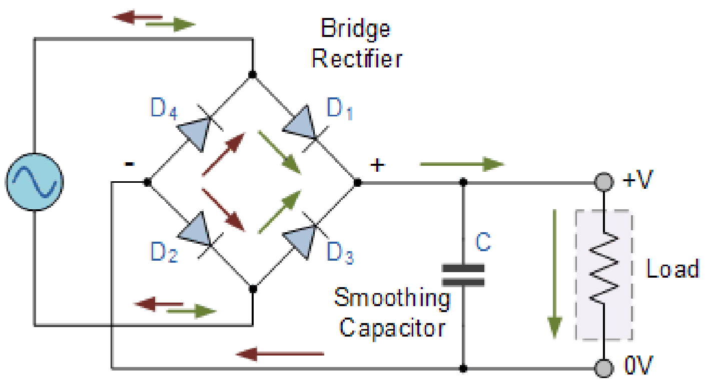
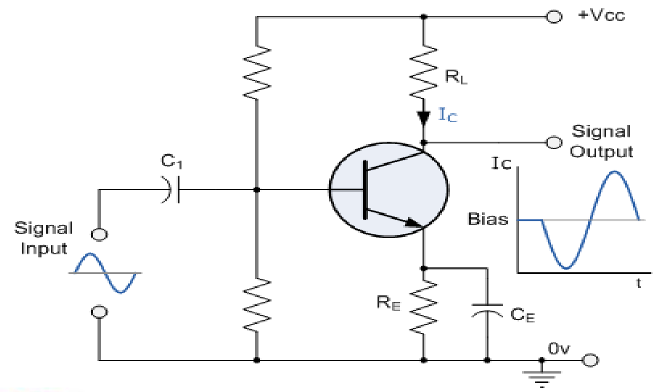
ELECTRONIC DEVICES AND CIRCUITS LABORATORY MANUAL (ECE-218)

(II/IV ECE & EEE 1st Semester for AU Curriculum)

(II/IV EEE 1st Semester for Autonomous Curriculum)





PRAGNANAM BRAHMA

ANITS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES

(Affiliated to AU, Approved by AICTE & Accredited by NBA)

SANGIVALASA-531 162, Bheemunipatnam Mandal, Visakhapatnam District

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2014

Mission

The Department aims to bring out competent young Electronics & Communication Engineers by achieving excellence in imparting technical skills, soft skills and the right attitude for continuous learning.

Objective

The objective of this laboratory is to understand the concepts,working and characteristics of Different Diodes, BJT and FET Transistors, amplifiers and compensation techniques of transistors.

Course Outcomes

1. An ability to verify the working of different diodes, transistors, CRO probes and measuring instruments. Identifying the procedure of doing the experiment.
2. An ability to design the circuits with basic semiconductor devices (active & passive elements), measuring instruments & power supplies that serves many practical purposes.
3. An ability to construct, analyze and troubleshoot the designed circuits.
4. Ability to measure and record the experimental data, analyze the results, and prepare a formal laboratory report.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2						3		
CO2	2	2	3	3							3	
CO3	2	3	3	3							3	
CO4	3	3	2	3						3		

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High)

Assessment CO matrix:

EDC Internal Lab Exam Assessment type	Course Outcomes			
	CO1	CO2	CO3	CO4
Record(20M)	30%	20%		30%
Design (10M)		50%	30%	10%
Implementation(10M)		20%	30%	
Results & Viva(10M)	10%	10%		40%

CO-PSO Mapping:

CO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1
CO2	3	3	2	1
CO3	3	3	2	1
CO4	3	3	2	1

MAJOR EQUIPMENT IN
ELECTRONIC DEVICES AND CIRCUITS LABORATORY

S.NO	DESCRIPTION	MAKE	QUANTITY
1.	20 MHz, 25MHz&30MHz DUAL TRACE OSCILLOSCOPE	SCIENTECH/SCIENTIFIC/ CADDO/FALCON	33
2.	1 MHz FUNCTION GENERATOR WITH DIGITAL DISPLAY	SCIENTECH/SCIENTIFIC/ SYSTRONICS/FUTURE TECH/METRAVI/APLAB	33
3.	TRPS 0-30V, 2A DUAL CHANNEL	ITL HYD/FALCON	20
4.	TRPS 0-30V, 2A SINGLE CHANNEL	ITL HYD	10
5.	AC MICRO VOLTMETER	SYSTRONICS	10
6.	DC MICRO VOLTMETER	SYSTRONICS	10
7.	BENCH TOP DIGITAL MULTIMETER	METRAVI/APLAB	13
8.	31/2 DIGITAL MULTIMETER	CIE	16

TOTAL EXPENDITURE OF LABORATORY : Rs. 12,79,992.29

ELECTRONIC DEVICES AND CIRCUITS LABORATORY MANUAL (ECE-218)

(II/IV ECE & EEE 1st Semester)

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INTRODUCTION

"A practical approach is probably the best approach to mastering a subject and gaining a clear insight."

Electronic Devices and Circuits Laboratory Manual covers those practical oriented electronic circuits that are very essential for the students to solidify their theoretical concepts. This Manual provides a communication bridge between the theory and practical world of the electronic circuits. The knowledge of these practicals is very essential for the engineering students.

This book comprises of three sections. The first section consists of Diode circuits. Some of the very useful diode based circuits are discussed in this section. Labs concerning over this part of the Manual basically provides the elementary knowledge of the subject.The second section of the Manual describes the Bipolar Junction Transistor based circuits. Different configurations of BJT amplifier are discussed in this part of the book. Each and every practical provides a great in depth practical concepts of BJT.

Field Effect Transistor (FET); one of the leading technology in electronics is discussed in third and the final section of this Manual. It gives the introduction to the FET based electronic circuits.

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1. Study of Cathode Ray Oscilloscope

Objective: To understand the operation of the CRO and to learn how to determine the Amplitude

Time period and Frequency of a given waveform using CRO

Apparatus:

S.No	Apparatus	Type	Range	Quantity
01	CRO			01
02	Function Generator		10-1MHz	01
03	Regulated Power supply		(0-30V)	01
04	Audio frequency probe			01

Introduction: CRO is an electronic device which is capable of giving a visual indication of a signal waveform. With an oscilloscope the waveform of the signal can be studied with respect to amplitude distortion and deviation from the normal. Oscilloscope can also be used for measuring voltage, frequency and phase shift.

Cathode Ray Tube**:** Cathode Ray Tube is a heart of Oscilloscope providing visual display of the input signals. CRT consists of three basic parts.

1.Electron Gun.

2.Deflecting System.

3.Flouroscent Screen

These essential parts are arranged inside a tunnel shaped glass envelope.

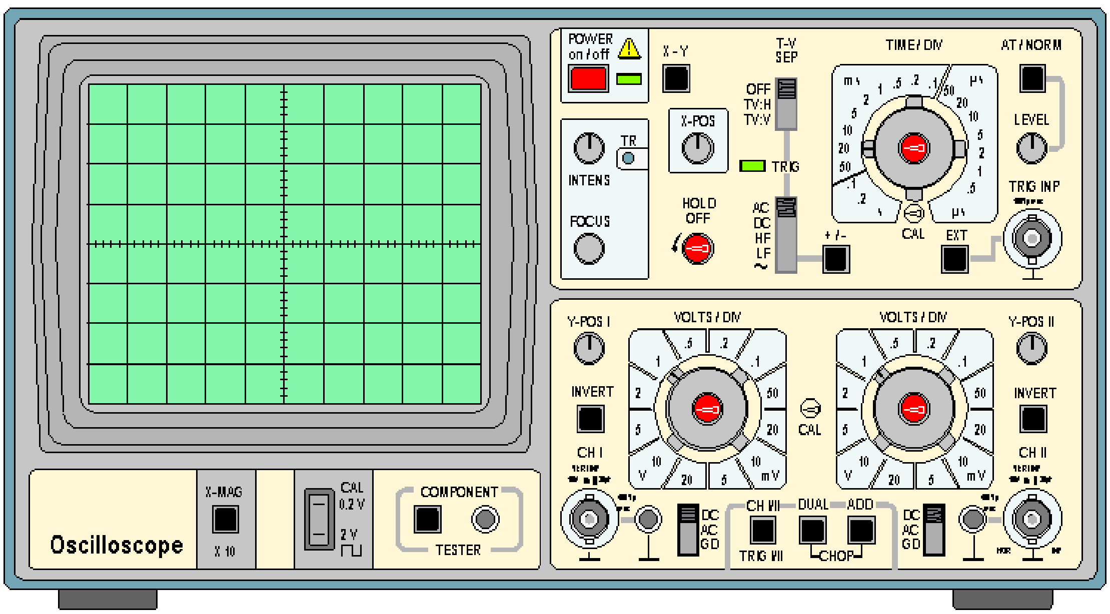
Electron Gun**:** The function of this is to provide a sharply focused stream of electrons. It mainly consists of an indirectly heated cathode, a control grid, focusing anode and accelerating anode. Control grid is cylinder in shape. It is connected to negative voltage w.r.t to cathode. Focusing and accelerating anodes are at high positive potential. w.r.t anode. Cathode is indirectly heated type & is heated by filament. Plenty of electrons are released from the surface of cathode due to Barium Oxide coating. Control Grid encloses the cathode and controls the number of electrons passing through the tube.

A voltage on the control grid consists the cathode determines the number of electrons freed by heating which are allowed to continue moving towards the face of the tube. The accelerated anode is heated at much higher potential than focusing anode. Because of this reason the accelerating anode accelerates the light beam into high velocity. The beam when strikes the screen produces the spot or visible light.

The name electron Gun is used because it fires the electrons like a gun that fires a bullet.

Deflection system**:** The beam after coming out of the accelerated anode passes through two sets of deflection plates with the tube . The first set is the vertical deflection plate and the second set is horizontal deflection plates. The vertical deflection plates are oriented to deflect the electron beam that moves vertically up and down. The direction of the vertical deflection beam is determined by the voltage polarity applied to the plates. The amount of deflection is set by the magnitude of the applied voltage. The beam is also deflected horizontally left or right by a voltage applied to horizontal plates. The deflecting beam is then further accelerated by a very high voltage applied to the tube.

Fluorescent Screen**:** The screen is large inside the face of the tube and is coated with a thin layer of florescent material called Phosphor. On this fluorescent material when high velocity electron beam strikes its converting the energy of the electron the electron beam between into visible light(spots). Hence the name is given as fluorescent screen.



PANEL CONTROLS:

1. POWER ON/OFF **:** Push the button switch to supply power to the instrument.

2. X5 **:** Switch when pushed inwards gives 5 times magnification of the X signal

3. XY : Switched when pressed cut off the time base and allows access the exit horizontal signal to be fed through CH II

(used for XY display).

4. CH I/CH II/TRIG I/ **:** Switch out when selects and triggers CH I and when

TRIG II. Pressed selects and triggers CH II.

5. MOD/DUAL **:** Switch when selects the dual operation switch

6. ALT/CHOP/ADD : Switch selects alternate or chopped in dual mode. If mode is selected then this switch enables addition or subtraction of the channel i.e. CH-! +- CH II.

7. TIME/DIV **:** Switch selects the time base speed.

8. AT/NORM **:** Switch selects AUTO/NORMAL position .Auto is used to get trace when no signal is fed at the input . In NORM the trigger level can be varied from the positive peak to negative peak with level control.

9. LEVEL **:** Controls the trigger level from the peak to peak amplitude signal.

10. TRIG.INP **:** Socket provided to feed the external trigger signal in EXT. mode.

11. CAL OUT **:** Socket provided for the square wave output 200 mv used for probe compensation and checking vertical sensitivity etc.

12. EXT **:** Switch when pressed allows external triggering signal to be fed from the socket marked TRIG.INP.

13. X-POS **:** Controls the horizontal position of the trace.

14. VAR **:** Controls the time speed in between two steps of time/div switch .For calibration put this fully anticlockwise (at cal pos)

15. TV **:** Switch when it allows video frequency up to 20 KHz to be locked.

16. + - : Switch selects the slope of trigger whether positive going or negative.

17. INV CHJ II **:** Switch when pressed inverts the CH ii.

18. INTENS **:** Controls brightness of trace.

19. TR **:** Controls the alignment of the trace with gratitude (screw driver adjustment).

20. FOCUS **:** Controls the sharpness of the trace.

21. CT : Switch when pressed starts CT operation.

22. **GD/AC /DC** : Input coupling switch for each channel. In AC the signal is coupled through the 0.1 MFD capacitor.

23. **DC/AC/GD** **:** BNC connectors serve as input connectors for the CH I and CH II channel input connector also serves as the horizontal external signal.

24. **CT-IN** **:**To test any components in the circuit, put one test probe in this socket and connect the other test probe in the ground socket.

25. VOLTS /DIV : Switches select the sensitivity of each channel.

26. **Y POS I AND II** **:** Controls provided for vertical deflection for each channel.

BACK PANEL CONTROLS

1. FUSE : 350 mA fuse is provided at the back panel spare fuses are provided inside the instrument.

2.ZMOD **:** Banana socket provided for modulating signal input i.e. Z-modulation.

Precautions

1. Avoid using CRO in high ambient light conditions.

2. Select the location free from Temperature & humidity. It should not be used in dusty environment.

3. Do not operate in a place where mechanical vibrations are more or in a place which generates strong magnetic fields or impulses.

5. Do not increase the brightness of the CRO than that is required.

Experiment:

1. Turn on the power of the CRO.

2. From the Function Generator select the desired frequency and amplitude of the sine wave.

3. The amplitude of the waveform is obtained by noting the number of divisions along the Y-axis in between peak to peak of the waveform (i.e. sine waveform / Triangular waveform /Square waveform) and multiplying with the divisional factor of the amplitude note in volts.

4. Time period is calculated from X-axis.

5. Frequency is obtained by formula F=1/T.

6. This frequency is compared with the frequency applied using function generator.

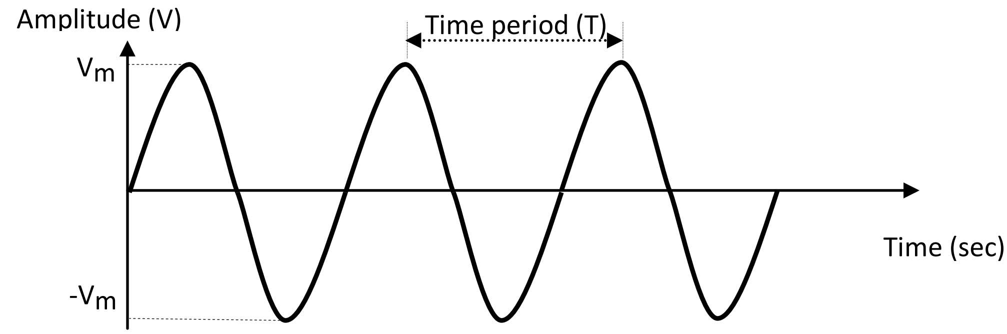
7. Voltage in the CRO is compared with the voltage applied from function generator.

8. By repeating the above steps we can find frequency and voltages of square wave & triangular waveforms.

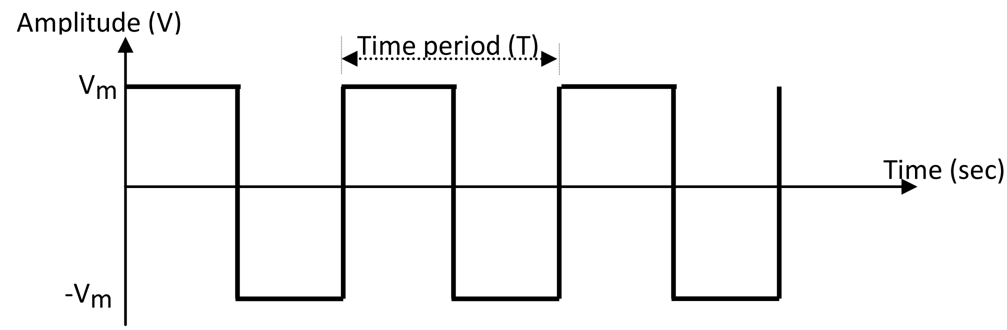
Tabular Column:

Waveform	Time Period(sec)		Frequency(Hz)		Amplitude(V)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical
Sinusoidal						
Triangular						
Square						

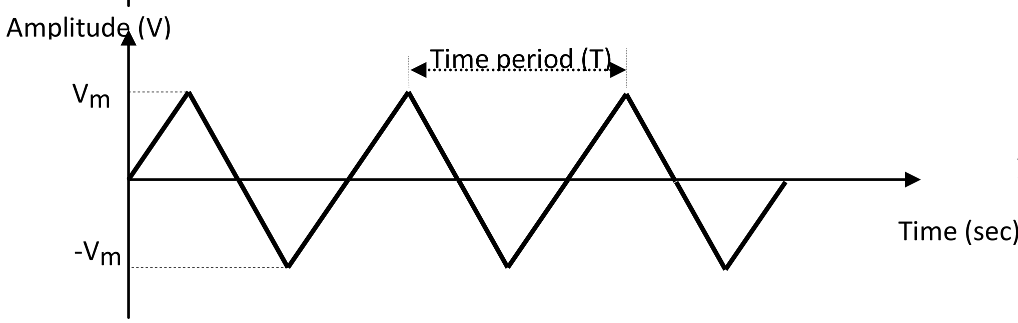
MODEL GRAPHS:



Sine wave



Square wave



Triangular wave

Calculations:

1. Sinusoidal Waveform:

   Amplitude: ____ V

   Time Period: ____Sec

   Frequency: ___Hz

2. Square Waveform:

   Amplitude: ____ V

   Time Period: ____Sec

   Frequency: ___Hz

3. Triangular Waveform:

Amplitude: ____ V

Time Period: ____Sec

Frequency: ___Hz

RESULT: The CRO Panel is studied and determined the Amplitude, Time period and Frequency of a given waveform using CRO.

2. Volt-Ampere Characteristics of PN junction diode.

Objective:

1. To plot Volt-Ampere Characteristics of Silicon P-N Junction Diode.
2. To find cut-in Voltage for Silicon P-N Junction diode.
3. To find static and dynamic resistances for P-N Junction diode.

Apparatus:

S.No	Apparatus	Type	Range	Quantity
01	PN Junction diode	1N4007		01
02	Resistance		470Ω,1KΩ	01
03	Regulated Power supply		(0-30V)	01
04	Ammeter		(0-100mA),(0-100μA)	01
05	Voltmeter		(0-2V),(0-30V)	01
06	Breadboard and Wires			

Introduction:

The semi conductor diode is created by simply joining an n-type and a p-type material together nothing more just the joining of one material with a majority carrier of electrons to one with a majority carrier of holes.

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 to cathode (N- side), 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(**injected minority current** – due to holes crossing the junction and entering N-side of the diode, due to electrons 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 thereby 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 small current is due to thermally generated carriers. Assuming current flowing through the diode to be negligible, the diode can be approximated as an open circuited switch. The volt-ampere characteristics of a diode explained by following equation:

$$I = I_0(e^{\frac{V}{\eta V_T}} - 1)$$

I=current flowing in the diode

I_o=reverse saturation current

V=voltage applied to the diode

V_T=volt-equivalent of temperature = $\frac{KT}{q} = \frac{T}{11,600} = 26mA$ at room temp

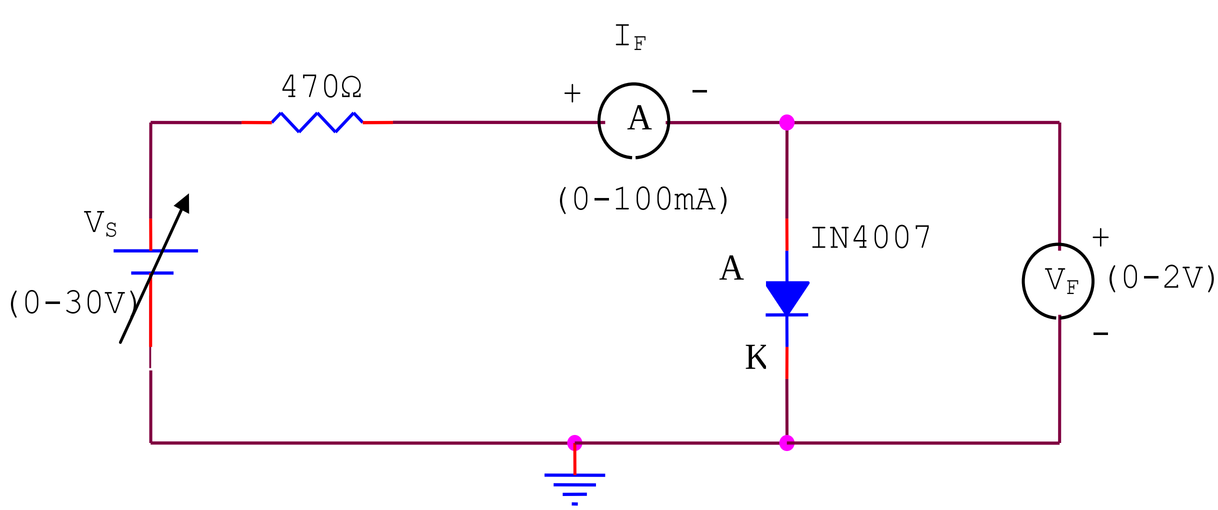
$\eta = 1$ (for Ge)

$\eta = 2$ (for Si)

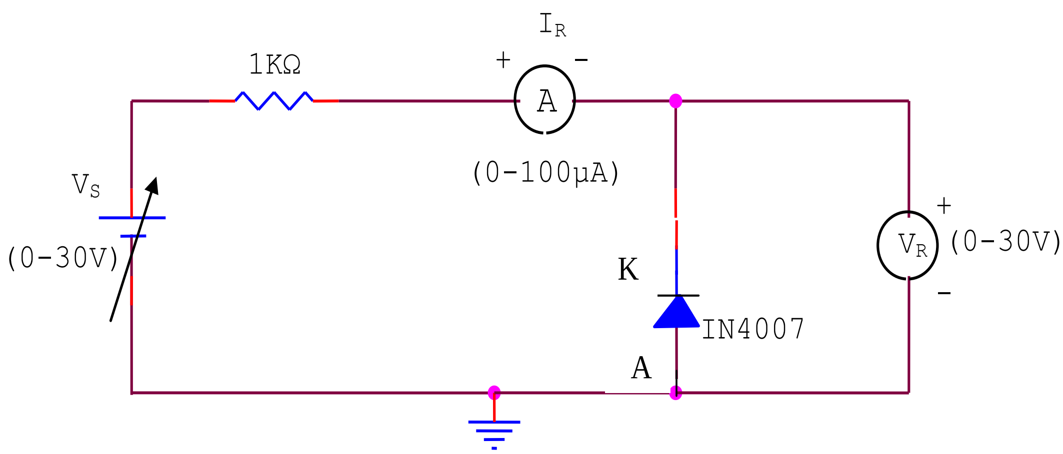
It is observed that Ge diode has smaller cut-in-voltage when compared to Si diode. The reverse saturation current in Ge diode is larger in magnitude when compared to silicon diode.

Circuit Diagram

Forward Bias



Reverse Bias:



Experiment

Forward Biased condition

1. Connect the PN Junction diode in forward bias i.e Anode is connected to positive of the power supply and cathode is connected to negative of the power supply .

2. Use a Regulated power supply of range (0-30)V and a series resistance of 470Ω

3. By varying the input voltage in steps of 0.1V, note down corresponding Ammeter readings.(I_F) and voltmeter reading.

4. Plot the graph between forward voltage (V_F) and forward current (I_F).

Reverse Biased condition

1. Connect the PN Junction diode in Reverse bias i.e; anode is connected to negative of the power supply and cathode is connected to positive of the power supply.

2. Use a Regulated power supply of range (0-30)V and a series resistance of 1KΩ

3. By varying the input voltage vary voltage (V_R) in steps of 1V and note down corresponding Ammeter readings.(I_R)

4. Plot the graph between Reverse voltage (V_R) and Reverse current (I_R).

Tabular column

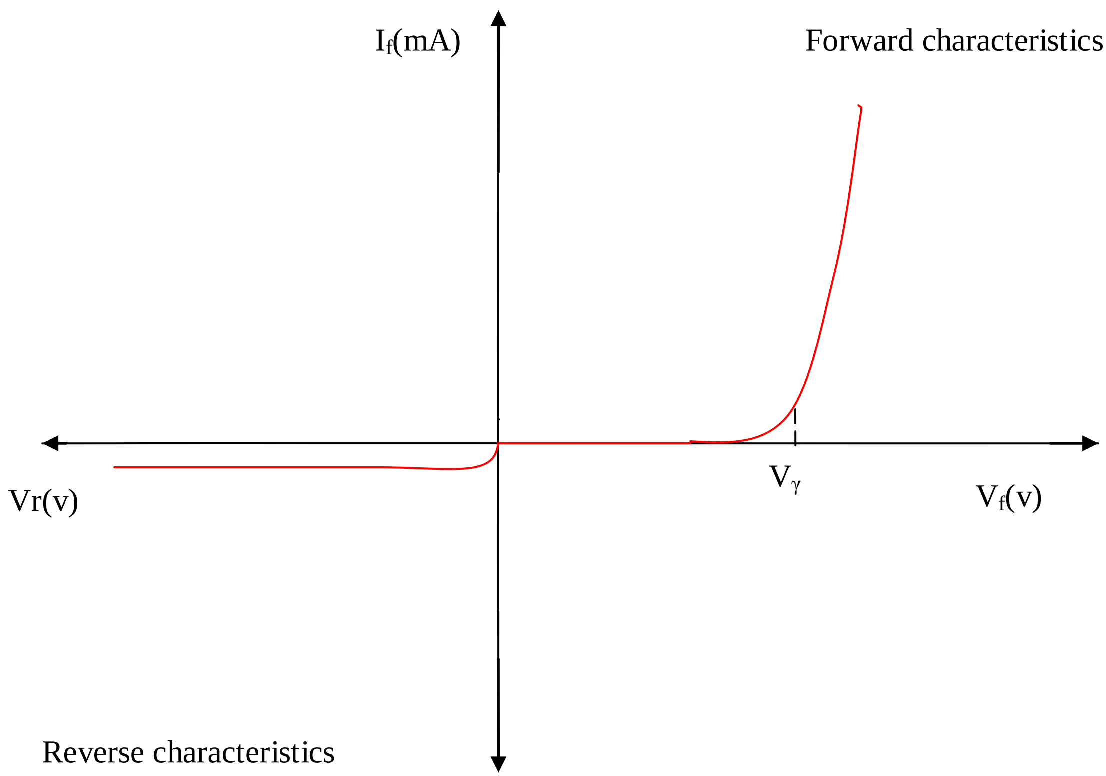
Forward Bias

S.No	V_S (Volts)	V_F (Volts)	I_F (mA)

Reverse Bias

S.No	V_S (Volts)	V_R (Volts)	I_R (µA)

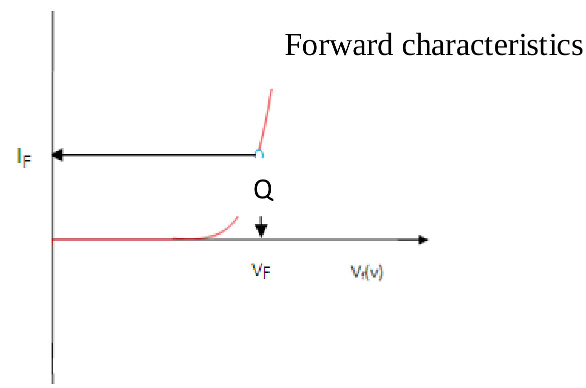
Model Graph



Calculations from the Graph

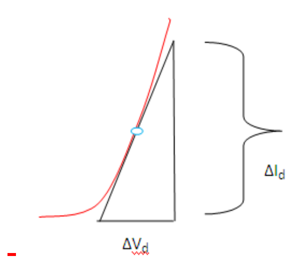
1. **Static Resistance:** To find the forward static resistance locate a point on characteristic curve obtained from the forward bias characteristics which is called operating point Q and draw a line onto the X-axis and Y-axis to obtain V_F and I_F Calculate static forward resistance using the formulae

   Static forward Resistance $R_{DC} = \frac{V_F}{I_F}\Omega$ at Q-point.



2. **Dynamic Resistance**: The dc resistance of a diode is independent of the shape of the characteristic in the region surrounding the point of interest. If a sinusoidal input is applied rather than a dc input ,the varying input will move the instantaneous operating point up and down a region of the characteristics and thus defines a specific change in current and voltage. To find the ac or dynamic resistance draw a straight line drawn tangent to the curve through the Q-point as shown in the figure will define a particular change in voltage and current that can be used to determine the ac or dynamic resistance for this region of the diode characteristics.

$$\text{Dynamic Resistance } r_d = \frac{\Delta V_d}{\Delta I_d} \quad \Omega \quad \text{at Q-point}$$



Precautions:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage 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:

Thus the VI characteristic of PN junction diode is verified.

1. Cut in voltage = ……… V
2. Static forward resistance = ………. Ω
3. ac or Dynamic resistance = ………. Ω

VIVA QUESTIONS:

1.When diode acts like ideal switch?

2. What is the cut in voltage? Give typical values for Ge and Si.
3. What is reverse saturation current?
4. What is Dynamic and static resistance?
5. What is V-I characteristics equation?
6. Define potential barrier.
7. Define doping.
8. What is the effect of temperature on Ico.
9. Define a Q point.
10. Explain how the diode can acts as a capacitor.

3. Volt-Ampere Characteristics of Zener Diode and Zener Voltage regulator characteristics.

Objective:

1. To plot Volt-Ampere Characteristics of Zener Diode in reverse bias.
2. To find Zener Breakdown Voltage in reverse biased condition.
3. To find load regulation characteristics of Zener voltage regulator

Apparatus:

S.No	Apparatus	Type	Range	Quantity
01	Zener diode	IMZ 5.1V		01
02	Resistance		470Ω	01
03	Regulated Power supply		(0-30V)	01
04	Ammeter		(0-100mA)	02
05	Voltmeter		(0-10V)	01
06	Decade Resistance Box		(0-10K)	01
07	Breadboard and Wires			

Introduction:

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.

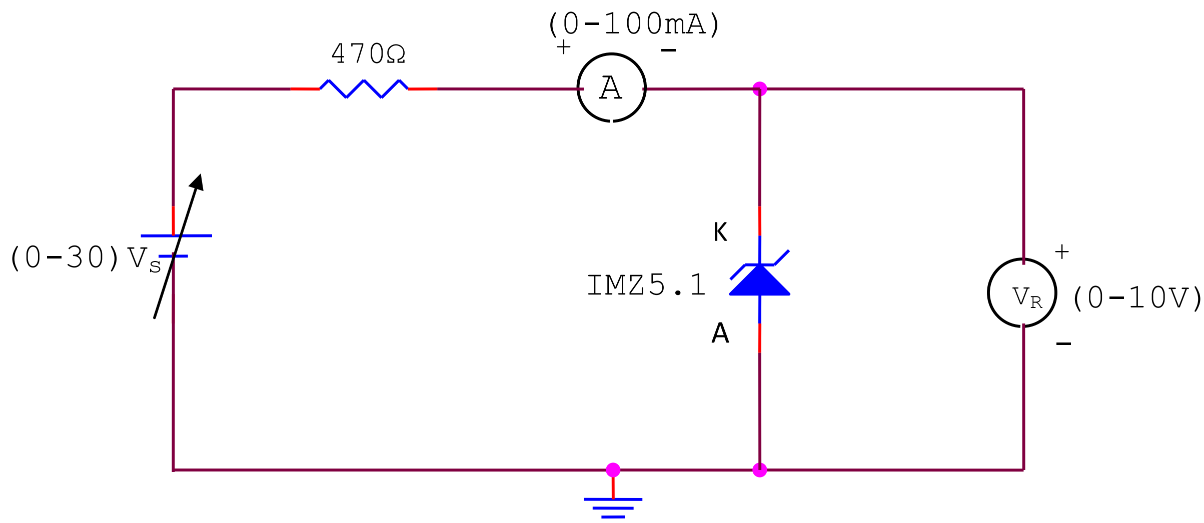
A **zener diode** when reverse biased can either undergo **avalanche break down** or **zener break down**.

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 may rupture covalent bonding between electrons. Such rupture leads to the generation of a large number of charge carriers resulting in **avalanche multiplication**.

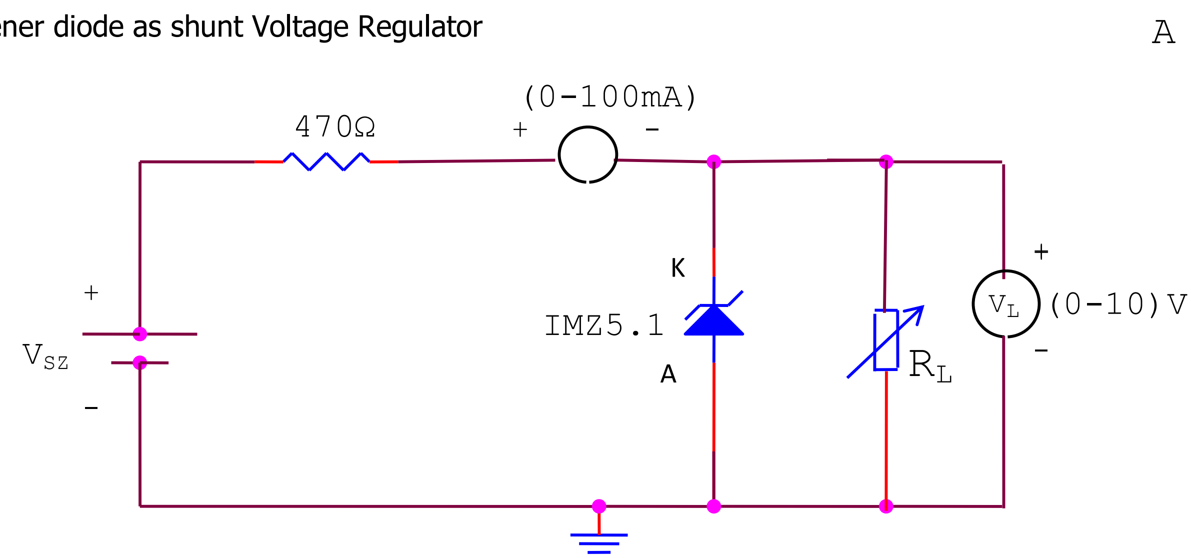
Zener break down:-If both p-side and n-side of the diode are heavily doped, depletion region at the junction reduces. Application of even a small voltage at the junction ruptures covalent bonding and generates large number of charge carriers. Such sudden increase in the number of charge carriers results in **zener mechanism**.

Circuit Diagram

Reverse Biased



Zener diode as shunt Voltage Regulator



Precautions:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage 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.

Experiment:

To plot V-I characteristics of Zener diode in reverse bias condition and to find Zener breakdown voltage

1. Connect the Zener diode in Reverse bias i.e; anode is connected to negative of the power supply and cathode is connected to positive of the power supply as in circuit.
2. Vary the input voltage in steps of 1V and note down reverse voltage(V_R) and the corresponding values of reverse current (I_R).
3. Plot the graph between reverse voltage (V_R) and the reverse current (I_R).

To plot the load regulation characteristics of the Zener voltage regulator.

1. Connect the Zener diode in Reverse bias i.e; anode is connected to negative of the power supply and cathode is connected to positive of the power supply as in circuit.
2. In finding load regulation , input voltage (V_{sz}) is kept constant i.e source voltage is chosen as a voltage at which Zener voltage V_Z is remaining constant while the current is increasing(V_{sz} from 1^{st} circuit characteristics)
3. Measure V_{NL} (No load voltage) by opening the load resistance.
4. Connect the load resistance, and vary the load resistance from 1100Ω to 100Ω in steps of 100Ω and note down the readings of V_L and I_Z
5. Calculate % Regulation by using the formula given below.

$$\% Regulation = \frac{V_{NL} - V_L}{V_L} X 100$$

Tabular column

1. To plot V-I characteristics

S.No	V_s(V)	V_R(V)	I_R(mA)

2. To find load regulation characteristics

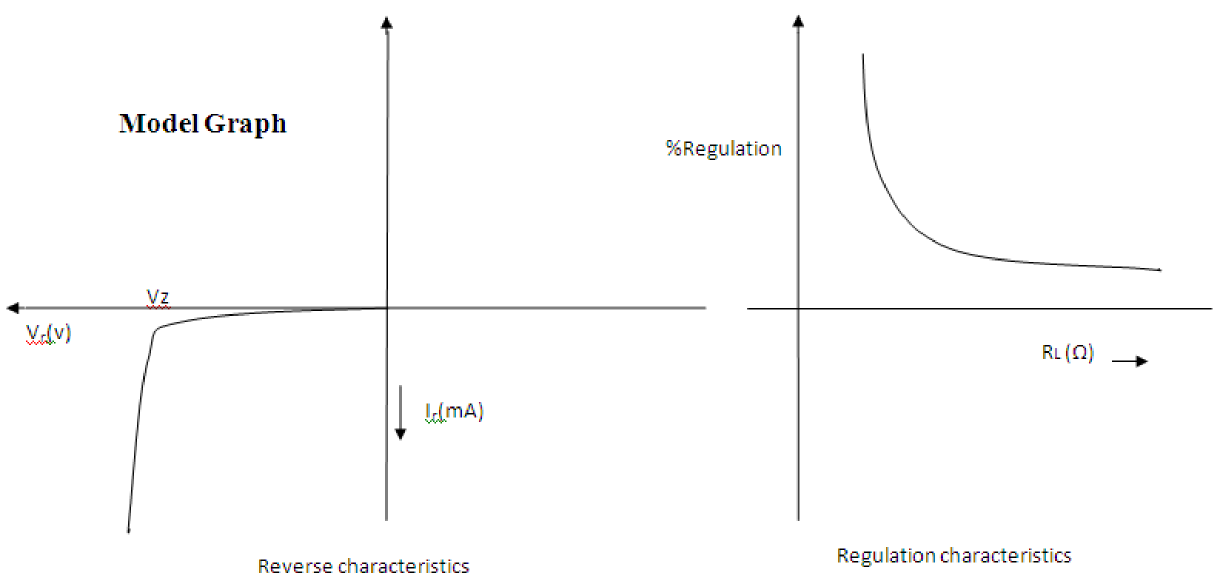
$V_{NL=}$ ----------------

S.No	R_L	I_Z(mA)	V_L(V)	% Regulation
	1100 **To** **100** (in steps of 100)			

Precautions:

Keeping the input voltage constant if the load resistance is increased zener current increases so as to make the load voltage to remain constant.

Model Graph:



Calculations from Graph

To find Zener breakdown voltage

1.In the reverse characteristics of Zener diode observe the voltage at which the reverse current is abnormally increasing while the reverse voltage remain constant.

2.That particular reverse voltage is called the breakdown voltage of the Zener diode

Result

1.The V-I characteristics of Zener diode were plotted and the Zener breakdown voltage was determined and is given as ------------------------V

2. Load regulation characteristics were plotted.

VIVA QUESTIONS:

1. Difference between Zener and Avalanche breakdown.
2. What is the difference between zener and ordinary diode?
3. Draw equivalent circuit for Zener diode.
4. What is Breakdown voltage?
5. What are the applications of zener diode?
6. How zener acts as a regulator?

4. Volt-Ampere Characteristics of Light Emitting Diode

Objective :

To obtain the V-I Characteristics of LED

Apparatus:

S.No	Apparatus	Type	Range	Quantity
01	LED			01
02	Resistance		470Ω	01
03	Regulated Power supply		(0-30V)	01
04	Ammeter		(0-100mA)	01
05	Voltmeter		(0-10V)	01
06	Breadboard and Wires			

Introduction:

Function

LEDs emit light when an electric current passes through them.

LED is connected in the circuit as shown in figure. LED operates only in forward biased condition. Under forward bias condition the anode is connected to the positive terminal and the cathode is connected to the negative terminal of the battery. It is like a normal pn junction diode except the basic semiconductor material is GaAs or InP which is responsible for the color of the light. When it is forward biased the holes moves from p to n and electrons flow from n to p. In the junction the carriers recombine with each other and released the energy in the form of light. Thus LED emits light under forward biased condition. Under reverse biased condition, there is no recombination due to majority carriers, so there is no emission of light.

Calculating LED resistor value

LED must have a resistor connected in series to limit the current through the LED; otherwise it will burn out almost instantly. The resistor value, R is given by:

$$R = \frac{(V_{S-}V_L)}{I}$$

V_S = supply voltage

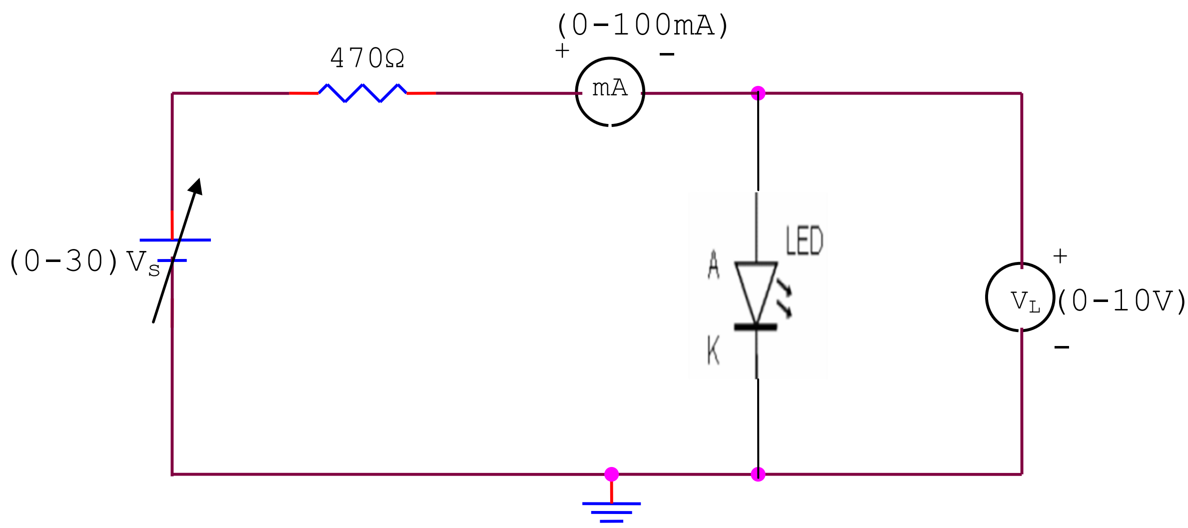
V_L = LED voltage (usually 2V, but 4V for blue and white LEDs)

I = LED current (e.g. 20mA), this must be less than the maximum permitted

For example

If the supply voltage V_S = 10V, and you have a red LED (V_L = 2V),requiring a current I = 20mA R = (10V - 2V) / 0.02A = 400 , so choose 470**Ω** (the nearest standard value which is greater).

Circuit Diagram



Precautions:

1. While doing the experiment do not exceed the ratings of the diode. This may lead to damage 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.

Experiment

To plot V-I Characteristics of LED

1.Connections must be made as per the circuit diagram.

2.Varying the source voltage in steps of 0.1V note down the corresponding current and the voltage readings.

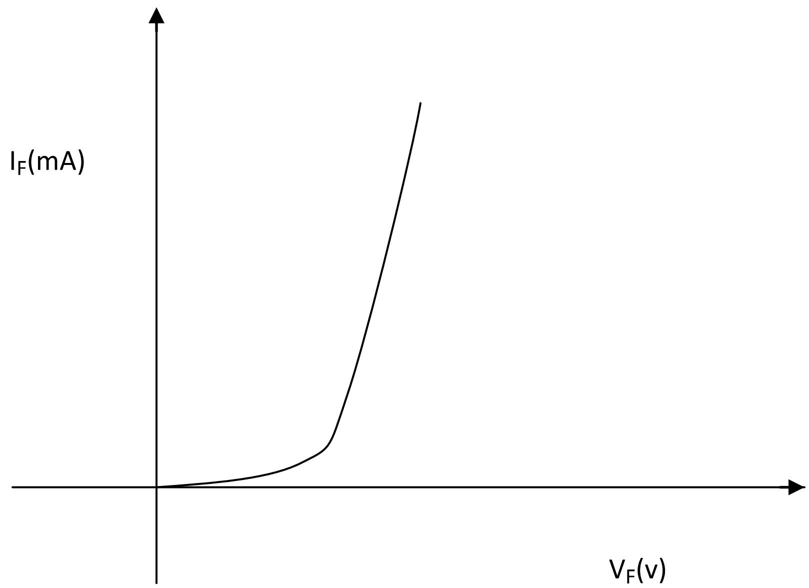
3. At the same time the glow intensity of the light emitting diode is also to be noted.

4. Plot the graph between voltage and current for forward bias

Tabular Column

S.No	$V_{S(V)}$	$V_{L(V)}$	$I_{f(mA)}$	Intensity of glow

Model Graph



Result:

Thus the VI characteristics of LED were studied.

VIVA QUESTIONS:

1. What is LED
2 Which materials are used in manufacturing of LEDs
3. What are the applications of LEDs
4. How LED is different from ordinary diode
5. What is the difference between direct band gap and indirect bandgap semiconductor?

4. Volt-Ampere Characteristics of Light Emitting Diode(Modified)

Objective :

To obtain the V-I Characteristics of LED for different LEDs (Red,Blue,Green,Yellow etc.) and fing the LED voltages of different LEDs

Apparatus:

S.No	Apparatus	Range	Quantity
01	LED	Red,Blue,Green,Yellow	01
02	Resistance	470Ω	01
03	Regulated Power supply	(0-30V)	01
04	Ammeter	(0-100mA)	01
05	Voltmeter	(0-20V)	01
06	Breadboard and Wires		

Introduction:

LEDs emit light when an electric current passes through them. LED is connected in the circuit as shown in figure. LED operates only in forward biased condition. Under forward bias condition the anode is connected to the positive terminal and the cathode is connected to the negative terminal of the battery. It is like a normal pn junction diode except the basic semiconductor material is GaAs or InP which is responsible for the color of the light.When it is forward biased the holes moves from p to n and electrons flow from n to p. In the junction the carriers recombine with each other and released the energy in the form of light. Thus LED emits light under forward biased condition. Under reverse biased condition, there is no recombination due to majority carriers, so there is no emission of light.

Testing an LED:

Never connect an LED directly to a battery or power supply!It will be destroyed almost instantly because too much current will pass through and burn it out. LEDs must have a resistor in series to limit the current to a safe value, for quick testing purposes a 1k resistor is suitable for most LEDs if your supply voltage is 12V or less. Remember to connect the LED the correct way round Colours of LEDs.LEDs are available in red, orange, amber, yellow, green, blue and white. Blue and white LEDs are much more expensive than the other colours. The colour of an LED is determined by the semiconductor material, not by the colouring of the 'package' (the plastic body). LEDs of all colours are available in uncoloured packages which may be diffused (milky) or clear (often described as 'water clear').The coloured packages are also available as diffused (the standard type) or transparent. As well as a variety of colours, sizes and shapes, LEDs also vary in their viewing angle. This tells you how much the beam of light spreads out. Standard LEDs have a viewing angle of 60° but others have a narrow beam of 30° or less.Calculating an LED resistor value An LED must have a resistor connected in series to limit the current through the LED, otherwise it will burn out almost instantly.

The resistor value, R is given by:

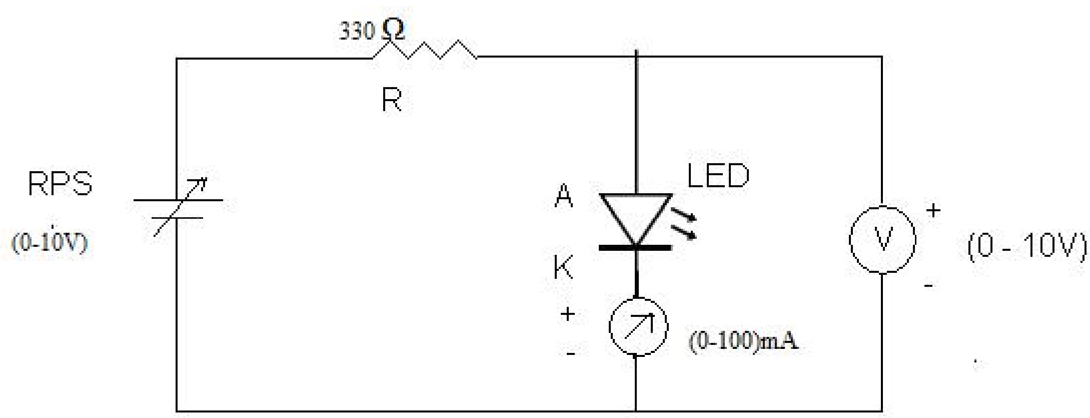
R = (VS - VL) / I

VS = supply voltage

VL = LED voltage (usually 2V, but 4V for blue and white LEDs)

I = LED current (e.g. 20mA), this must be less than the maximum permitted.

Circuit diagram: Forward bias:



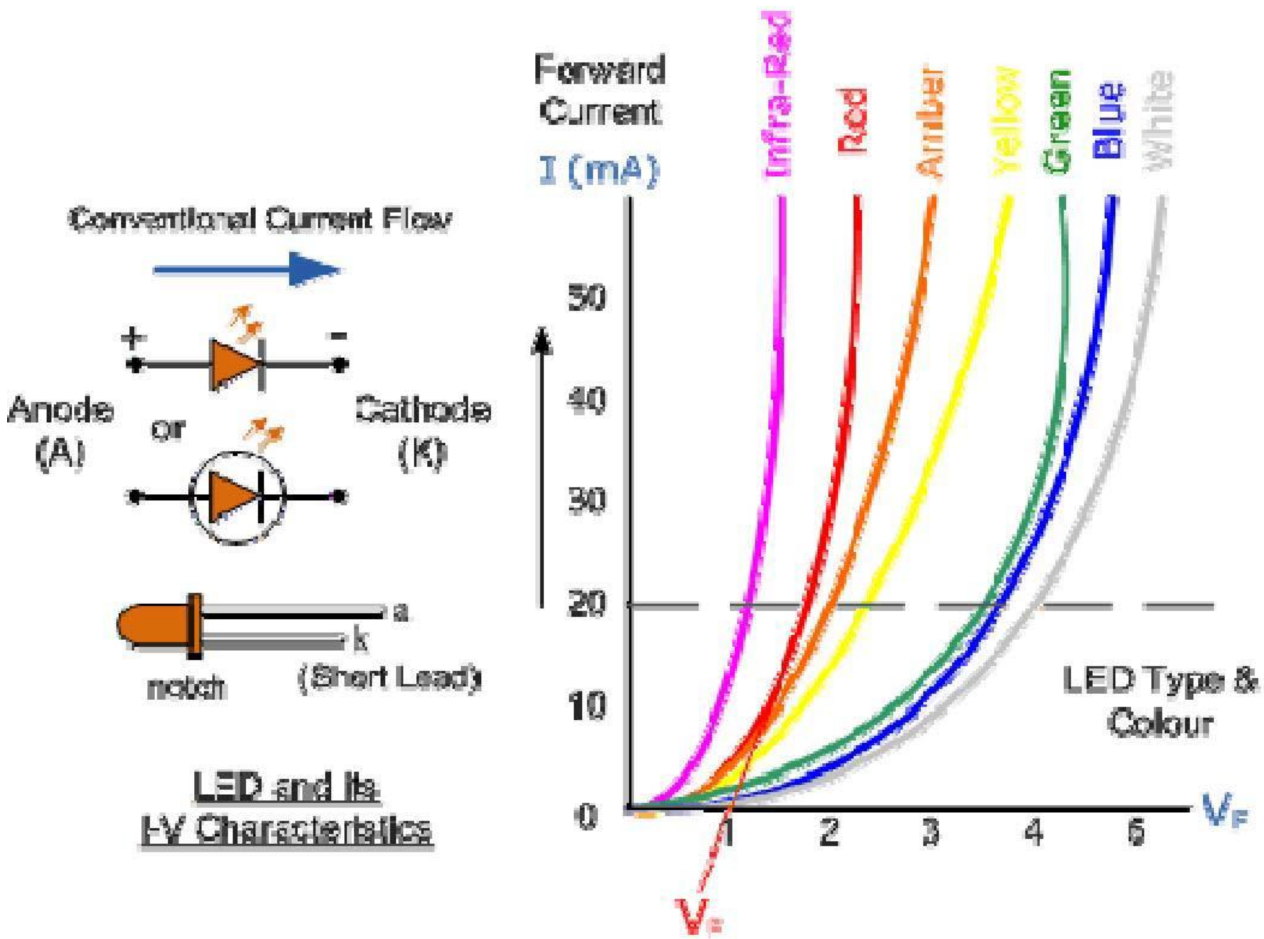
Procedure:

1. Give the connection as per the circuit diagram.
2. Vary the input voltages at the RPS and note down the corresponding current for the voltages.
3. Repeat the procedure for different color LEDs and tabulate the corresponding voltages and currents.
4. Plot the graph between voltage and current for all LEDs.
5. Observe the LED voltage for different LEDs

Tabular column:

	LED Colour: Red		LED Colour: Green		LED Colour: Yellow	
S.No.	Voltage(V)	Current(mA)	Voltage(V)	Current(mA)	Voltage(V)	Current(mA)

Model Graph:



Result:

Thus the VI characteristics of LED were studied.

VIVA QUESTIONS:

1. Differentiate LED from normal PN junction diode?

2. Define wavelength.
3. What happens when LEDs connected in series and parallel?
4. What are the advantages of LED over laser diode?
5. What are the desired characteristics of LED?

5. Half-Wave rectifier with and without filter

Objective

1. To plot input and output waveforms of the Half Wave Rectifier with and without Filter
2. To find ripple factor of Half Wave Rectifier with and without Filter
3. To find percentage regulation of Half Wave Rectifier with and without Filter

Apparatus

S.No	Apparatus	Type	Range	Quantity
01	Transformer	Step-down	0-12V	01
02	Diode	IN4007		01
03	Decade Resistance Box		10-1KΩ	01
04	Capacitor		1000μF/25V	01
05	Digital Multimeter(DMM)		(0-20V)	01
06	CRO & CRO Probes			01
07	Breadboard and Wires			

INTRODUCTION:

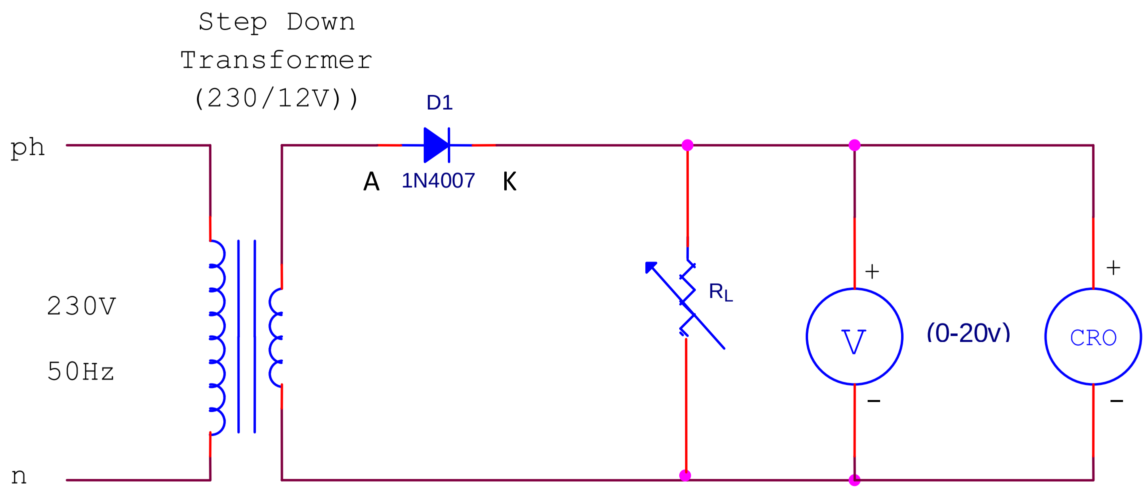
A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non zero average component is called a rectifier.

A practical half wave rectifier with a resistive load is shown in the circuit diagram. During the positive half cycle of the input the diode conducts and all the input voltage is dropped across R_L. During the negative half cycle the diode is reverse biased and it acts as almost open circuit so the output voltage is zero.

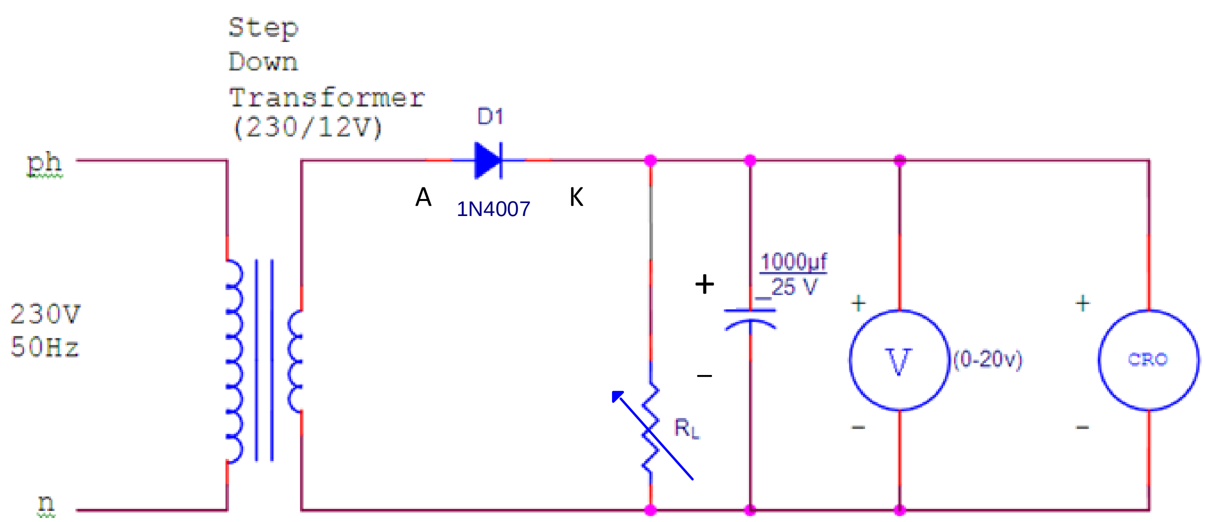
The filter is simply a capacitor connected from the rectifier output to ground. The capacitor quickly charges at the beginning of a cycle and slowly discharges through R_L after the positive peak of the input voltage. The variation in the capacitor voltage due to charging and discharging is called ripple voltage. Generally, ripple is undesirable, thus the smaller the ripple, the better the filtering action.

Circuit Diagram

Without Filter



With Filter



PRECAUTIONS

1. The primary and secondary sides of the transformer should be carefully identified.
2. The polarities of the diode should be carefully identified.

Theoretical calculations for Ripple factor:-

Without Filter:-

$$V_{dc} = \frac{V_m}{\pi}$$

$$V_{rms} = \frac{V_m}{2}$$

$$\text{Ripple factor} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} \qquad =1.21$$

With Filter:-

$$\text{Ripple factor} = \frac{1}{2\sqrt{3}fCR_L} \quad =$$

Where f =50Hz
C =1000µF
R_L=1KΩ

EXPERIMENT (without Filter)

1. Connections are made as per the circuit diagram of the rectifier without filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3.Note down the no load voltage before applying the load to the Circuit and by using the Multimeter, measure the ac input voltage of the rectifier and its frequency.

4.Now Vary the R_L in steps of 100Ω by varying the DRB from 1100Ω to 100Ω and note down the load voltage (V_L) using the multimeter for each value of R_L and calculate the percentage regulation.

5.Measure the AC and DC voltage at the output of the rectifier for each value of R_L using Multimeter.

6.Now Observe the output waveform on CRO across R_L and find out value of V_m.

7. Now calculate V_{dc}, V_{rms}, Ripple Factor and other parameters of half wave rectifier according to the given formulae.

8.Measure the amplitude and timeperiod of the transformer secondary(input waveform) by connecting CRO.

9.Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

EXPERIMENT (with Filter)

1. Connections are made as per the circuit diagram of the rectifier with filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4.Measure the amplitude and timeperiod of the transformer secondary(input waveform) by connecting CRO.

5.Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

Tabular Column: **Without Filter**

Using DMM:

V_{ac}	V_{dc}	Ripple Factor(ɤ)= V_{ac}/ V_{dc}

Using CRO :

R_L (Ω)	V_L (V)	V_m (V)	$Vdc = \frac{Vm}{\pi}$ (V)	$Vrms = \frac{Vm}{2}$ (V)	$Vr(rms) = \sqrt{Vrms^2 - Vdc^2}$ (V)	R.F= $\frac{Vr(rms)}{Vdc}$	% Regulation $= \frac{V(NL)-V(L)}{VL}$

With Filter

Using DMM:

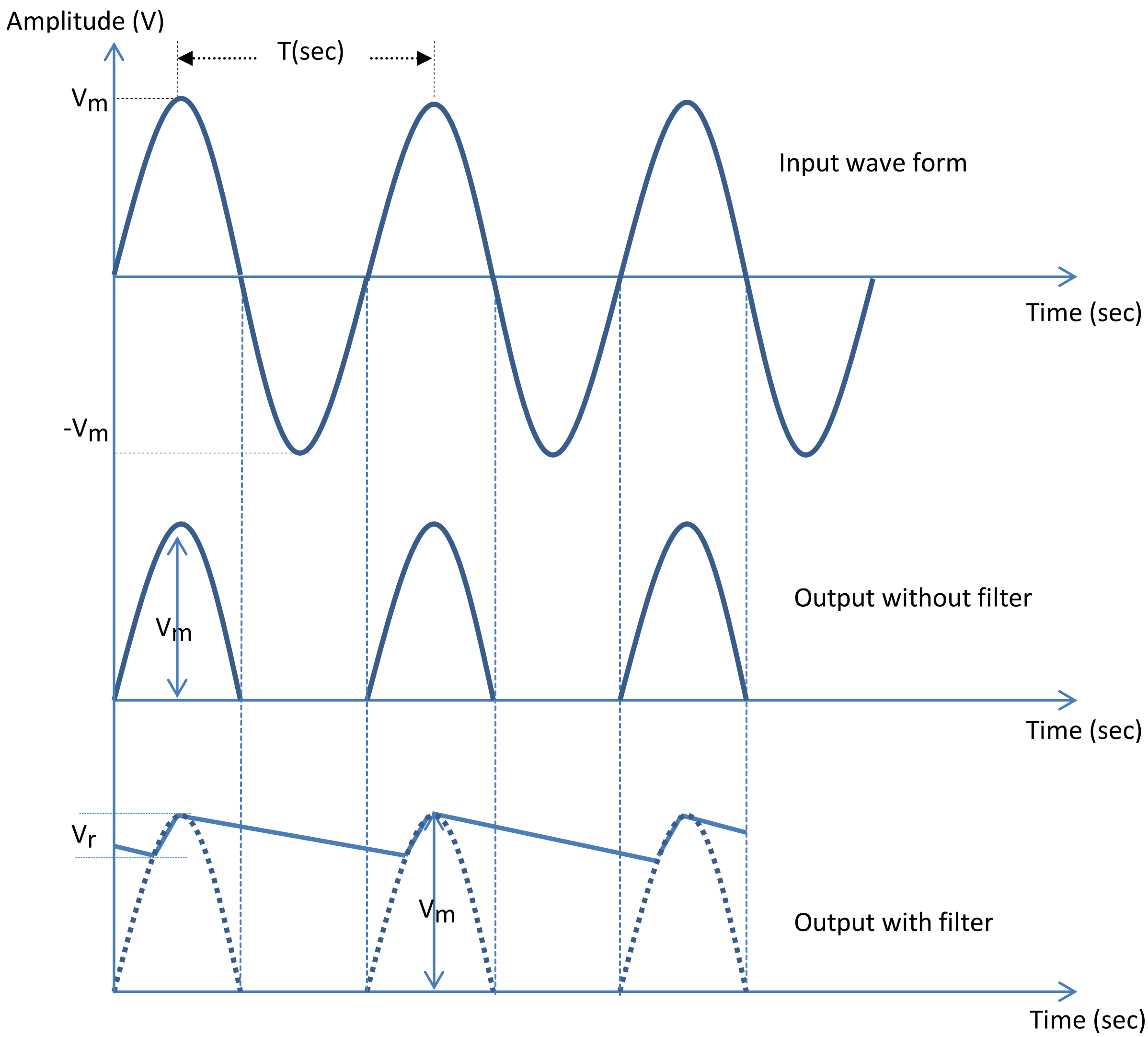
V_{ac}	V_{dc}	Ripple Factor(ɤ)= V_{ac}/ V_{dc}

Using CRO :

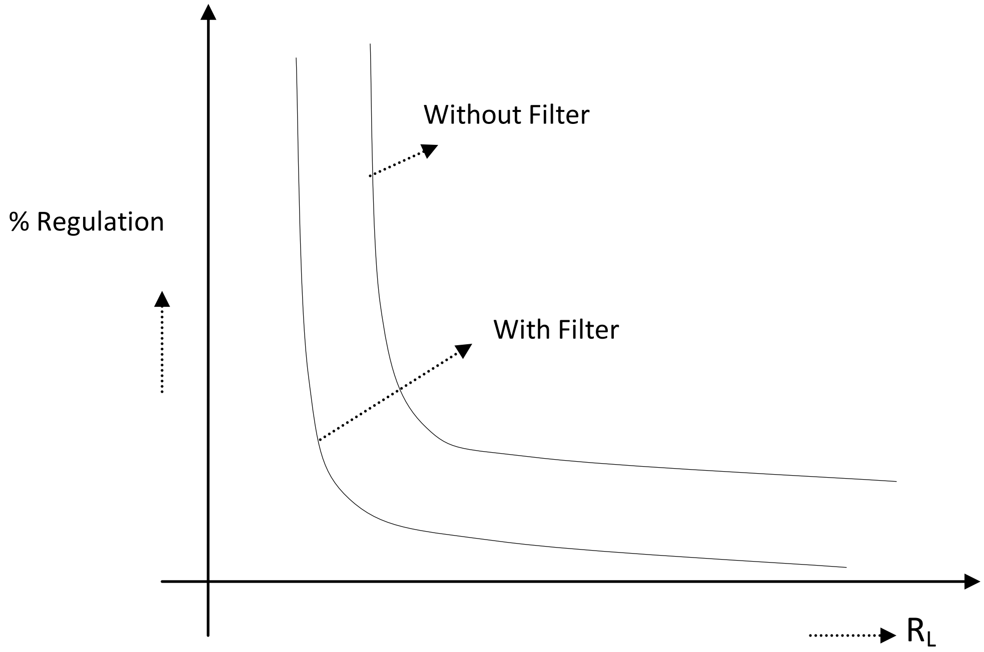
V_{NL}=

R_L (Ω)	V_L (V)	V_m (V)	V_r (V)	$Vdc = Vm - \frac{Vr}{2}$ (V)	$Vr(rms) = \frac{Vr}{2\sqrt{3}}$	R.F=$\frac{Vr(rms)}{Vdc}$	% Regulation $=\frac{V(NL)-V(L)}{VL}$

OUTPUT WAVEFORMS:



REGULATION GRAPH:



Result: The input and output waveforms of half wave rectifier is plotted and the ripple factor and regulation at 1100Ω are

Ripple factor with out Filter =

Ripple factor with Filter =

%Regulation=

VIVA QUESTIONS:

1. What is rectifier?
2. What is filter?
3. Define Ripple factor.
4. What is Peak inverse voltage?
5. How capacitor acts as filter.
6. Define regulation.
7. What are the applications of rectifiers?
8. Define transformer utilization factor.

6. Full-Wave rectifier with and without filter

Objective

1. To plot input and output waveforms of the Full Wave Rectifier with and without Filter

2. To find ripple factor for Full Wave Rectifier with and without Filter

3. To find regulation for Full Wave Rectifier with and without Filter

Apparatus

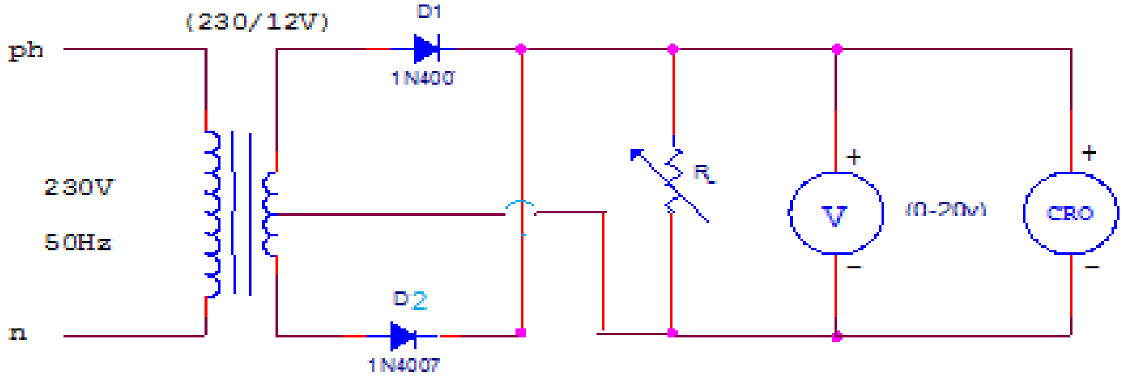
S.No	Apparatus	Type	Range	Quantity
01	Transformer	Centertapped	12-0-12V	01
02	Diode	IN4007		02
03	Resistance		1KΩ	01
04	Capacitor		1000µF/25V	01
05	Multimeter		(0-20V)	01
06	CRO			01
07	Breadboard and Wires			

INTRODUCTION:

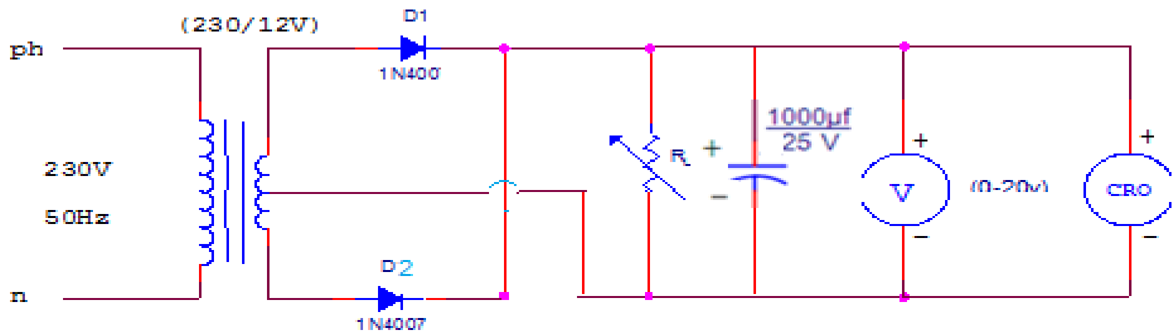
A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non zero average component is called a rectifier. A practical half wave rectifier with a resistive load is shown in the circuit diagram. It consists of two half wave rectifiers connected to a common load. One rectifies during positive half cycle of the input and the other rectifying the negative half cycle. The transformer supplies the two diodes (D1 and D2) with sinusoidal input voltages that are equal in magnitude but opposite in phase. During input positive half cycle, diode D1 is ON and diode D2 is OFF. During negative half cycle D1 is OFF and diode D2 is ON. Generally, ripple is undesirable, thus the smaller the ripple, the better the filtering action.

Circuit Diagram

Without Filter



With Filter



PRECAUTIONS

1. The primary and secondary sides of the transformer should be carefully identified.
2. The polarities of the diode should be carefully identified.

Theoretical calculations for Ripple factor:-

Without Filter:-

$$V_{dc} = \frac{2V_m}{\pi}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$$\text{Ripple factor} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} \qquad = 0.482$$

With Filter:-

$$\text{Ripple factor} = \frac{1}{4\sqrt{3}\,fCR_L} =$$

Where f =50Hz
C =1000µF
R_L=1KΩ

Experiment(without filter)

1. Connections are made as per the circuit diagram of the rectifier without filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4. Measure the amplitude and time period of the transformer secondary(input waveform) by connecting CRO.

5. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the Waveform.

Experiment (With filter)

1. Connections are made as per the circuit diagram of the rectifier with filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4. Measure the amplitude and time period of the transformer secondary(input waveform) by connecting CRO.

5. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

Tabular Column Without Filter

Using DMM:

V_{ac}	V_{dc}	Ripple Factor(γ)= V_{ac}/ V_{dc}

Using CRO :

V_{NL}=

R_L (Ω)	V_L (V)	V_m (V)	$Vdc = \frac{2Vm}{\pi}$ (V)	$Vrms = \frac{Vm}{\sqrt{2}}$ (V)	$Vr(rms) = \sqrt{Vrms^2 - Vdc^2}$ (V)	R.F= $\frac{Vr(rms)}{Vdc}$	% Regulation $= \frac{V(NL)-V(L)}{VL}$

With Filter

Using DMM:

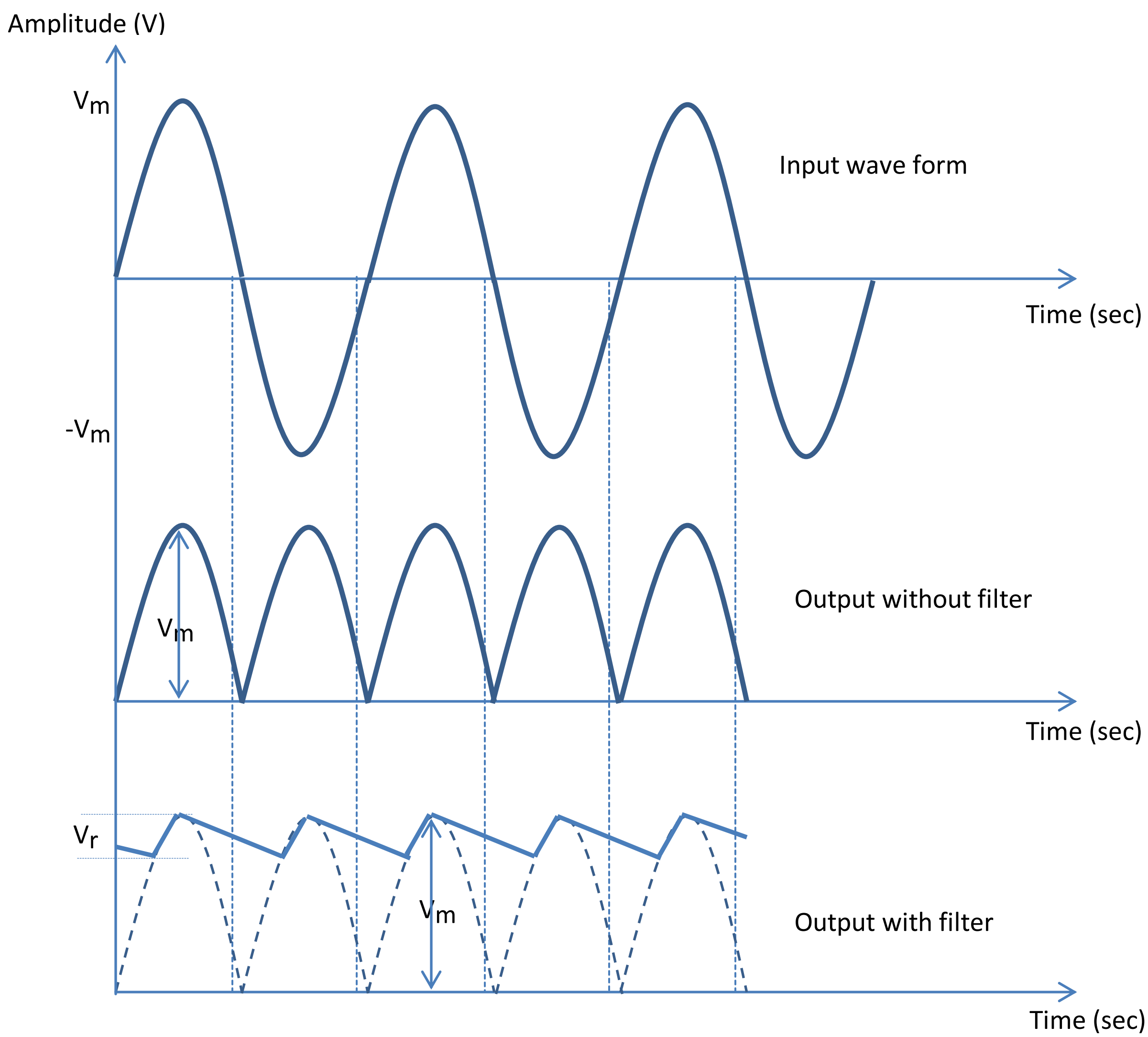
V_{ac}	V_{dc}	Ripple Factor(ɤ)= V_{ac}/ V_{dc}

Using CRO :

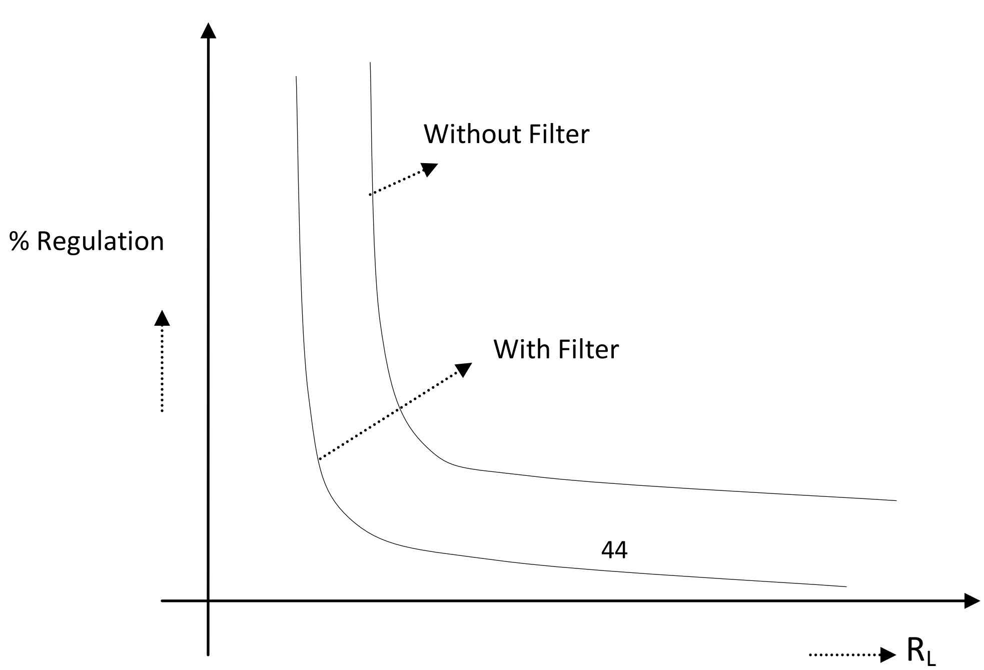
V_{NL}=

R_L (Ω)	V_L (V)	V_m (V)	V_r (V)	$Vdc = Vm - \frac{Vr}{2}$ (V)	$Vr(rms) = \frac{Vr}{4\sqrt{3}}$	R.F= $\frac{Vr(rms)}{Vdc}$	% Regulation $= \frac{V(NL)-V(L)}{VL}$

Model Graph



REGULATION GRAPH:



Result: The input and output waveforms of Full wave rectifier is plotted and the ripple factor and regulation at 1100Ω are

Ripple factor with out Filter =

Ripple factor with Filter =

%Regulation=

VIVA QUESTIONS:

1. What are the advantages of full wave rectifier over half wave rectifier?
2. Compare the PIV of half wave rectifier and full wave rectifier.
3. Why center tapped transformer is required for full wave rectifier operation.

7. Bridge rectifier with and without filter

Objective

1. To plot input and output waveforms of the Bridge Rectifier with and without Filter

2. To find ripple factor for Bridge Rectifier with and without Filter

3. To find Regulation factor for Bridge Rectifier with and without Filter

Apparatus

S.No	Apparatus	Type	Range	Quantity
01	Transformer	Stepdown	12-0-12V	01
02	Diode	IN4007		04
03	Resistance		1KΩ	01
04	Capacitor		1000µF/25V	01
05	Voltmeter		(0-20V)	01
06	CRO			01
07	Breadboard and Wires			

INTRODUCTION:
S

A device is capable of converting a sinusoidal input waveform into a unidirectional waveform with non zero average component is called a rectifier.

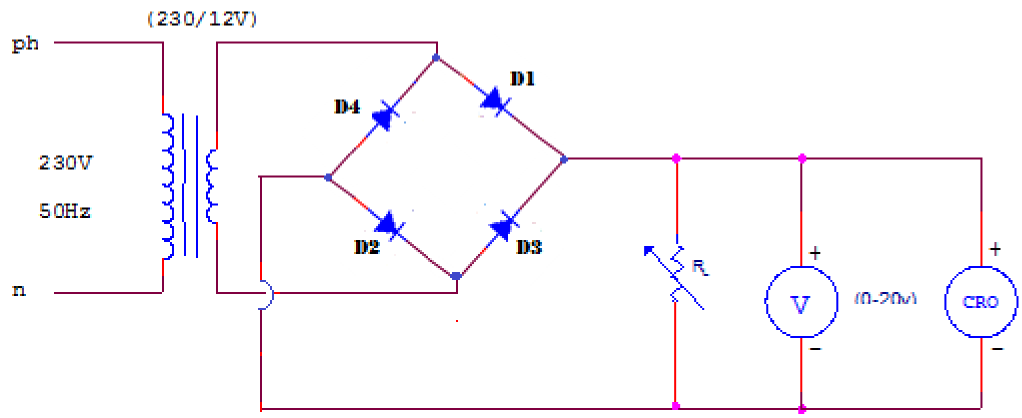
The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier has four diodes connected to form a Bridge. The load resistance is connected between the other two ends of the bridge.

For the positive half cycle of the input ac voltage, diode D1 and D3 conducts whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance RL and hence the load current flows through R_L .

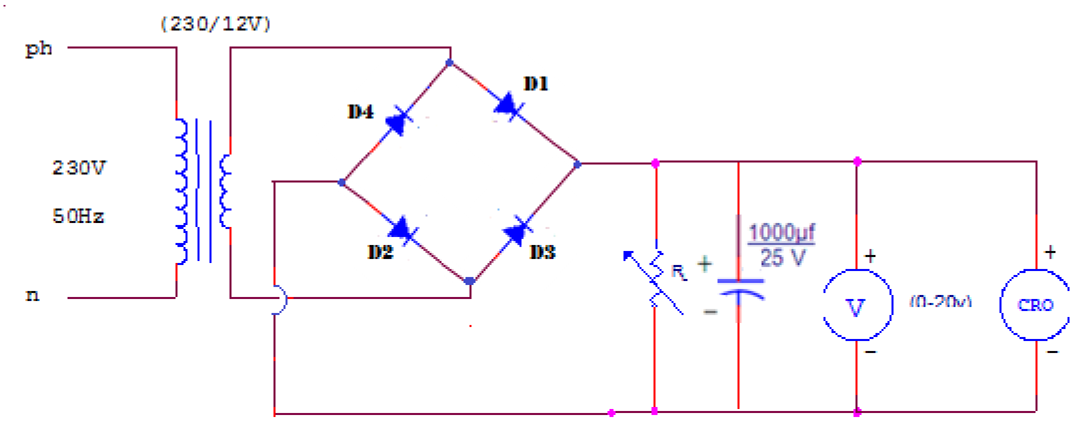
For the negative half cycle of the input ac voltage, diode D2 and D4 conducts whereas diodes D1 and D3 remain in the OFF state. The conducting diodes will be in series with the load resistance RL and hence the load current flows through RL in the same direction as in the previous half cycle. Thus a bidirectional wave is converted into a unidirectional wave.

Circuit Diagram

Without Filter



With Filter



<u>Theoretical calculations for Ripple factor:-</u>

<u>Without Filter:-</u>

$$V_{dc} = \frac{2V_m}{\pi}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$$\text{Ripple factor } = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} \quad = 0.482$$

<u>With Filter</u>:-

$$\text{Ripple factor} = \frac{1}{4\sqrt{3}\, fCR_L} =$$

Where f =50Hz
C =1000µF
R_L=1KΩ

Experiment (without filter)

1. Connections are made as per the circuit diagram of the rectifier without filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4. Measure the amplitude and timeperiod of the transformer secondary(input waveform) by connecting CRO.

5. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

Experiment (With filter)

1. Connections are made as per the circuit diagram of the rectifier with filter.

2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.

3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.

4. Measure the amplitude and timeperiod of the transformer secondary(input waveform) by connecting CRO.

5. Feed the rectified output voltage to the CRO and measure the time period and amplitude of the waveform.

Tabular Column: **Without Filter**

Using DMM:

V_{ac}	V_{dc}	Ripple Factor(γ)= V_{ac}/ V_{dc}

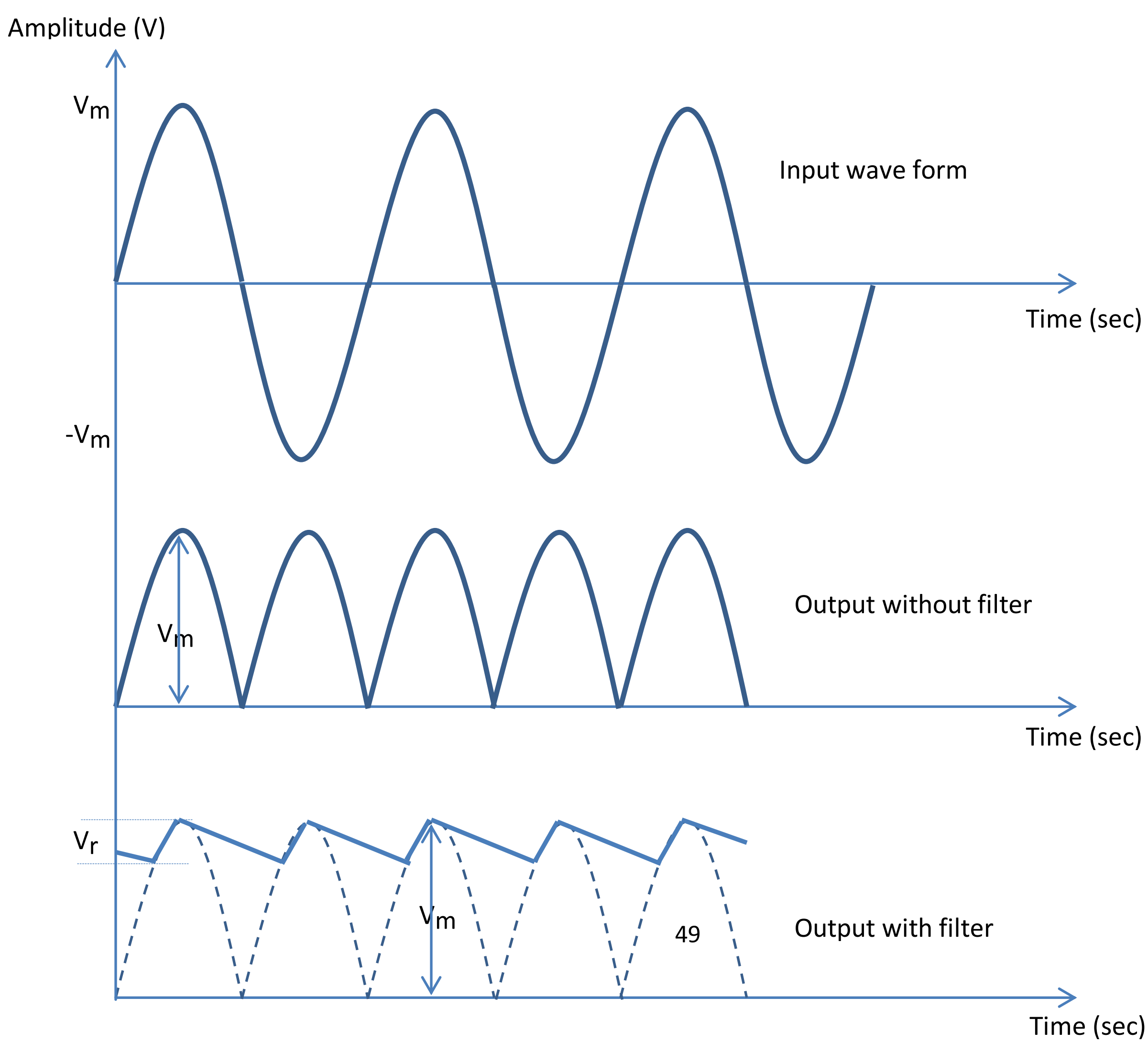
Using CRO : V_{NL}=

R_L (Ω)	V_L (V)	V_m (V)	$Vdc = \frac{2Vm}{\pi}$ (V)	$Vrms = \frac{Vm}{\sqrt{2}}$ (V)	$Vr(rms) = \sqrt{Vrms^2 - Vdc^2}$ (V)	R.F= $\frac{Vr(rms)}{Vdc}$	% Regulation = $\frac{V(NL)-V(L)}{VL}$

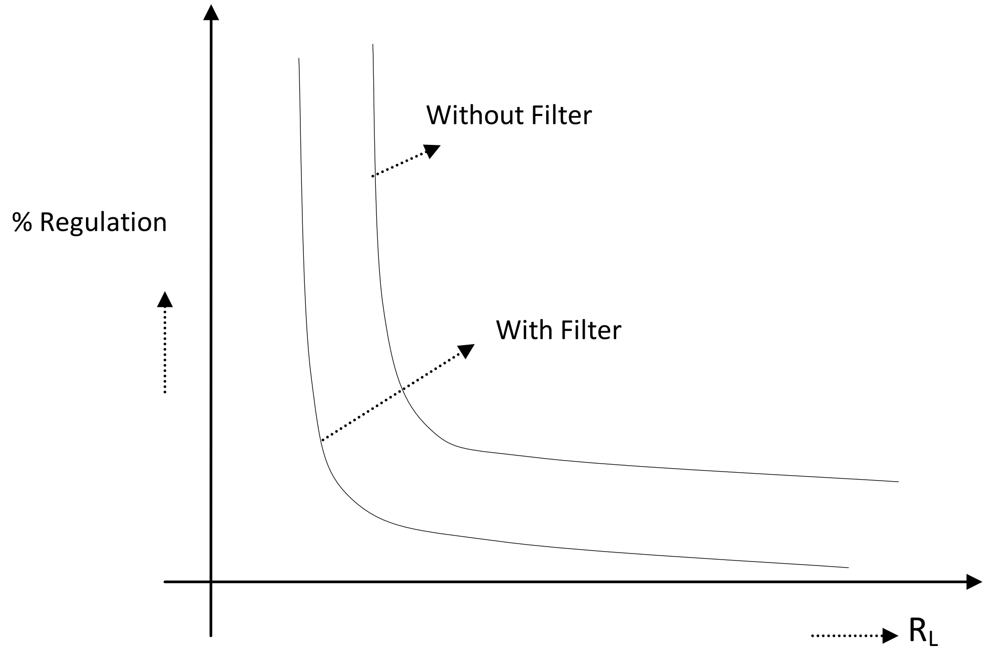
With Filter V_{NL}=

R_L (Ω)	V_L (V)	V_m (V)	V_r (V)	$Vdc = Vm - \frac{Vr}{2}$ (V)	$Vr(rms) = \frac{Vr}{4\sqrt{3}}$	R.F= $\frac{Vr(rms)}{Vdc}$	% Regulation = $\frac{V(NL)-V(L)}{VL}$

Model Graph:



REGULATION CHARACTERISTICS:



PRECAUTIONS:

1. The primary and secondary sides of the transformer should be carefully identified.
2. The polarities of the diode should be carefully identified.

Result: The input and output waveforms of Bridge wave rectifier is plotted and the ripple factor and regulation at 1100Ω are

Ripple factor with out Filter =

Ripple factor with Filter =

%Regulation=

VIVA QUESTIONS:

1. What are the advantages of Bridge rectifiers when compared to other rectifiers?

2. How the regulation is improved in bridge rectifier?

3. What is the necessity of step down transformer?

4. Compare HWR, FWR and Bridge Rectifier.

8.Common Base Configuration

Objective :

To plot the input and output characteristics of a transistor in CB Configuration and to compute the h – parameters.

Apparatus

S.No	Apparatus	Type	Range	Quantity
01	Transistor	BC107		01
02	Resistance		1KΩ	02
03	Regulated Power supply		(0-30V)	02
04	Ammeter		(0-100mA)	02
05	Voltmeter		(0-2V),(0-20V)	01
06	Breadboard and Wires			

Introduction:

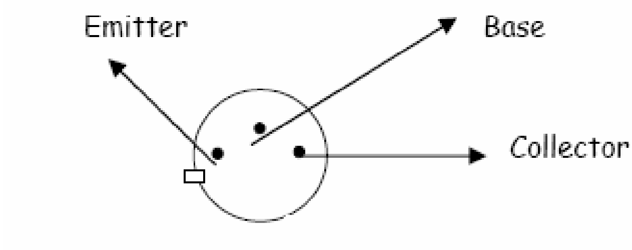
Bipolar junction transistor (BJT) is a 3 terminal (emitter, base, collector) semiconductor device. There are two types of transistors namely NPN and PNP. It consists of two P-N junctions namely emitter junction and collector junction.

In Common Base configuration the input is applied between emitter and base and the output is taken from collector and base. Here base is common to both input and output and hence the name common base configuration.

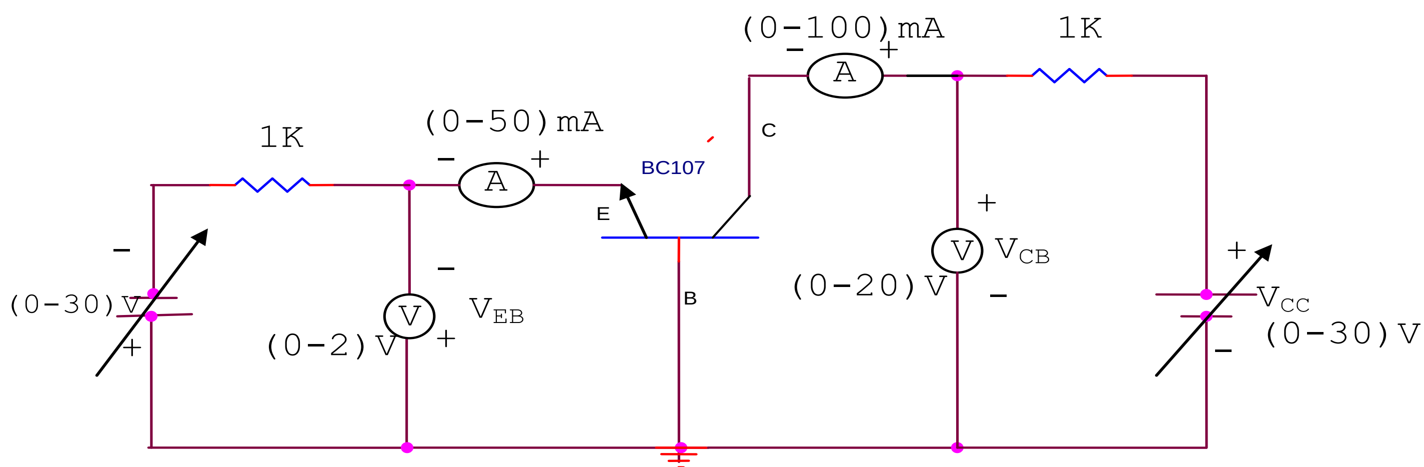
Input characteristics are obtained between the input current and input voltage taking output voltage as parameter. It is plotted between V_{EB} and I_E at constant V_{CB} in CB configuration.

Output characteristics are obtained between the output voltage and output current taking input current as parameter. It is plotted between V_{CB} and I_C at constant I_E in CB configuration.

PIN Assingnment



Circuit Diagram



Precautions:

1. While doing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.

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.

4. Make sure while selecting the emitter, base and collector terminals of the transistor.

Experiment

Input Characteristics

1. Connect the transistor in CB configuration as per circuit diagram

2. Keep output voltage V_{CB} = 0V by varying V_{CC}.

3. By varying V_{EE} , vary V_{EB} in steps of 0.1V and note down emitter current I_E.

4. Repeat above procedure (step 3) for various values of V_{CB} (V_{CB}=5V and V_{CB}=10V)

Output Characteristics

1. Make the connections as per circuit diagram.
2. By varying V_{EE} keep the base current I_E =10mA.
3. By varying V_{CC} ,vary V_{CB} in steps of 1V and note down the readings of collector-current (I_C).
4. Repeat above procedure (step 3) for different values of I_E (I_E=15mA & I_E=20mA)

Tabular column

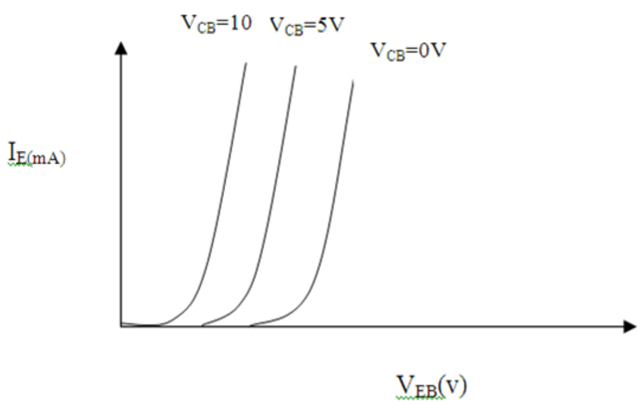
Input Characteristics

V_{CB}= 0 V		V_{CB}= 5V		V_{CB} = 10 V	
V_{EB} (V)	I_E(mA)	V_{EB} (V)	I_E (mA)	V_{EB} (V)	I_E (mA)

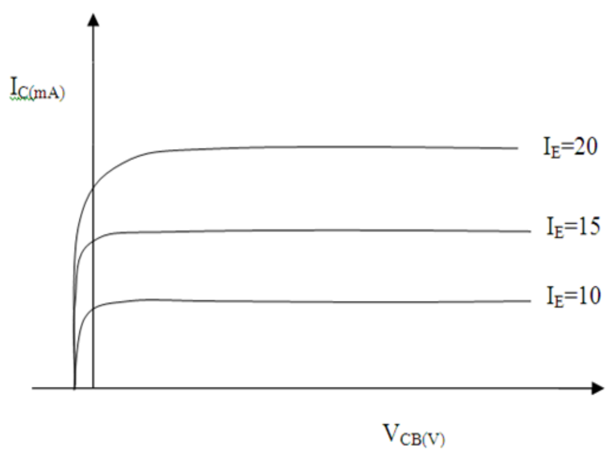
Output Characteristics

I_E = 10 mA		I_E = 15 mA		I_E = 20 mA	
V_{CB} (V)	I_C (mA)	V_{CB} (V)	I_C (mA)	V_{CB} (V)	I_C (mA)

Model Graph



Input characteristics



Output characteristics

Calculations from the Graph

Input characteristics

a) Input impedance(h_{ib})= ΔV_{EB} / ΔI_E , V_{CB} constant.

b) Reverse voltage gain(h_{rb})= ΔV_{EB}/Δ V_{CB} , I_E constant

Output characteristics

a) Output admittance(h_{ob})= ΔIc / Δ V_{CB} , I_E constant

b) Forward current gain(h_{fb})= ΔIc / ΔI_E , V_{CB} constant

Result:

Thus the input and output characteristics of CB configuration are plotted and h parameters are found.

a) Input impedance(h_{ib})=

b) Forward current gain(h_{fb})=

c) Output admittance(h_{ob})=

d) Reverse voltage gain(h_{rb})=

VIVA QUESTION:

1. What is Early effect?
2. Draw the small signal model of BJT Common Base Configuration.
3. What is Reach –Through effect?
4. What are the applications of Common Base.
5. What will be the parameters of CB.
6. Explain the Transistor operation?

9.Common Emitter Configuration

Objective :

To plot the input and output characteristics of a transistor in CE Configuration and to compute the h – parameters.

Apparatus

S.No	Apparatus	Type	Range	Quantity
01	Transistor	BC107		01
02	Resistance		300KΩ,1KΩ	01
03	Regulated Power supply		(0-30V)	01
04	Ammeter		(0-100mA),(0-100µA)	01
05	Voltmeter		(0-2V),(0-20V)	01
06	Breadboard and Wires			

Introduction:

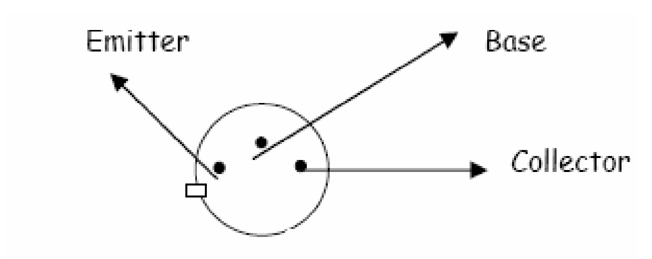
Bipolar junction transistor (BJT) is a 3 terminal (emitter, base, collector) semiconductor device. There are two types of transistors namely NPN and PNP. It consists of two P-N junctions namely emitter junction and collector junction.

In Common Emitter configuration the input is applied between base and emitter and the output is taken from collector and emitter. Here emitter is common to both input and output and hence the name common emitter configuration.

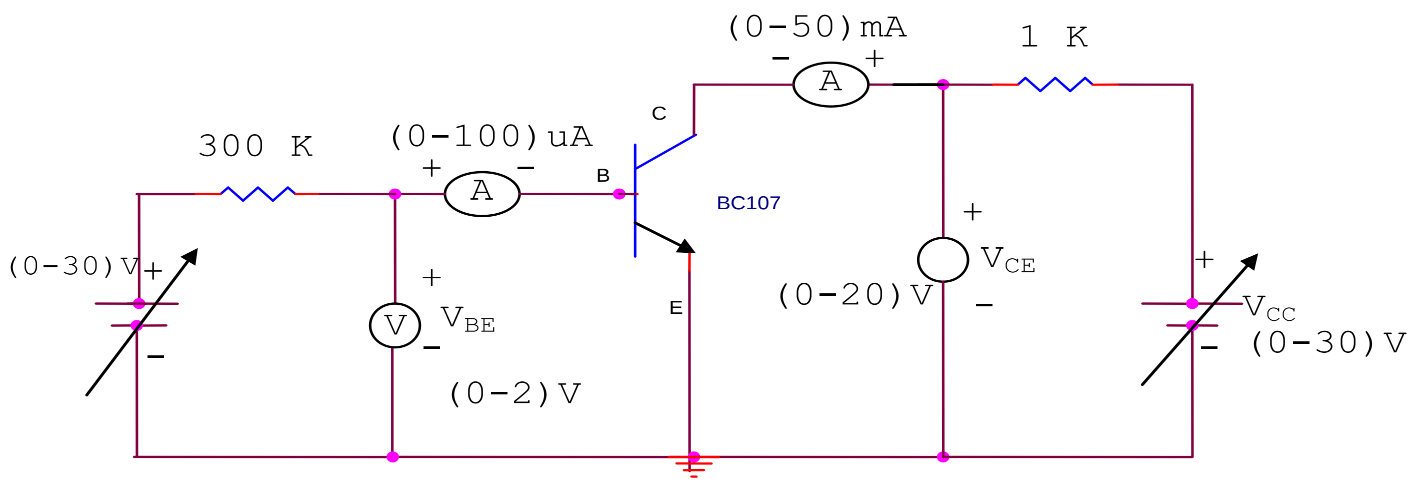
Input characteristics are obtained between the input current and input voltage taking output voltage as parameter. It is plotted between V_{BE} and I_B at constant V_{CE} in CE configuration.

Output characteristics are obtained between the output voltage and output current taking input current as parameter. It is plotted between V_{CE} and I_C at constant I_B in CE configuration.

PIN Assingnment



Circuit Diagram



Precautions:

1. While doing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.

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.

4. Make sure while selecting the emitter, base and collector terminals of the transistor.

Experiment

Input Characteristics

1. Connect the transistor in CE configuration as per circuit diagram

2. Keep output voltage V_{CE} = 0V by varying V_{CC}.

3. By varying V_{BB} ,vary V_{BE} in steps of 0.1V and note down base current I_B .

4. Repeat above procedure (step 3) for various values of V_{CE} (V_{CE}=5V and V_{CE}=10V)

5. Plot the input characteristics by taking V_{BE} on X-axis and I_B on Y-axis at constant V_{CE}.

Output Characteristics

1. Make the connections as per circuit diagram.

2. By varying V_{BB} keep the base current I_B = 0µA.

3.By varying V_{CC} , vary V_{CE} in steps of 1V and note down the readings of collector-current (I_C)

4. Repeat above procedure (step 3) for different values of I_B

5.Plot the output characteristics by taking V_{CE} on x-axis and I_C on y-axis by taking I_B as a constant parameter.

Tabular column

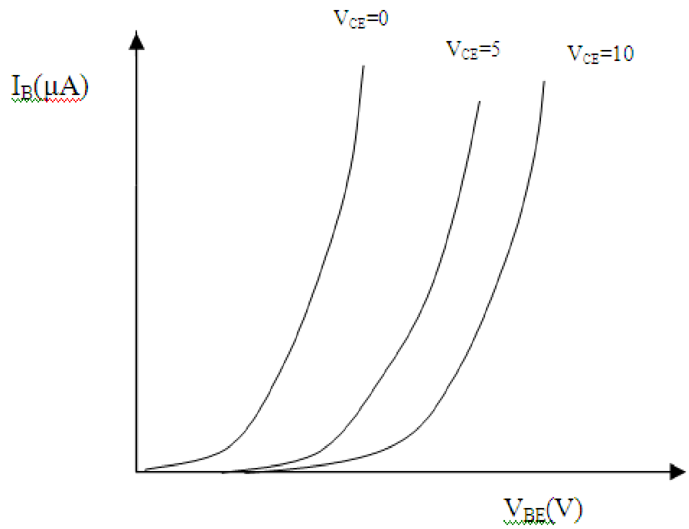
Input Characteristics

V_{CE}= 0 V		V_{CE}= 5 V		V_{CE} = 10 V	
V_{BE} (V)	I_B (µA)	V_{BE} (V)	I_B (µA)	V_{BE} (V)	I_B (µA)

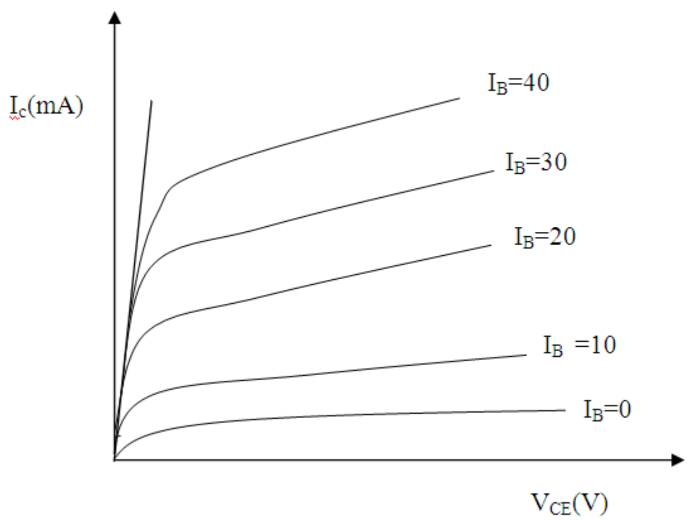
Output Characteristics

I_B = 0 µA		I_B = 10 µA		I_B = 20 µA	
V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)

Model Graph



Input characteristics



Output characteristics

Calculations from graph:

Input characteristics

a) Input impedance(h_{ie})= $\Delta V_{BE} / \Delta I_B$, V_{CE} constant.

b) Reverse voltage gain(h_{re})= $\Delta V_{BE}/\Delta V_{CE}$, I_B constant

Output characteristics

a) Output admittance(h_{oe})= $\Delta Ic / \Delta V_{CE}$, I_B constant

b) Forward current gain(h_{fe})= $\Delta Ic / \Delta I_B$, V_{CE} constant

Result:

Thus the input and output characteristics of CE configuration is plotted.

a) Input impedance(h_{ie})=

b) Forward current gain(h_{fe})=

c) Output admittance(h_{oe})=

d) Reverse voltage gain(h_{re})=

VIVA QUESTION:

1. Why CE configuration is most widely used?
2. Draw the equivalent Circuit of C.E
3. What is the Current Gain,voltage gain,i/p and o/p impedance in CE?.
4. Relation between ‘α’ and ‘β’ and γ
5. Give the condition to operate the given Transistor in active,saturation &Cut-off Regions
6. What is Emitter Efficiency?

10. Drain and transfer characteristics of JFET

Objective

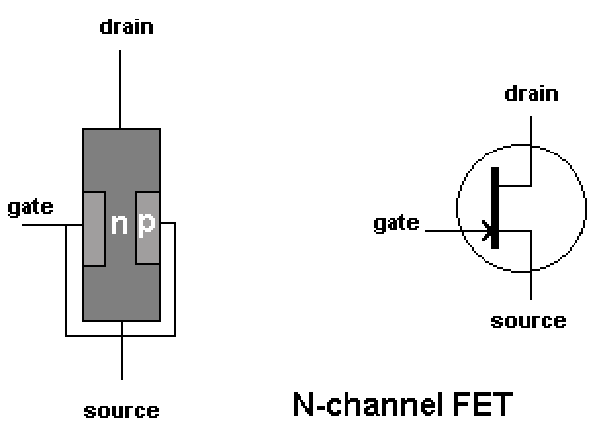
1.To study Drain characteristics and Transfer characteristics

2.To find the Transconductance ,Drain resistance and Amplification factor

Apparatus

S.No	Apparatus	Type	Range	Quantity
01	JFET	BFW10		01
02	Resistance		1KΩ	01
03	Regulated Power supply		(0-30V)	01
04	Ammeter		(0-100mA)	01
05	Voltmeter		(0-10V),(0-20V)	01
06	Breadboard and Wires			

Introduction:



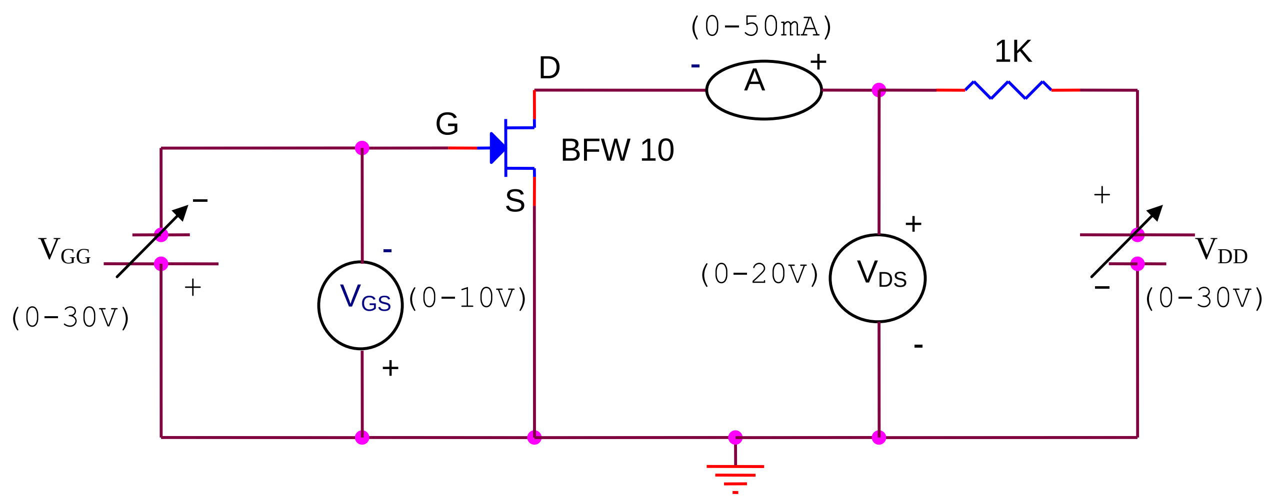
N-channel FET

The field effect transistor (FET) is made of a bar of N type material called the SUBSTRATE with a P type junction (the gate) diffused into it. With a positive voltage on the drain, with respect to the source, electron current flows from source to drain through the CHANNEL.

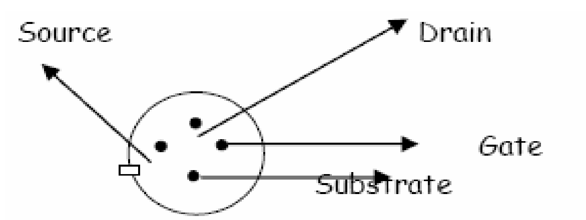
If the gate is made negative with respect to the source, an electrostatic field is created which squeezes the channel and reduces the current. If the gate voltage is high enough the channel will be "pinched off" and the current will be zero. The FET is voltage controlled, unlike the transistor which is current controlled. This device is sometimes called the junction FET or IGFET or JFET.

If the FET is accidentally forward biased, gate current will flow and the FET will be destroyed. To avoid this, an extremely thin insulating layer of silicon oxide is placed between the gate and the channel and the device is then known as an insulated gate FET, or IGFET or metal oxide semiconductor FET (MOSFET) Drain characteristics are obtained between the drain to source voltage (V_{DS}) and drain current (I_D) taking gate to source voltage (V_{GS}) as the parameter. Transfer characteristics are obtained between the gate to source voltage (V_{GS}) and Drain current (I_D) taking drain to source voltage (V_{DS}) as parameter

Circuit Diagram



Pin assignment of FET:



Precautions:

1. While doing the experiment do not exceed the ratings of the FET. This may lead to damage the FET.
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.
4. Make sure while selecting the Source, Drain and Gate terminals of the FET.

Experiment:

Drain characteristics

1.By Varying V_{GG} keep V_{GS} = 0v.

2.By varying V_{DD} , vary V_{DS} in steps of 0.5V and note down corresponding I_D

3.Repeat the above procedure for different values of V_{GS} (i.e. V_{GS}=-1V & V_{GS}=-2V)

4.Plot its characteristics with respect to V_{DS} versus I_D

Transfer characteristics:

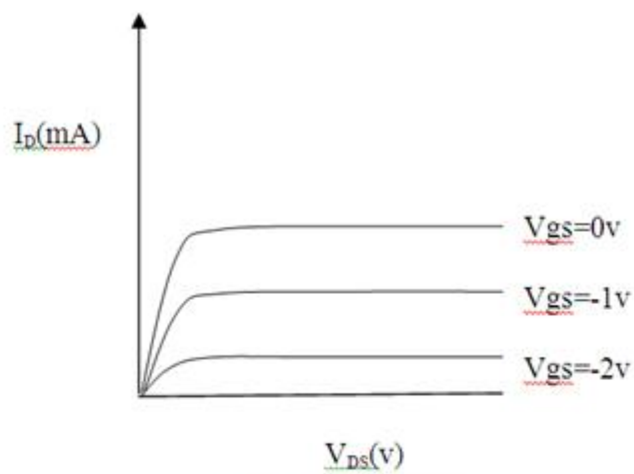
1.By Varying V_{DD} keep V_{DS} = 1v.

2.By varying V_{GG} , vary V_{GS} in steps of 0.5V and note down corresponding I_D

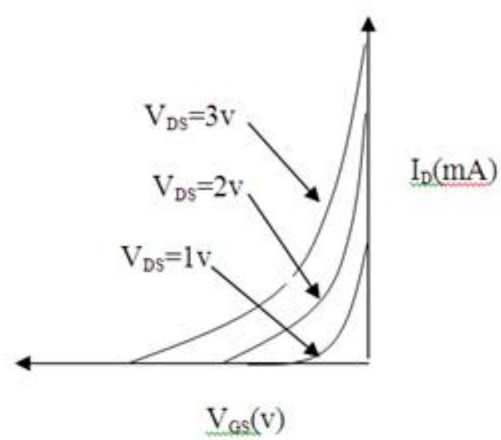
3.Repeat the above procedure for different values of V_{DS} (i.e. V_{DS}=2V & V_{DS}=3V)

4.Plot its characteristics with respect to V_{GS} versus I_D

Model Graph



Drain characteristics



Transfer Characteristics

Tabular column

Drain Characteristics

V_{GS} = 0V		V_{GS} = -1V		V_{GS} = -2V	
V_{DS}(V)	I_D (mA)	V_{DS} (V)	I_D (mA)	V_{DS} (V)	I_D (mA)

Transfer Characteristics

V_{DS} = 1V		V_{DS} = 3V		V_{DS} = 5V	
V_{GS}(V)	I_D (mA)	V_{GS} (V)	I_D (mA)	V_{GS} (V)	I_D (mA)

Graph (Instructions):

1. Plot the drain characteristics by taking V_{DS} on X-axis and I_D on Y-axis at constant V_{GS}.
2. Plot the Transfer characteristics by taking V_{GS} on X-axis and I_D on Y-axis at constant V_{DS}.

Calculations from graph:

Drain characteristics

Drain resistance is given by the ration of small change in drain to source voltage (ΔV_{DS}) to the corresponding change in Drain current (ΔI_D) for a constant gate to source voltage (V_{GS}), when the JFET is operating in pinch-off or saturation region.

Drain resistance (r_d) = $\frac{\Delta V_{DS}}{\Delta I_D}$ (Ω) at constant V_{GS}

Transfer characteristics

Ratio of small change in drain current (ΔI_D) to the corresponding change in gate to source voltage (ΔV_{GS}) for a constant V_{DS}. $g_m = \Delta I_D / \Delta V_{GS}$ at constant V_{DS} . (from transfer characteristics) The value of gm is expressed in mho's or siemens (s).

Mutual conductance (g_m) = $\frac{-\Delta I_D}{\Delta V_{GS}}$

Amplification Factor (μ) :

It is given by the ratio of small change in drain to source voltage (ΔV_{DS}) to the corresponding change in gate to source voltage (ΔV_{GS}) for a constant drain current.

$\mu = \Delta V_{DS} / \Delta V_{GS}$.

$\mu = (\Delta V_{DS} / \Delta I_D) X (\Delta I_D / \Delta V_{GS})$

$\mu = r_d X g_m$.

Result

Drain resistance (r_d) =

Mutual conductance (g_m) =

Amplification factor(μ)=

Viva Questions:

1 .What is meant by Field Effect Transistor?

2. What is meant by Uniploar and bipolar?

3. What is the difference between BJT and FET?

4. What are the characteristics of FET

5. What is Pinch Off Voltage?

6. Why FET is called Voltage controlled Device?

7. Draw Small Signal model of FET.

8. What are the advantages of FET?

11. Frequency response of CE amplifier

Objective:

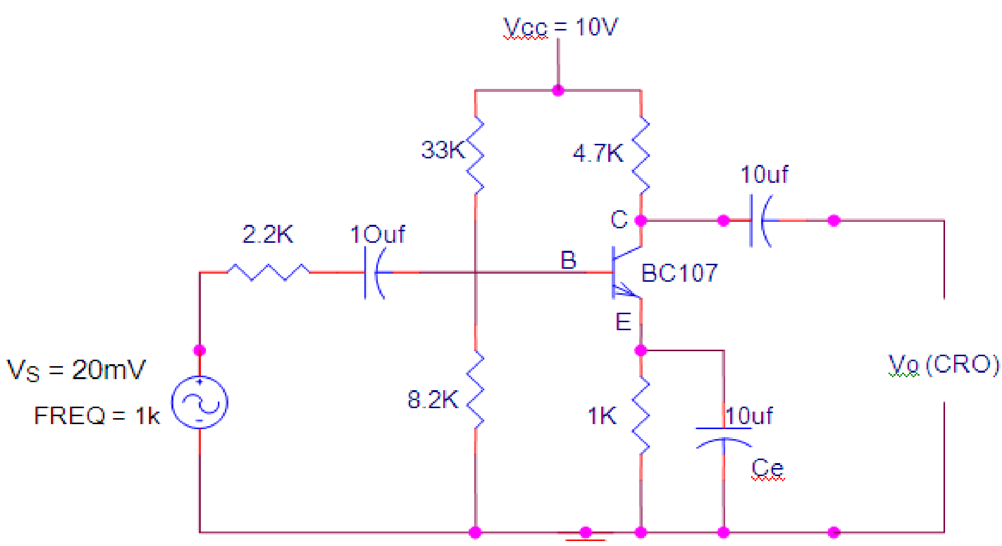
1.To obtain Frequency response characteristics of Common emitter amplifier and

2.To determine Bandwidth.

Apparatus

S.No	Apparatus	Type	Range	Quantity
01	Transistor	BC107		01
02	Resistance		33KΩ,4.7 KΩ,2.2 KΩ 8.2 KΩ,1 KΩ	01
03	Regulated Power supply		(0-30V)	01
04	Capacitor		10µF	03
05	Signal Generator		10-1M Hz	01
06	CRO			01
07	Breadboard and Wires ,CRO Probes			

Circuit Diagram



Experiment

1. Connections are made as per the circuit diagram.

2. A 10V supply is given to the circuit.

3. A certain amplitude of input signal (say 20mv at 1 kHz) is kept constant using signal generator and for different frequencies, the output voltage (V_0) from CRO are noted.

4. Gain for with and without feedback is calculated using $Gain(dB) = 20\log\frac{V_0}{V_i}$

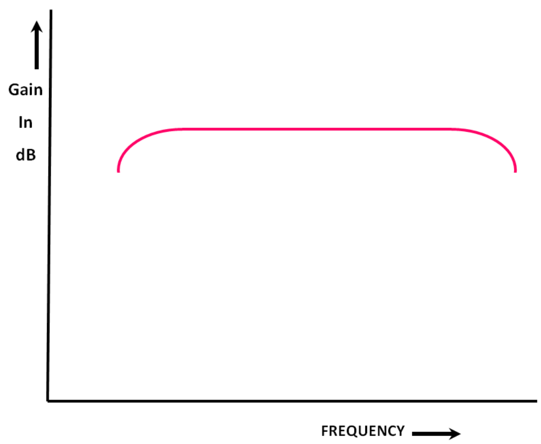
Where V_o is output voltage, V_i is input voltage.

5.Plot the graph between Gain(in dB) and frequency.

Tabular Column

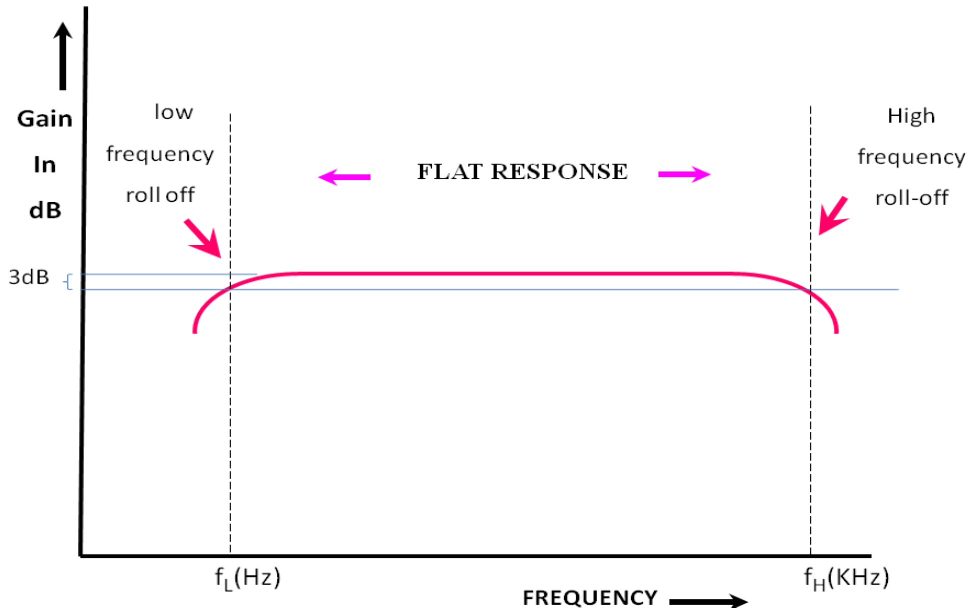
S.no.	Input frequency (Hz)	o/p voltage(v_o) (mv)	voltage gain Av= $\frac{V_0}{V_i}$	$Gain(dB) = 20\log\frac{V_0}{V_i}$
	10Hz To 1MHz			

Model Graph



Caluculations from Graph

1.Draw a line at maximum gain(dB) less than by 3dB parallel to the X-axis as shown in the figure



2.Draw two lines at the intersection of the characteristic curve and the 3dB line onto the X-axis which gives the (f_H) and (f_L)

3.The difference between f_H and f_L gives the Bandwidth of the amplifier.

Precautions:

1. While doing the experiment do not exceed the ratings of the transistor. This may lead to damage the transistor.
2. Do not switch **ON** the power supply unless you have checked the circuit connections as per the circuit diagram.
3. Make sure while selecting the emitter, base and collector terminals of the transistor.

Result

Frequency response of CE amplifier was plotted and Bandwidth was determined and it is given as BW=

VIVA QUESTIONS:

1.What is an amplifier?

2.Explian the effect of capacitors on frequency response?

3.why gain is constant in mid frequency region?

4.what is bandwidth.

5.what is the relation between bandwidth and gain?

12.Frequency response of Common Source FET amplifier

Objective:

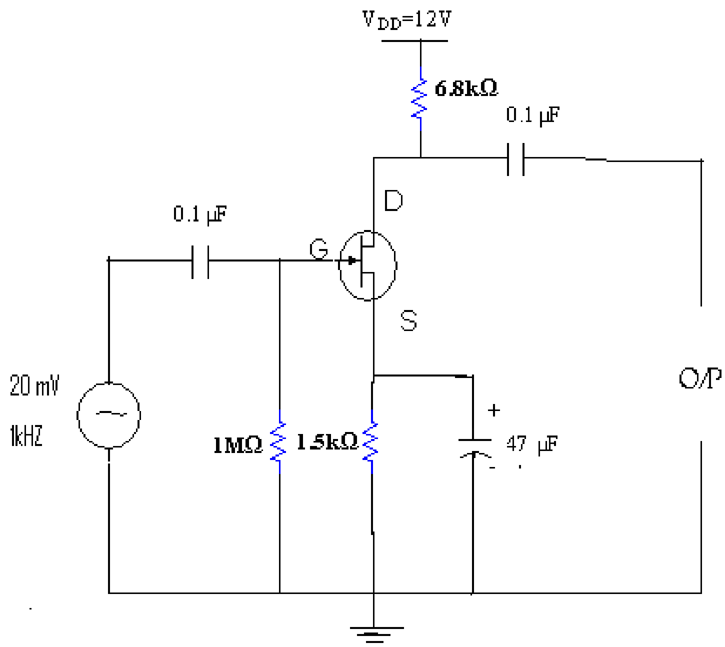
1.To obtain Frequency response characteristics of Common Source FET amplifier

2.To determine Bandwidth.

Apparatus

S.No	Apparatus	Type	Range	Quantity
01	N-Channel FET	BFW10		01
02	Resistance		(6.8KΩ, 1MΩ, 1.5KΩ)	01
03	Regulated Power supply		(0-30V)	01
06	Capacitor		(0.1μF, 0.1μF, 47μF)	01
07	Signal Generator		10-1M Hz	01
08	CRO			01
09	Breadboard and Wires ,CRO Probes			

Circuit Diagram



Experiment

1. Connections are made as per the circuit diagram.
2. A 10V supply is given to the circuit.
3. A certain amplitude of input signal (say 20mv at 1 kHz) is kept constant using signal generator and for different frequencies, the output voltage (V_0) is taken at Drain from CRO .
4. Gain of the amplifier is calculated using $Gain(dB) = 20\log\frac{V_0}{V_i}$

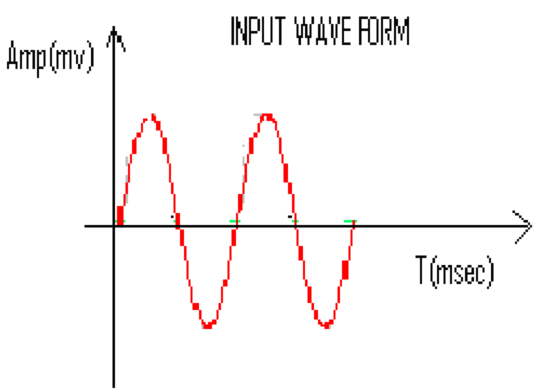
Where V_o is output voltage, V_i is input voltage.

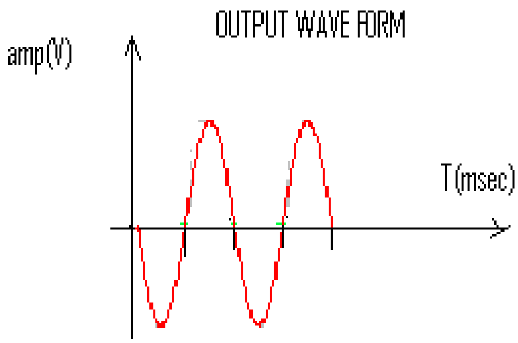
5.Plot the graph between Gain in dB and frequency.

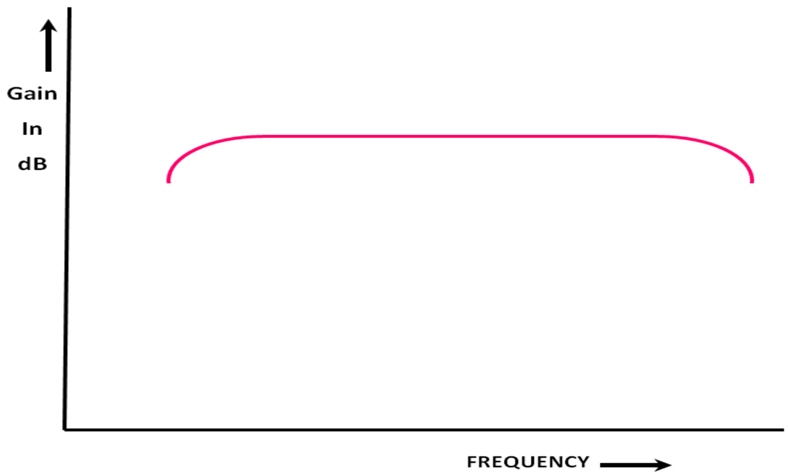
Tabular Column **V_{in}=**

S.no.	Input frequency (Hz)	O/p voltage(V_O) (mv)	voltage gain Av= $\frac{V_0}{V_i}$	$Gain(dB) = 20\log\frac{V_0}{V_i}$
	10Hz To 1MHz			

Model Graph

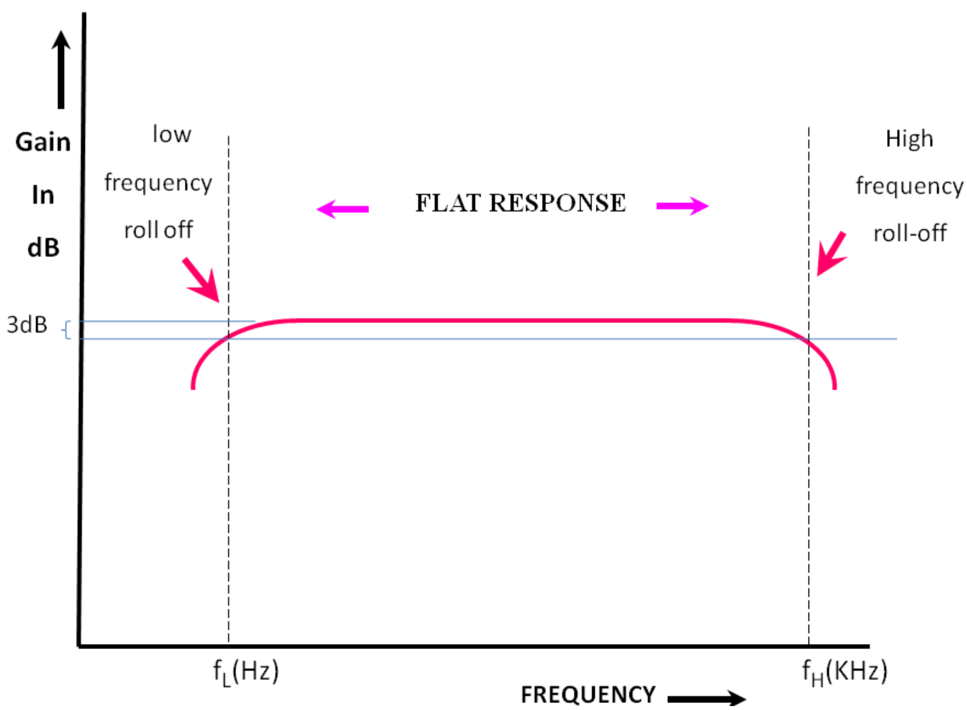






Calculations from Graph

1.Draw a line at maximum gain(dB) less than by 3dB parallel to the X-axis as shown in the figure



2.Draw two lines at the intersection of the characteristic curve and the 3dB line onto the X-axis which gives the (f_H) and (f_L)

3.The difference between f_H and f_L gives the Bandwidth of the amplifier.

Precautions:

1. While doing the experiment do not exceed the ratings of the transistor. This may lead to damage of the transistor.
2. Do not switch **ON** the power supply unless you have checked the circuit connections as per the circuit diagram.
3. Transistor terminals must be identified properly.

Result

Frequency response of CS FET amplifier was plotted and Bandwidth was determined and it is given as BW=

VIVA QUESTIONS:

1.What is an amplifier?

2.Explian the effect of capacitors on frequency response?

3.why gain is constant in mid frequency region?

4.what is bandwidth?

5.what is the relation between bandwidth and gain?

13. Comparison of Performance of Self Bias and Fixed Bias Circuits

Objective: To Compare the relationship between I_C & I_{CO} for Self Bias and Fixed Bias Circuits and find the stability factor for each case.

Apparatus:

S.No	Apparatus	Type	Range	Quantity
01	Transistor	BC107		01
02	Resistance		470Ω,220Ω,100KΩ,1 KΩ	01
03	Regulated Power supply		(0-30V)	02
04	Ammeters		0-50µA,100mA	01
05	DRB			02
06	Breadboard and Wires			

Theory:

One of the basic problems with transistor amplifiers is establishing and maintaining the proper values of quiescent current and voltage in the circuit. This is accomplished by selecting the proper circuit-biasing conditions and ensuring these conditions are maintained despite variations in ambient (surrounding) temperature, which cause changes in amplification and even distortion (an unwanted change in a signal). Thus a need arises for a method to properly bias the transistor amplifier and at the same time stabilize its dc operating point (the no signal values of collector voltage and collector current). As mentioned earlier, various biasing methods can be used to accomplish both of these functions. Although there are numerous biasing methods, only three basic types will be considered.

TYPES OF BIAS

- Base-Current Bias (Fixed Bias)
- Emitter to Collector Bias
- Self-Bias

Self-Bias

A better method of biasing is obtained by inserting the bias resistor directly between the base and collector, as shown in figure 2-13. By tying the collector to the base in this manner, feedback voltage can be fed from the collector to the base to develop forward bias. This arrangement is called SELF-BIAS.

Now, if an increase of temperature causes an increase in collector current, the collector voltage (V_C) will fall because of the increase of voltage produced across the load resistor (R_L). This drop in V_C will be fed back to the base and will result in a decrease in the base current. The decrease in base current will oppose the original increase in collector current and tend to stabilize it. The exact opposite effect is produced when the collector current decreases.

Self-bias has two small drawbacks: (1) It is only partially effective and, therefore, is only used where moderate changes in ambient temperature are expected; (2) it reduces amplification since the signal on the collector also affects the base voltage. This is because the collector and base signals for this particular amplifier configuration are 180 degrees out of phase (opposite in polarity) and the part of the collector signal that is fed back to the base cancels some of the input signal. This process of returning a part of the output back to its input is known as DEGENERATION or NEGATIVE FEEDBACK. Sometimes degeneration is desired to prevent amplitude distortion (an output signal that fails to follow the input exactly) and self-bias may be used for this purpose.

A circuit which is used to establish a stable operating point is the self-biasing. The current in the resistance R_E in the emitter lead causes a voltage drop which is in the direction to reverse-bias the emitter junction. Since this junction must be forward-biased, the base voltage is obtained from h_e supply through the R_1& R_2 network. Now, if IC tends to increase, say, because I_{CO} has rise as a result of an elevated temperature, the current in R_E increases. Hence IC will increase less than it would
have, had there been no self-biasing resistor R_E. This combines features of fixed bias and constant base bias.

Circuit Diagram:

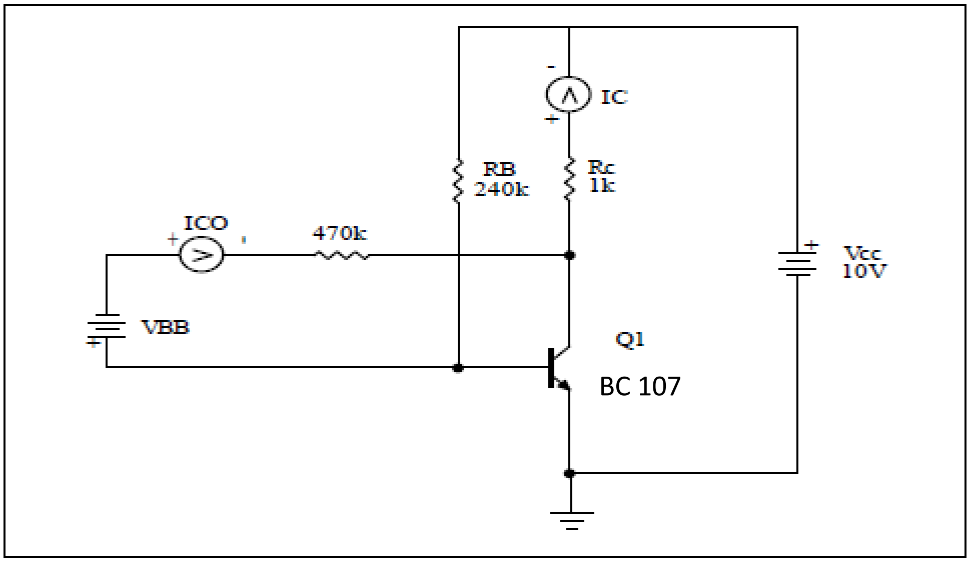


Fig.(4): Fixed Biasing Circuit with I_{CO} source for test

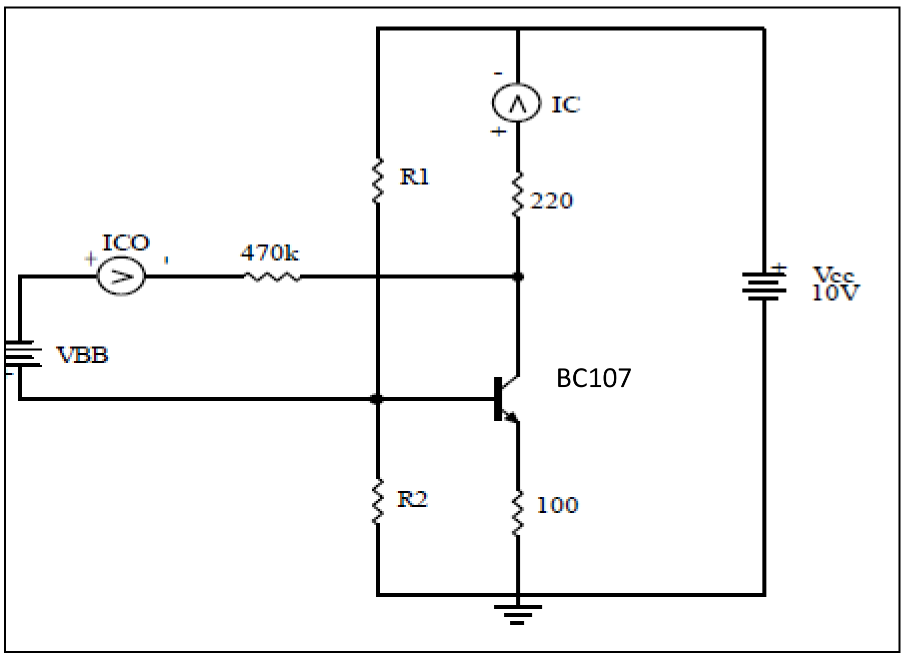


Fig.(5): Self-bias circuit with I_{CO} source for test

Procedure:

1. Connect the circuit shown in Fig.(4).
2. Change values of "RB" until IC=5mA, then record the value of RB.
3. Connect the source which gives ICO. Then change the voltage source until ICO= 15µA. Record the value of collector current IC.
4. Repeat step (3) for ICO = (20, 25, 30)µ A.
5. Connect the circuit shown in Fig.(5)

6. Record the value of collector current without ICO.
7. Repeat steps (3, 4) for R1=   kΩ & R2=   kΩ.
8. Repeat steps (6, 7) for R1=   kΩ & R2=   kΩ.
9. Plot the relationship between IC & ICO for two circuits.
10. Find the stability factor for each case.

Calculations:

Circuit Analysis for self bias circuit

Analysis begins with KVL around B-E loop:

$$V_{BB} = I_B R_B + V_{BE} + I_E R_E$$

But in the active region $I_E = (\beta + 1) I_B$:

$$V_{BB} = I_B R_B + V_{BE} + (\beta + 1) I_B R_E$$

Now we solve for I_B :

$$I_B = \frac{V_{BB} - V_{BE}}{R_B + (\beta + 1) R_E}$$

And multiply both sides by β :

$$\beta I_B = I_C = \frac{\beta (V_{BB} - V_{BE})}{R_B + (\beta + 1) R_E}$$

We complete the analysis with KVL around C-E loop:

$$V_{CE} = V_{CC} - I_C R_C - I_E R_E$$

Bias Stability

Bias stability can be illustrated with equation below:

$$\beta I_B = I_C = \frac{\beta (V_{BB} - V_{BE})}{R_B + (\beta + 1) R_E}$$

Notice that if $R_E = 0$, we have *fixed bias*. While if $R_B = 0$, we have *constant base bias*.

To maximize bias stability:

1. We minimize variations in I_C with changes in β.

By letting $(\beta + 1) R_E >> R_B$, then β and (β + 1) nearly cancel in above equation

$$\left.\begin{array}{ll} \textit{Rule of Thumb:} & \text{let } (\beta + 1) R_E \approx 10\, R_B \\ \textit{Equivalent Rule:} & \text{let } I_{R_2} \approx 10 I_{B_{max}} \end{array}\right\} \quad \beta = 100$$

2. We also minimize variations in I_C with changes in V_{BE} . . .

By letting $V_{BB} >> V_{BE}$

$$\textit{Rule of Thumb:} \quad \text{let } V_{R_C} \approx V_{CE} \approx V_{R_E} \approx \frac{1}{3} V_{CC}$$

Because $V_{R_E} \approx V_{BB}$ if V_{BE} and I_B are small.

For β = 100 (and V_{BE} = 0.7 V):

$$I_B = \frac{V_{BB} - V_{BE}}{R_B + (\beta+1)R_E} = 41.2\ \mu\text{A} \quad \Rightarrow \quad I_C = \beta I_B = 4.12\ \text{mA}$$

$$\Rightarrow \quad I_E = \frac{I_C}{\alpha} = 4.16\ \text{mA} \quad \Rightarrow \quad V_{CE} = V_{CC} - I_C R_C - I_E R_E = 6.72\ \text{V}$$

For β = 300:

$$I_B = \frac{V_{BB} - V_{BE}}{R_B + (\beta+1)R_E} = 14.1\ \mu\text{A} \quad \Rightarrow \quad I_C = \beta I_B = 4.24\ \text{mA}$$

$$\Rightarrow \quad I_E = \frac{I_C}{\alpha} = 4.25\ \text{mA} \quad \Rightarrow \quad V_{CE} = V_{CC} - I_C R_C - I_E R_E = 6.50\ \text{V}$$

Thus we have achieved a reasonable degree of bias stability.

<u>The Fixed Bias Circuit</u>

For β = 100

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{15\ \text{V} - 0.7\ \text{V}}{200\text{k}\Omega} = 71.5\mu\text{A}$$

$$I_C = \beta I_B = 7.15\ \text{mA} \quad \Rightarrow \quad V_{CE} = V_{CC} - I_C R_C = 7.85\ \text{V}$$

For β = 300

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{15\ \text{V} - 0.7\ \text{V}}{200\text{k}\Omega} = 71.5\ \mu\text{A}$$

$$I_C = \beta I_B = 21.5\text{mA} \quad \Rightarrow \quad V_{CE} = V_{CC} - I_C R_C = -6.45\ \text{V}$$

RESULT:

Thus we can conclude that fixed bias provides *extremely poor bias stability*.

QUESTIONS:

1. What the factors effects on the selection operating point (Q-point).
2. What the effect of decrease the values of R1 and R2 on the stability factors.
3. What the disadvantage of using small values of R1 and R2.
4. Why we need stable operating point.
5. By using load line and Q-point, explain how the change in ICO effect on the amp Find the stability factor for each case. amplifier output.

14. Applications of Diodes

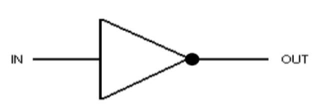
Objective: To verify the truth table for Logic Gates (AND & OR) using Diodes.

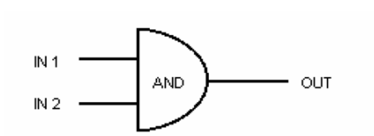
Apparatus:

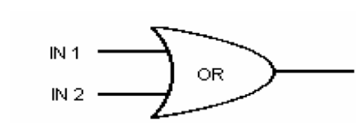
S.No	Apparatus	Type	Range	Quantity
01	Diode	IN4007		02
02	Resistance		1KΩ,10KΩ	01
03	Regulated power supply		(0-30V)	01
04	Voltmeter/Digital Multimeter			01
05	Breadboard and Wires			

Introduction

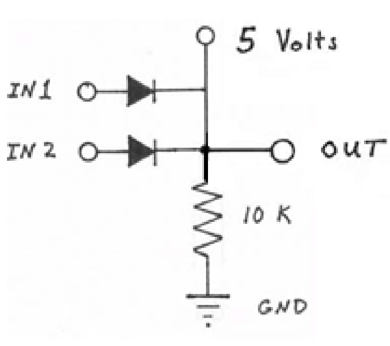
There are three types of basic Logic Operations. These can be executed by electronic circuits or devices (also called gates or switches). They are: AND, OR and NOT. AND and OR have two inputs and one output. NOT has one input and one output. Using 0's to represent 0 Volts and 1's to represent 5 Volts, the tables below show the outputs for all the possible inputs on the logic gates. Below each table (called a "truth table") is the electronic symbol for the device.



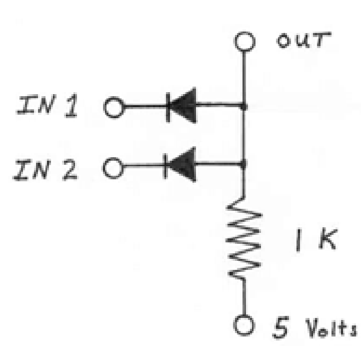




Circuit Diagram



DDL OR Gate



DDL AND Gate

Truth table

In1	In2	Output
0	0	0
0	1	1
1	0	1
1	1	1

In1	In2	Output
0	0	0
0	1	0
1	0	0
1	1	1

Precautions

1. Loose and wrong connections should be avoided.
2. Supply should be switched on only after giving all the input connections.
3. Power should be switched off while connecting.

Experiment

1.Connections are made as per the circuit diagram of AND gate.

2. Apply the supply of 5V

3.Give the In1 and In2 to the circuit according to the truth table (i.e for '0' apply 0V and for '1' apply 5V) and verify the output of the circuit and tabulate the readings

4.verify the truth table with the truth table of the AND gate.

5.Repeat the steps 1 to 4 for the circuit diagram of OR gate.

Tabular Column

Logic Gate	In1	In2	O/P
AND			

Logic Gate	In1	In2	O/P
OR			

Result: The truth tables of the AND and OR gates using DDL logic is verified.

VIVA QUESTIONS:

1. Explain about the switching action of transistor
2. Draw the internal diagram of PN diode
3. Give some applications of diode**.**

16.CHARACTERISTICS OF THERMISTOR

OBJECTIVE:

To study and verify the physical characteristics of the given thermistor and ccalculate the resistance of the thermistor and the temperature coefficient using the given formula for different temperatures

HARDWARE REQUIRED:

S.No	Apparatus	Type	Range	Quantity
01	Thermistor			01
02	Thermometer			01
03	Heater			01
04	Digital Multimeter			01
05	Breadboard and Wires			

INTRODUCTION:

A thermistor is a type of resistor whose resistance varies with temperature. The word thermistor is a combination of words “thermal” and “resistor”. A thermistor is a temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance proportional to a small change in temperature. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting over current protectors, and self-regulating heating elements. Assuming, as a first-order approximation, that the relationship between resistance and temperature is linear, then: R = k T Where R = change in resistance. T = change in temperature. k = first-order temperature coefficient of resistance Thermistors can be classified into two types depending on the sign of k. If k is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (PTC) thermistor, or posistor. If k is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (NTC) thermistor. Resistors that are not thermistors are designed to have a k as close to zero as possible, so that their resistance remains nearly constant over a wide temperature range.PTC thermistors can be used as heating elements in small temperature controlled ovens. NTC thermistors are used as resistance thermometers in low temperature measurements of the order of 10 K. NTC thermistors can be used also as inrushcurrent limiting devices in power supply circuits. They present a higher resistance initially which prevents large currents from flowing at turn-on, and then heat up and become much lower resistance to allow higher current flow during normal operation. These thermistors are usually much larger than measuring type thermistors, and are purpose designed for this application. Thermistors are also commonly used in modern digital thermostats and to monitor the temperature of battery packs while charging. They are most commonly made from the oxides of metals such as manganese,cobalt, nickel andcopper. The metals are oxidized through a chemical reaction, ground to a fine powder, thencompressed and subject to very high heat. Some NTC thermistors are crystallized from semiconducting material such as silicon and germanium. Thermistors differ from resistance temperature detectors (RTD) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range [usually -90C to 130C].

Applications:

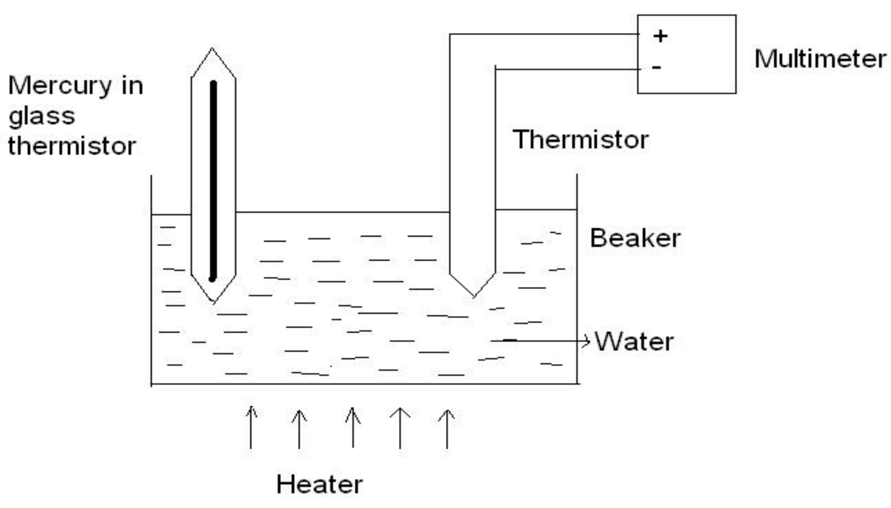
• NTC thermistors are used as resistance thermometers in low-temperature measurements of the order of 10 K.

• NTC thermistors can be used as inrush-current limiting devices in power supply circuits. They present a higher resistance initially which prevents large currents from flowing at turn-on, and then heat up and become much lower resistance to allow higher current flow during normal operation. These thermistors are usually much 76 larger than measuring type thermistors, and are purposely designed for this application.

• NTC thermistors are regularly used in automotive applications. For example, they monitor things like coolant temperature and/or oil temperature inside the engine and provide data to the ECU and, indirectly, to the dashboard.

• Thermistors are also commonly used in modern digital thermostats and to monitor the temperature of battery packs while charging.

Experimental Set up:



Procedure:

1. The apparatus are placed as it is given in the experimental set up.

2. The thermistor is placed in a vessel containing water and using heater rise the temperature of the water.

3. Find the resistance of the given thermistor at room temperature using multimeter.

4. Dip the thermometer in water and measure the temperature

4. Repeat the experiment for different temperatures and calculate the temperature coefficient

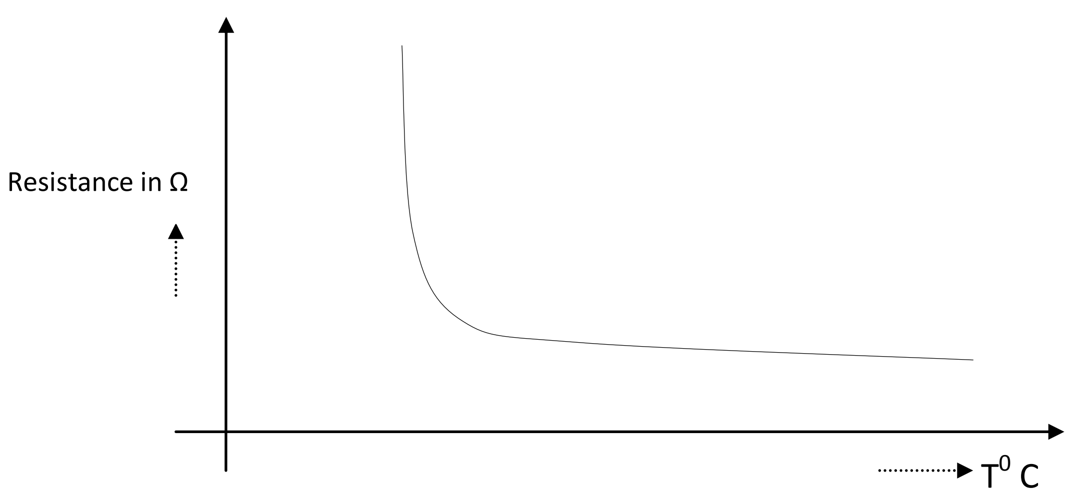
for various temperatures.

5. A graph was plotted between temperature °C and resistance in ohms of the thermistor.

Tabular column:

S.No	Temperature °C	Resistance in ohms

Model graph:



Result:

Thus the given thermistor characteristics were measured and verified.

VIVA QUESTIONS:

1. What is meant by temperature sensor and what are the types of temperature sensors
2. What is meant by positive and negative temperature co- efficient of resistance?
3. Give the differences between active and passive transducers?
4. What is a thermistor and how it is made?