temperature?

Q 4. What is cut-in-voltage?

Experiment No: 2

AIM: To plot V-I Characteristics of Zener Diode

Components Required:

Components:

Name	Quantity
Zener Diodes 1N4735A/ FZ 5.1	1
Resistor 1K Ω	1

Equipments:

Name	Range	Quantity
Bread board		1
Regulated power supply	0-30V	1
Digital Ammeter	200mA	1
Digital Voltmeter	0-20V	1
Connecting Wires		

Theory

Zener diode is a heavily doped Silicon diode. An ideal P-N junction diode does not conduct in reverse biased condition. A Zener diode conducts excellently even in reverse biased condition. These diodes operate at a precise value of voltage called break down voltage. A Zener diode when forward biased behaves like an ordinary P-N junction diode. A Zener diode when reverse biased can undergo avalanche break down or zener break down.

Avalanche Break down:

If both p-side and n-side of the diode are lightly doped, depletion region at the junction widens. Application of a very large electric field at the junction increases the kinetic energy of the charge carriers which collides with the adjacent atoms and generates charge carriers by breaking the bond, they in-turn collides with other atoms by creating new charge carriers, this process is cumulative which results in the generation of large current resulting in Avalanche Breakdown.

Zener Break down:

If both p-side and n-side of the diode are heavily doped, depletion region at the junction reduces, it leads to the development of strong electric field and application of even a small voltage at the junction may rupture covalent bond and generate large number of charge carriers. Such sudden increase in the number of charge carriers results in Zener break down.

Circuit Diagram:

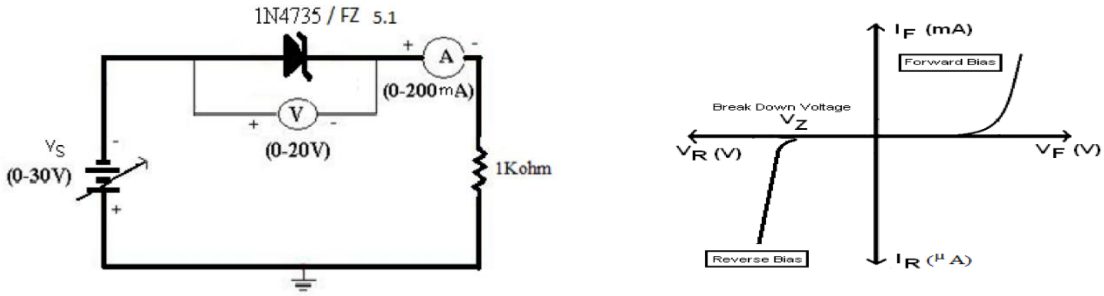


Fig. 2.1: Circuit diagram showing Zener diode under reverse biased Connection & its VI Characteristics

Procedure:

- Connect the Zener diode in reverse bias as shown in the fig.2.
- Vary the voltage across the diode in steps of 1V from 0 V to 6 V and in steps of 0.1 V till its breakdown voltage is reached.
- In each step note the current flowing through the diode
- Plot a graph between V and I. This graph will be called the V-I characteristics of Zener diode. From the graph find out the breakdown voltage for the diode.

Observation Table:

S. No.	Reverse Voltage across the diode V_r (Volt)	Zener Current through the diode I_d (mA)
1		
2		
3		

Result:

Thus, the Zener Diode Characteristics have been studied successfully.

Viva-Voce:

Q 1. What is the difference between p-n Junction diode and zener diode?
Q 2. What is break down voltage?
Q 3. What are the applications of Zener diode?
Q 4. What is voltage regulator?
Q 5. What is peak inverse voltage?

Experiment No: 3

AIM: To study operation of Half Wave and Full Wave Rectifier without Filter.

Components Required:

Components:

Name	Quantity
Diodes 1N4007(Si)	2
Resistor 1K Ω	1

Equipments:

Name	Range	Quantity
CRO	(0-20)MHz	1
CRO probes		2
Digital Ammeter, Voltmeter	[0-200μA/200mA], [0-20V]	1
Transformer	220V/9V, 50Hz	1
Connecting Wires		

Theory

A rectifier is a circuit that converts a pure AC signal into a pulsating DC signal or a signal that is a combination of AC and DC components.

A half wave rectifier makes use of single diode to carry out this conversion. It is named so as the conversion occurs for half input signal cycle. During the positive half cycle, the diode is forward biased and it conducts and hence a current flows through the load resistor. During the negative half cycle, the diode is reverse biased and it is equivalent to an open circuit, hence the current through the load resistance is zero. Thus the diode conducts only for one half cycle and results in a half wave rectified output.

A full wave rectifier makes use of a two diodes to carry out this conversion. It is named so as the conversion occurs for complete input signal cycle. The full-wave rectifier consists of a center-tap transformer, which results in equal voltages above and below the center-tap. During the positive half cycle, a positive voltage appears at the anode of D1 while a negative voltage appears at the anode of D2. Due to this diode D1 is forward biased it results in a current Id1 through the load R. During the negative half cycle, a positive voltage appears at the anode of D2 and hence it is forward biased. Resulting in a current Id2 through the load at the same instant a negative voltage appears at the anode of D1 thus reverse biasing it and hence it doesn't conduct.

S. No.	Particulars	Type of Rectifier	
		Half-Wave	Full-Wave
1.	No. of diodes	1	2
2.	Maximum Rectification Efficiency	40.6%	81.2%
3.	$V_{d.c}$ (no load)	$\frac{V_m}{\pi}$	$\frac{2V_m}{\pi}$
4.	Ripple Factor	1.21	0.48
5.	Peak Inverse Voltage	V_m	$2V_m$
6.	Output Frequency	f	2f
7.	Transformer Utilization Factor	0.287	0.693

Circuit Diagram:

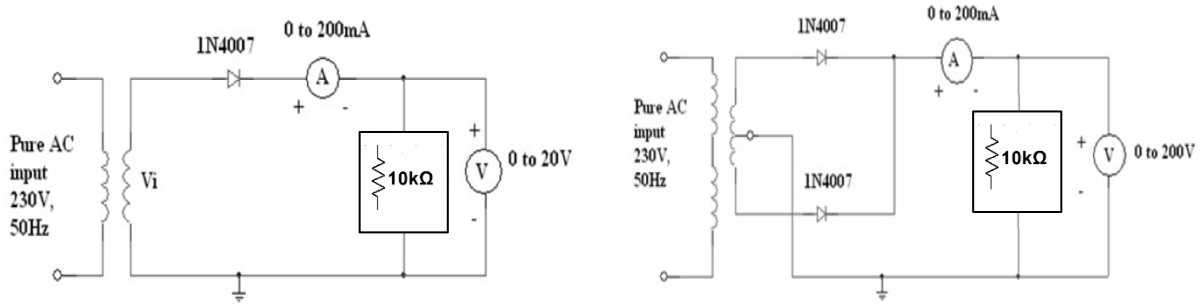


Fig 3.1: Circuit Diagram Showing Half Wave and Full Wave Rectifier.

Procedure:

PART-I: Half wave rectifier without filter

- Connect the circuit as shown in the fig. 3.1
- Connect the multimeter across the 1kΩ load.
- Measure the AC and DC voltages by setting multimeter to ac and dc mode respectively.
- Now calculate the ripple factor using the following formula.

$$\text{Ripple factor } (\gamma) = \frac{V_{AC}}{V_{DC}}$$

- Connect the CRO channel-1 across input and channel-2 across output i.e load and observe the input and output Waveforms.
- Now calculate the peak voltage of input and output waveforms and also the frequency.

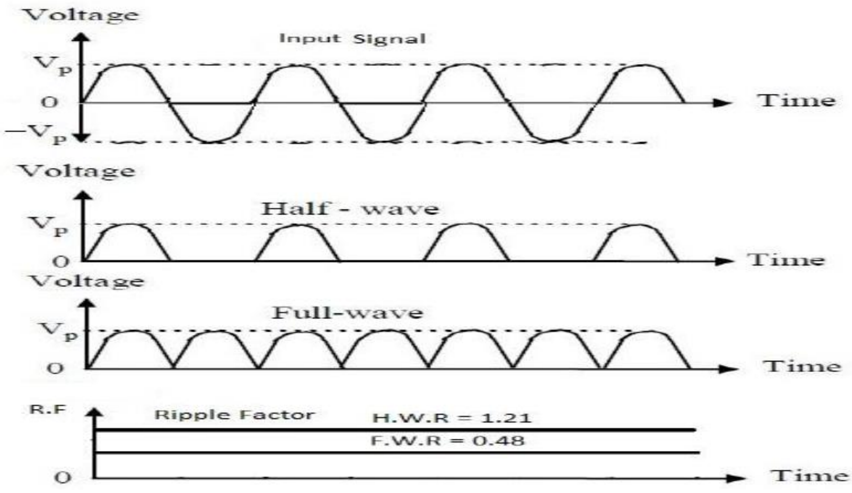
PART-II: Full wave rectifier without filter

- Connect the circuit as shown in the fig.3.1.
- Repeat the above steps
- Plot different graphs for wave forms and calculate ripple factor

Observation Table:

Load Resistance (R_L)	V_{AC}(V)	V_{DC}(V)	Ripple Factor $\gamma=\frac{Vac}{Vdc}$	Input Signal		Output Signal	
				Vm p-p(v)	Frequency (Hz)	Vm p-p(v)	Frequency (Hz)

Expected Waveforms:



Result:

Thus, the Half Wave and Full Wave rectifier characteristics are studied successfully.

Viva-Voce:

Q 1. What is a rectifier?

Q 2. What is the definition of efficiency?

Q 3. What is peak inverse voltage (PIV)?

Q 4. What are the applications of rectifier?

Experiment No: 4

AIM: To study operation of Half Wave and Full Wave Rectifier with Filter.

Components Required:

Components:

Name	Quantity
Diodes 1N4007(Si)	2
Resistor 1KΩ	1
Capacitor 100µF	2
Inductor (35 mH),	1

Equipment:

Name	Range	Quantity
CRO	(0-20)MHz	1
CRO probes		2
Digital Ammeter, Voltmeter	[0-200µA/200mA], [0-20V]	1
Transformer	220V/9V, 50Hz	1
Connecting Wires		

Theory

A rectifier is a circuit that converts a pure AC signal into a pulsating DC signal or a signal that is a combination of AC and DC components. In DC supplies, a rectifier is often followed by a filter circuit which converts the pulsating DC signal into pure DC signal by removing the AC component. An L-section filter consists of an inductor and a capacitor connected in the form of an inverted L. A π- section filter consists of two capacitors and one induction in the form symbol pi. These filters reduce the amount of ripple content present in the rectifier output.

Circuit Diagram:

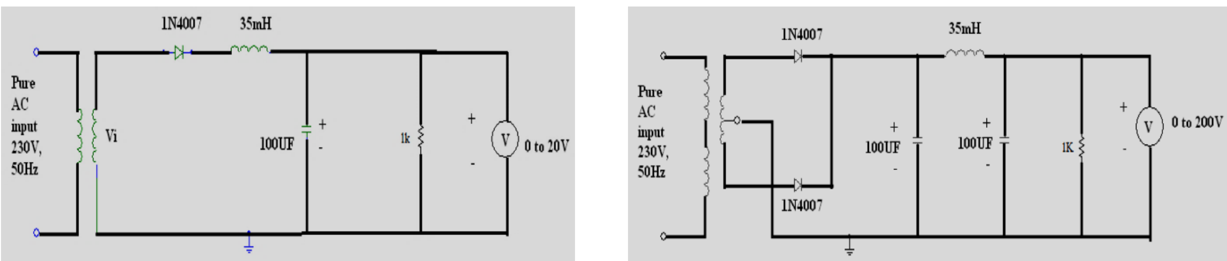


Fig 4.1: Circuit Diagram Showing Half Wave and Full Wave Rectifier with Filters.

Procedure:

PART-I: Half wave rectifier with LC filter

- Connect the circuit as shown in the fig. 4.1
- Connect the multimeter across the 1kΩ load.
- Measure the AC and DC voltages by setting multimeter to ac and dc mode respectively.
- Now calculate the ripple factor using the following formula.

$$\text{Ripple factor } (\gamma) = \frac{V_{AC}}{V_{DC}}$$

- Connect the CRO channel-1 across input and channel-2 across output i.e load and observe the input and output Waveforms.
- Now calculate the peak voltage of input and output waveforms and also the frequency.

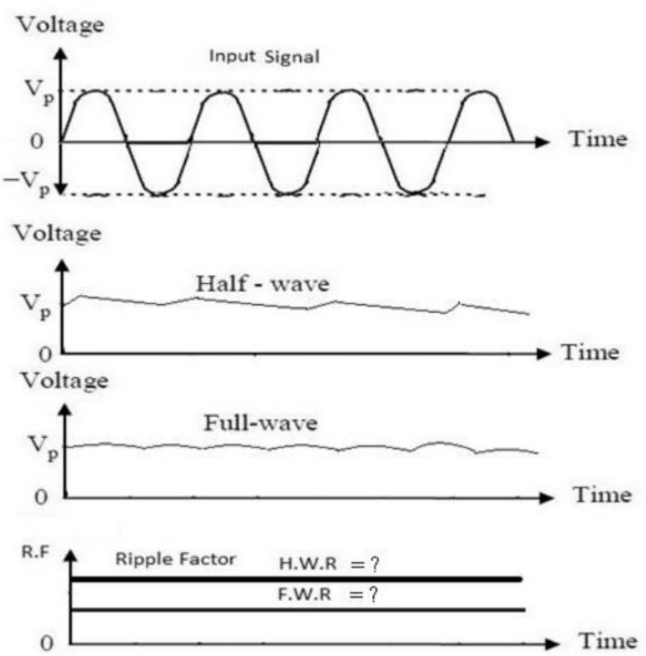
PART-II: Full wave rectifier with pi-filter

- Connect the circuit as shown in the fig. 4.1.
- Repeat the above steps
- Plot different graphs for wave forms and calculate ripple factor

Observation Table:

Load Resistance (R_L)	V_{AC}(V)	V_{DC}(V)	Ripple Factor $\gamma=\frac{Vac}{Vdc}$	Input Signal		Output Signal	
				Vm p-p(v)	Frequency (Hz)	Vm p-p(v)	Frequency (Hz)

Expected Waveforms:



Result:

Thus, the Half Wave and Full Wave rectifier with filters, have been studied successfully.

Viva-Voce:

Q 1. What is a rectifier?

Q 2. What is the definition of efficiency?

Q 3. What is peak inverse voltage (PIV)?

Q 4. What are the applications of rectifier?

Q 5. What is a filter?

Q 6. In filters, capacitor is always connected in parallel, why?

Experiment No: 5

AIM: To study input & output characteristics of BJT in Common Emitter Configuration.

Components Required:

Components:

Name	Quantity
Transistor BC 107	1
Resistor 1KΩ	1

Equipment:

Name	Range	Quantity
Bread Board		1
Regulated power supply	0-30V	2
Digital Ammeter	0-200mA/0-200µA	1
Digital Voltmeter	0-20V	2
Connecting Wires		

Theory

A BJT is called as Bipolar Junction Transistor and it is a three terminal active device which has emitter, base and collector as its terminals. It is called as a bipolar device because the flow of current through it is due to two types of carriers i.e., majority and minority carriers.

A transistor can be in any of the three configurations viz, Common base, Common emitter and Common Collector.

The relation between α, β, γ of CB, CE, CC are

$$\alpha = \frac{\beta}{1+\beta} \qquad \beta = \frac{\alpha}{1-\alpha} \qquad \gamma = 1+\beta = \frac{1}{1-\alpha}$$

In CE configuration base will be input node and collector will be the output node .Here emitter of the transistor is common to both input and output and hence the name common emitter configuration.

The collector current is given as

$$I_C = \beta I_B + (1+\beta)I_{CO}$$

A transistor in CE configuration is used widely as an amplifier. While plotting the characteristics of a transistor the input voltage and output current are expressed as a function of input current and output voltage.

i.e, $V_{BE} = f(I_B, V_{CE})$ and

$I_C = f(I_B, V_{CE})$

Transistor characteristics are of two types.

Input characteristics:- Input characteristics are obtained between the input current and input voltage at constant output voltage. It is plotted between V_{BE} and I_B at constant V_{CE} in CE configuration.

Output characteristics:- Output characteristics are obtained between the output voltage and output current at constant input current. It is plotted between V_{CE} and I_C at constant I_B in CE configuration.
The different regions of operation of the BJT are

Emitter Junction	Collector Junction	Region	Application
RB	RB	CUTT OFF	OFF SWITCH
FB	FB	SATURATION	ON SWITCH
FB	RB	ACTIVE	AMPLIFIER
RB	FB	REVERSE ACTIVE	ATTENUATOR

Circuit Diagram:

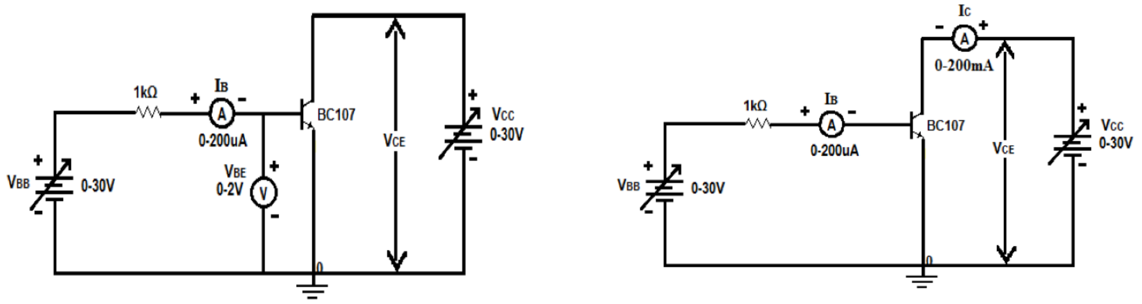


Fig 5.1: Circuit Diagram for Input and Output Characteristics of BJT in Common Emitter Configuration.

Procedure:

Input Characteristics:

- Connect the circuit as shown in fig. 5.1. Adjust all the knobs of the power supply to their minimum positions before switching the supply on.
- Adjust the V_{CE} to 0 V by adjusting the supply V_{CC}.
- Vary the supply voltage V_{BB} so that V_{BE} varies in steps of 0.1 V from 0 to 0.5 V and then in steps of 0.02 V from 0.5 to 0.7 V. In each step note the value of base current I_B.
- Adjust V_{CE} to 1, 2 V and repeat step-3 for each value of V_{CE}.
- Plot a graph between V_{BE} and I_B for different values of V_{CE}. These curves are called input characteristic

Output Characteristics:

- Connect the circuit as shown in fig. 5.1. All the knobs of the power supply must be at the minimum position before the supply is switched on.
- Adjust the base current I_B to 20 µA by adjusting the supply V_{BB}.
- Vary the supply voltage V_{CC} so that the voltage V_{CE} varies in steps of 0.2 V from 0 to 2 V and then in steps of 1 V from 2 to 10 V. In each step the base current should be adjusted to the present value and the collector current I_C should be recorded.
- Adjust the base current at 40, 60 µA and repeat step-3 for each value of I_B.

- Plot a graph between the output voltage V_{CE} and output current I_C for different values of the input current I_B. These curves are called the output characteristics.

Observation Table:

Input Characteristics

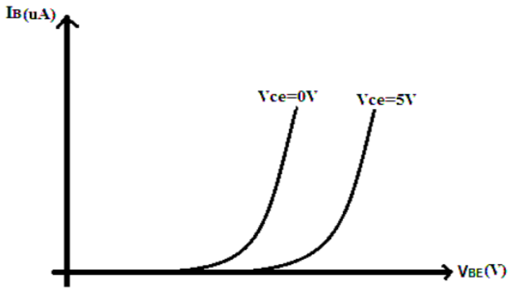
$V_{CE} = 0V$		$V_{CE} = 2V$	
$V_{BE}(V)$	$I_B(\mu A)$	$V_{BE}(V)$	$I_B(\mu A)$

Output Characteristics

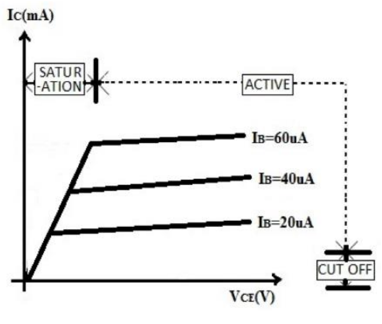
$I_B = 20\mu A$		$I_B = 40\mu A$		$I_B = 60\mu A$	
$V_{CE}(V)$	$I_C(mA)$	$V_{CE}(V)$	$I_C(mA)$	$V_{CE}(V)$	$I_C(mA)$

Expected Graph:

Input Characteristics



Output Characteristics



Result:

Thus, the input & output characteristics of BJT in Common Emitter Configuration has been studied successfully.

Viva-Voce:

Q 1. What is a transistor?

Q 2. Can we replace transistor by two back to back connected diodes?

Q 3. For amplification CE is preferred, why?

Q 4. What is the range if β?

Experiment No: 6

AIM: To study applications of Operational Amplifier as adder & subtractor.

Components Required:

IC741, Regulated DC power supply (2), Resistors (10 kΩ(4), 1kΩ(2)), multimeter, Signal generator, CRO, CRO probes, Bread board and jumper wires.

Theory

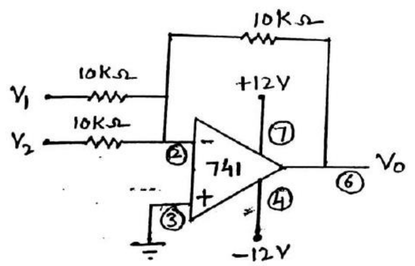
The Operational amplifier (Op-amp) is a high gain, direct coupled, differential amplifier with high input resistance & low output resistance. It is named so as it can be used to perform a number of mathematical operations, like addition, subtraction, comparison, integration & differentiation etc.

A circuit in which the output voltage is sum of the inputs is called an adder amplifier.

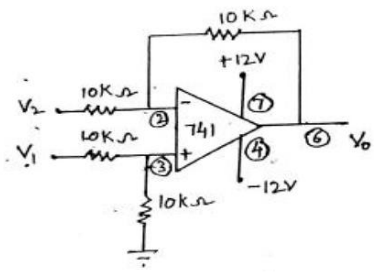
A circuit in which the output voltage is difference between the inputs is called a subtractor amplifier.

Circuit Diagram:

Inverting Adder Ckt



Subtractor Ckt



Procedure:

- Connect the circuits as shown in Fig. above.
- Apply the inputs from a regulated power supply.
- Measure the output voltage using a multimeter.
- Repeat the above steps for different values of inputs.

Observation Table:

Inverting Adder

S. No.	V_1	V_2	V_o

Subtractor

S. No.	V_1	V_2	V_o

Result:

Thus, the Operational amplifier is studied as Adder and Subtractor, and their outputs are verified successfully.

Viva-Voce:

Q 1. What are the properties of ideal op-amp?

Q 2. What do you mean by virtual ground concept?

Q 3. What is gain-bandwidth product?