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College of Engineering

Department of Electrical Engineering



Fundamentals of Electronic Devices Laboratory Manual

EE323

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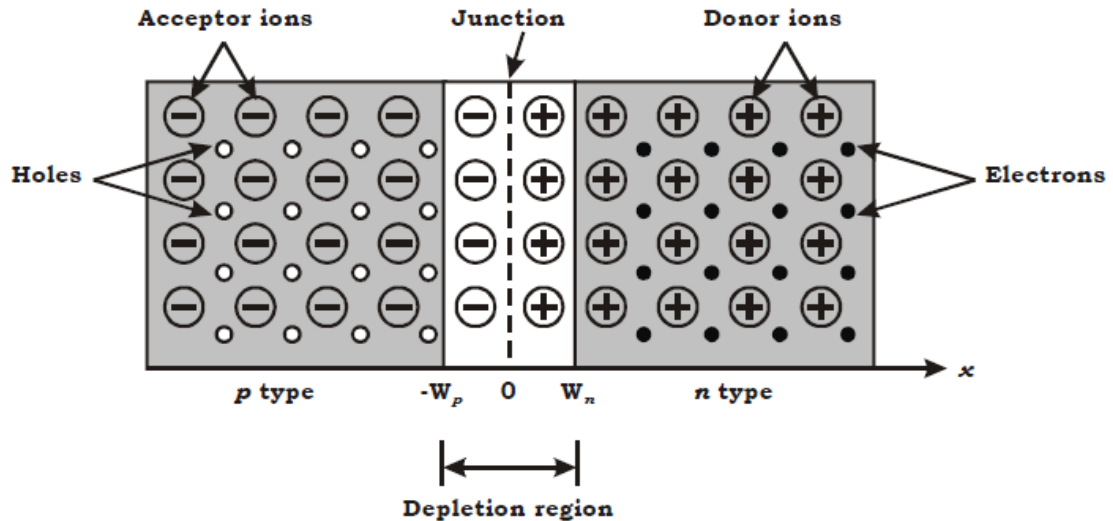
EXPERIMENT NO. 1

V-I Characteristics of A *pn* Junction Diode

AIM: To Obtain V-I characteristics of a pn-junction diode in Forward and Reverse Bias.

Introduction:

The semiconductor diode is formed by doping P-type impurity in one side and N-type of impurity in another side of the semiconductor crystal forming a p-n junction as shown in the following figure.



At the junction initially free charge carriers from both side recombine forming negatively charged ions in P side of junction(an atom in P-side accept electron and becomes negatively charged ion) and positively charged ion on n side(an atom in n-side accepts hole i.e. donates electron and becomes positively charged ion)region. This region deplete of any type of free charge carrier is called as depletion region. Further recombination of free carrier on both side is prevented because of the depletion voltage generated due to charge carriers kept at distance by depletion (acts as a sort of insulation) layer as shown dotted in the above figure.

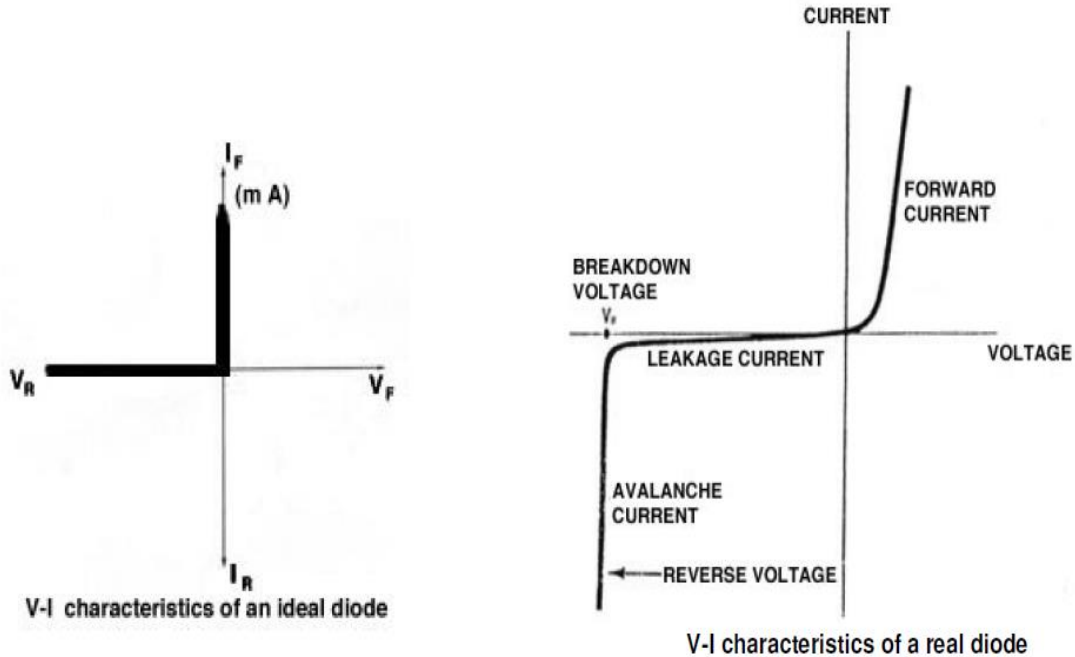
Working principle:

When voltage is not applied across the diode, depletion region forms as shown in the above figure. When the voltage is applied between the two terminals of the diode (anode and cathode) two possibilities arises depending on polarity of DC supply.

[1] Forward-Bias Condition: When the +Ve terminal of the battery is connected to P-type material & -Ve terminal to N-type terminal as shown in the circuit diagram, the diode is said to be forward biased. The application of forward bias voltage will force electrons in N-type and holes in P-type material to recombine with the ions near boundary and to flow crossing junction. This reduces width of depletion region. This further will result in increase in majority carriers flow across the junction.

If forward bias is further increased in magnitude the depletion region width will continue to decrease, resulting in exponential rise in current as shown in ideal diode characteristic curve.

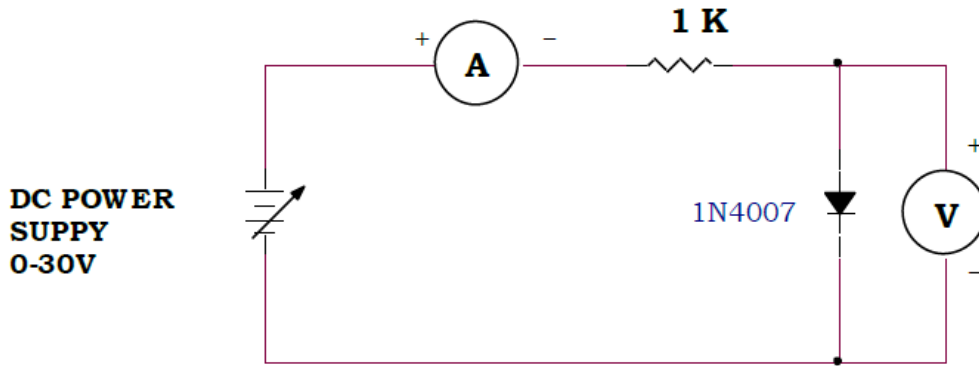
[2]Reverse-biased: If the negative terminal of battery (DC power supply) is connected with P-type terminal of diode and +Ve terminal of battery connected to N type then diode is said to be reverse biased. In this condition the free charge carriers (i.e. electrons in N-type and holes in P-type) will move away from junction widening depletion region width. The minority carriers (i.e. óve electrons in p-type and +ve holes in n-type) can cross the depletion region resulting in minority carrier current flow called as reverse saturation current (I_s). As no of minority carrier is very small so the magnitude of I_s is few microamperes. Ideally current in reverse bias is zero. In short, current flows through diode in forward bias and does not flow through diode in reverse bias. Diode can pass current only in one direction.



Experiment Procedure:

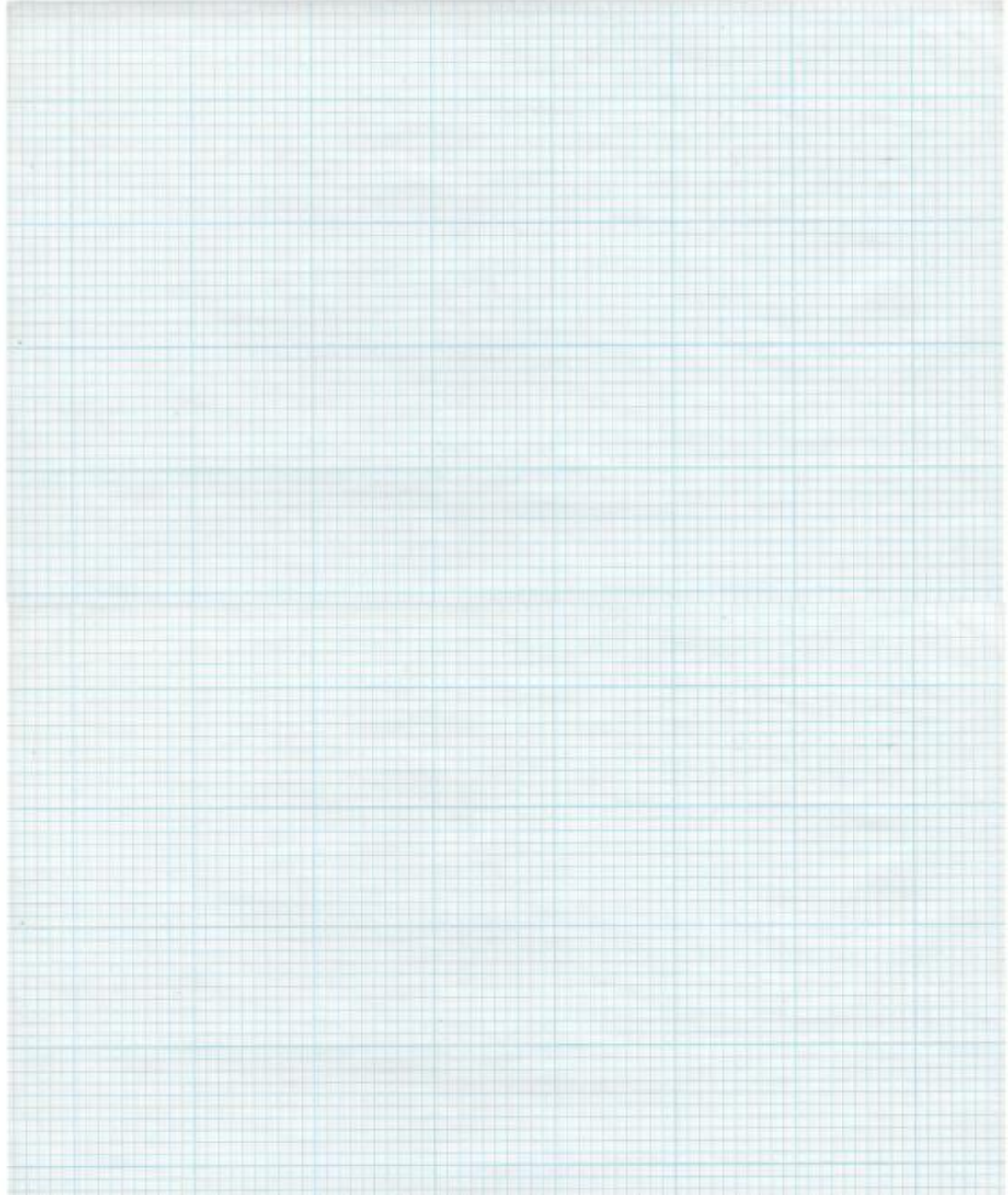
1. Connect the power supply, voltmeter, current meter with the diode as shown in the figure for forward bias diode. You can use two multimeter (one to measure current through diode and other to measure voltage across diode)
2. Increase voltage from the power supply from 0V to 20V in step as shown in the observation table
3. Measure voltage across diode and current through diode. Note down readings in the observation table.
4. Reverse DC power supply polarity for reverse bias
5. Repeat the above procedure for the different values of supply voltage for reverse bias
6. Draw VI characteristics for forward bias and reverse bias in one graph

Circuit Diagram for Forward Bias

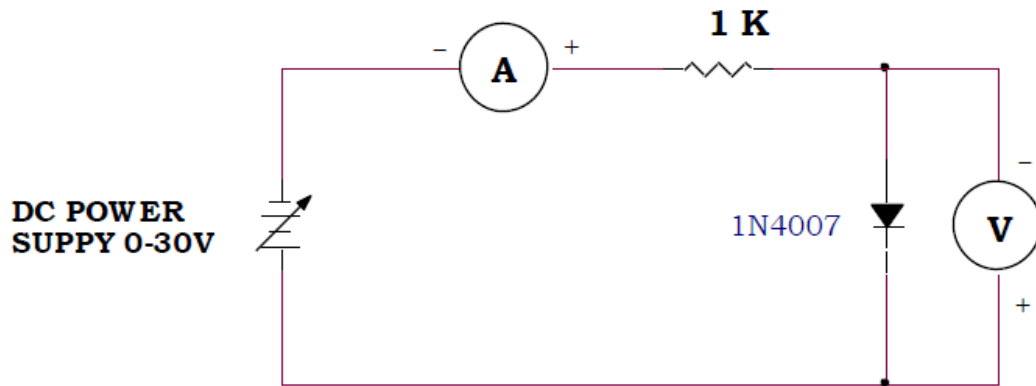


Tabular Column

Sr. No.	Supply voltage (Volt)	Diode voltage (Vd)	Diode current (Id)
1	0		
2	.2		
3	.3		
4	.4		
5	.5		
6	.6		
7	.7		
8	.8		
9	.9		
10	1		
11	2		
12	4		
13	6		
14	8		
15	10		

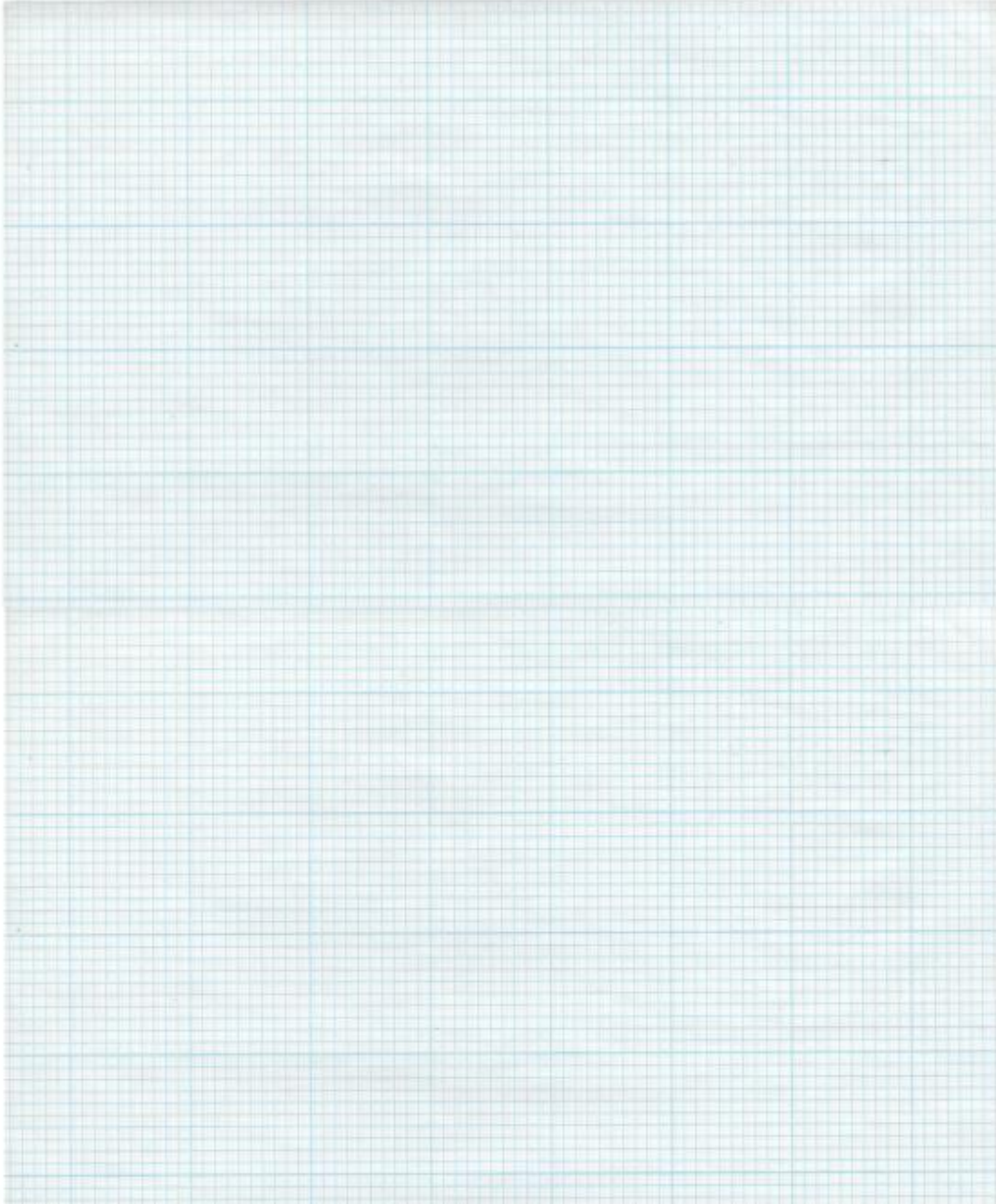


Circuit Diagram for Reverse Bias



Tabular Column

Sr. No.	Supply voltage (Volt)	Diode voltage (Vd)	Diode current (Id)
1	0		
2	2		
3	3		
4	4		
5	5		
6	6		
7	7		
8	8		
9	9		
10	10		
11	12		
12	14		
13	15		



Conclusion:

Questions:

[1] List important specifications of the diode

[2] What is breakdown voltage? What is the breakdown voltage of diode 1N4001 and 1N4007?

[3] What is the highest forward current in the diode 1N4007 and 1N5002?

[4] List different types of the diode

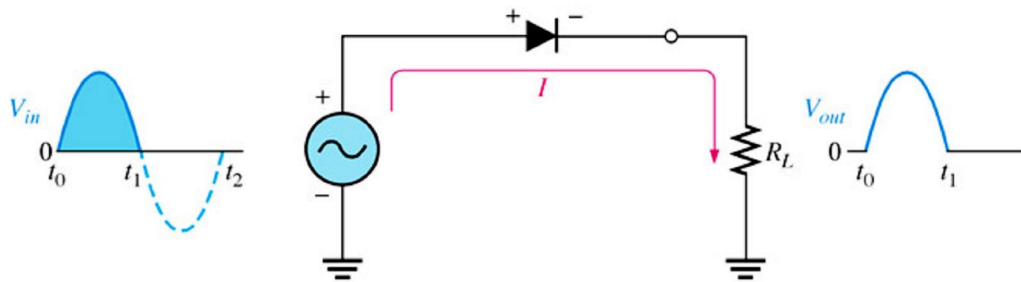
[5] List applications of the diode?

EXPERIMENT NO. 2
HALF WAVE RECTIFIER WITH & WITHOUT FILTER

AIM: To observe waveform at the output of half wave rectifier with and without filter.

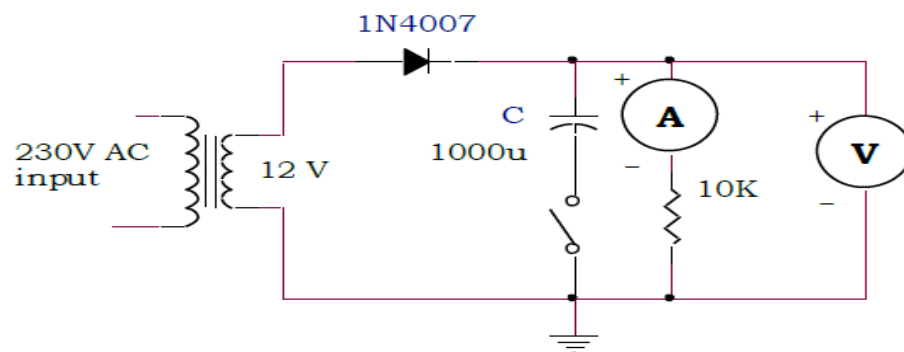
Theory of half wave rectifier:

In half wave rectifier only half cycle of applied AC voltage is used. Another half cycle of AC voltage (negative cycle) is not used. Only one diode is used which conducts during positive cycle. The circuit diagram of half wave rectifier without capacitor is shown in the following figure. During positive half cycle of the input voltage anode of the diode is positive compared with the cathode. Diode is in forward bias and current passes through the diode and positive cycle develops across the load resistance R_L . During negative half cycle of input voltage, anode is negative with respect to cathode and diode is in reverse bias. No current passes through the diode hence output voltage is zero.



Half wave rectifier without filter capacitor convert AC voltage into pulsating DC voltage. Filter capacitor is used to obtain smooth DC voltage. Construct following circuit to perform this practical.

Practical Circuit Diagram:

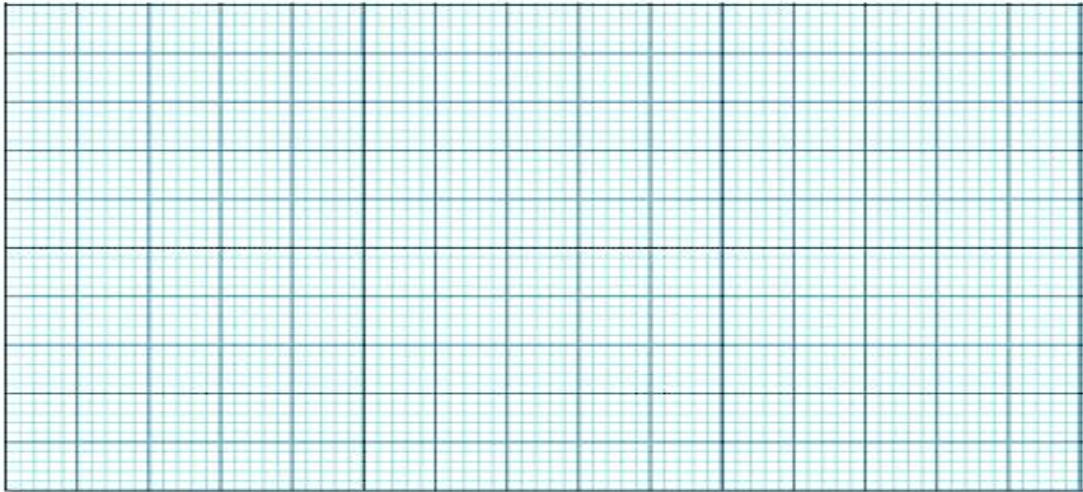


Procedure:

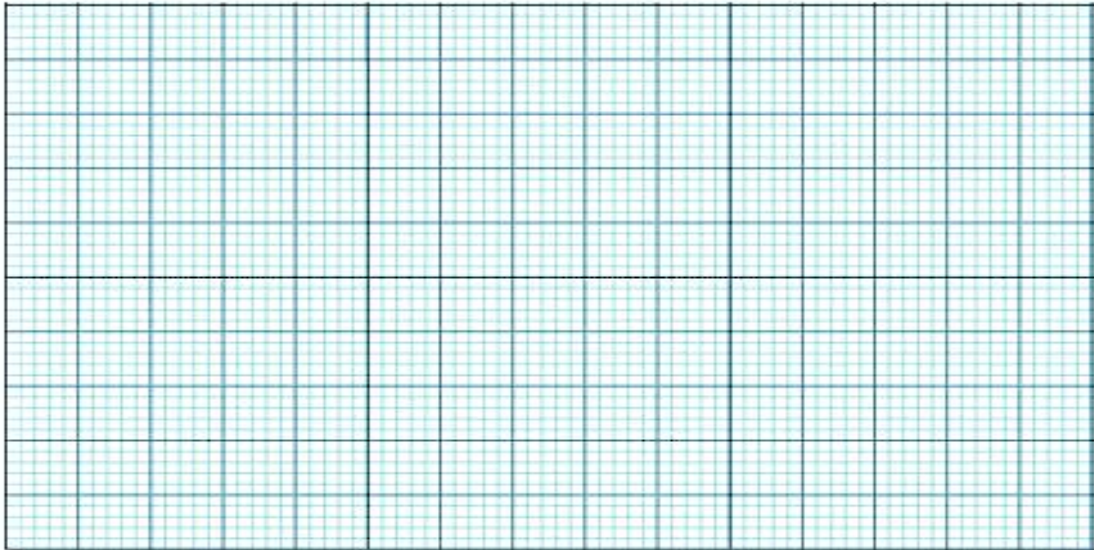
1. Connect the circuit as shown in above figure.
2. Apply an input of 12 volts AC .

- 3. Keeping the capacitor switch open, observe the output of the rectifier on CRO, and measure the output parameters. Draw the input and output waveforms on the graph sheet.
- 4. Switch on the capacitor (filter) , and observe the output DC voltage, and plot it on the graph.

Waveforms: [1] Without C-filter:
Input Waveform at secondary of transformer:



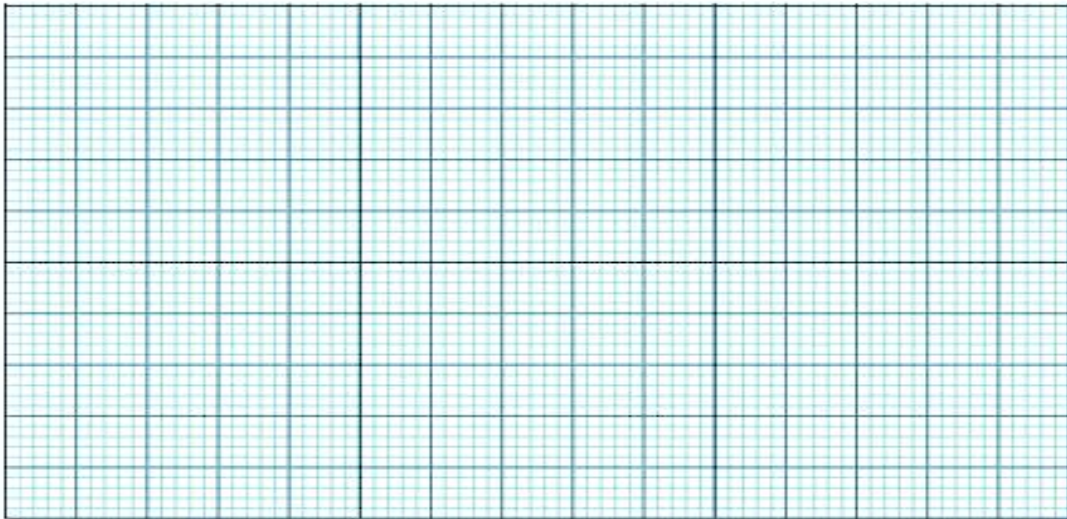
Output waveform:



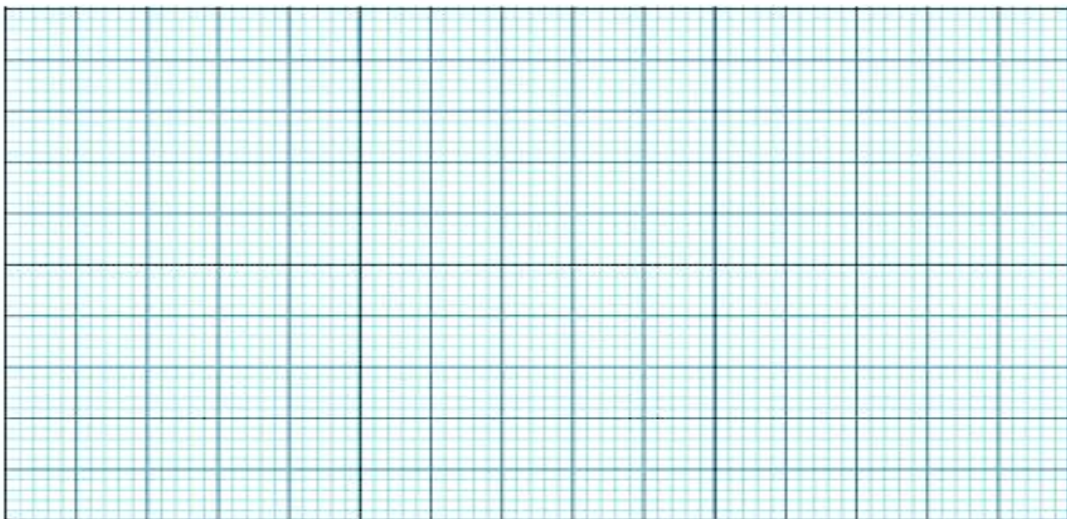
[2]

Waveforms with C-Filter:

Input waveform:



Output waveform with C-filter:



Observations:

[1] Without filter capacitor

AC Input voltage (rms) $V_{rms} =$ _____

DC output voltage $V_{DC} =$ _____

AC output voltage (Ripple voltage) $V_r:$ _____

Ripple factor: $(V_r/V_{DC}) =$ _____

[2] With filter capacitor

AC Input voltage (rms) $V_{rms} =$ _____

DC output voltage $V_{DC} =$ _____

AC output voltage (Ripple voltage) $V_r:$ _____

Ripple factor: $(V_r/V_{DC}) =$ _____

Conclusion:

Questions:

[1] Define ripple factor.

[2] What is the effect of load resistance on ripple voltage in presence of filter capacitor?

[3] What is the effect of value of filter capacitor on ripple voltage?

[4] What is the PIV necessary for the diode if transformer of 24V is used ?

[5] What is the mathematical relationship between rms input AC voltage and DC output voltage in half wave rectifier with and without filter capacitor?

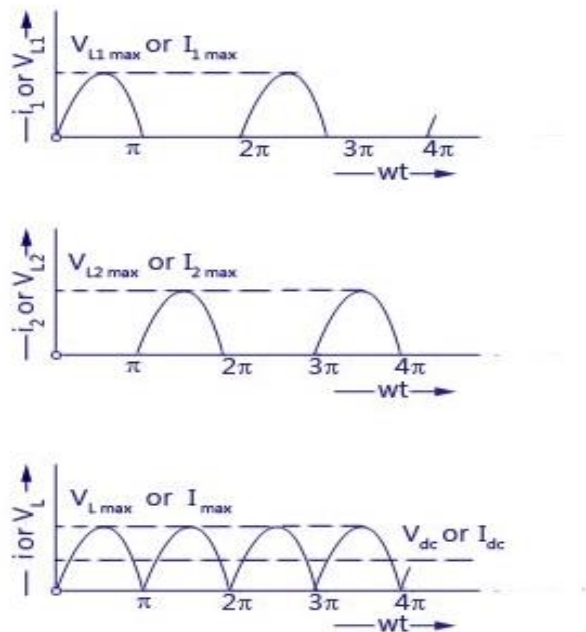
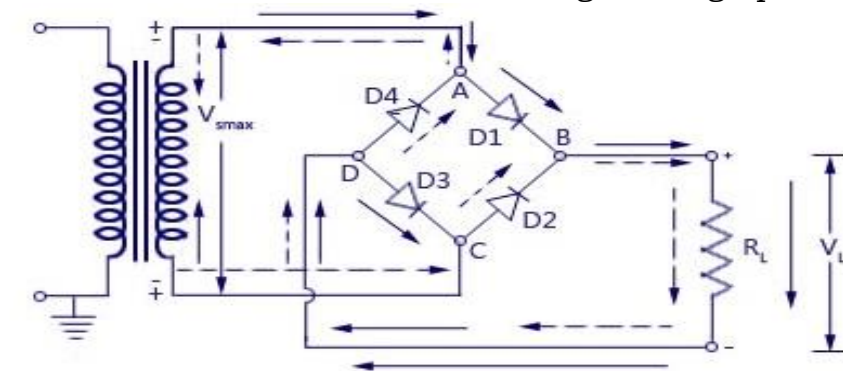
[6] Define Efficiency of HWR.

EXPERIMENT NO. 3
FULL WAVE RECTIFIER WITH & WITHOUT FILTER

AIM: To observe waveform at the output of a full wave rectifier with and without filter.

Theory of full wave rectifier:

The circuit diagrams and wave forms we have given below will help you understand the operation of a bridge rectifier perfectly. In the circuit diagram, 4 diodes are arranged in the form of a bridge. The transformer secondary is connected to two diametrically opposite points of the bridge at points A & C. The load resistance R_L is connected to bridge through points B and D.

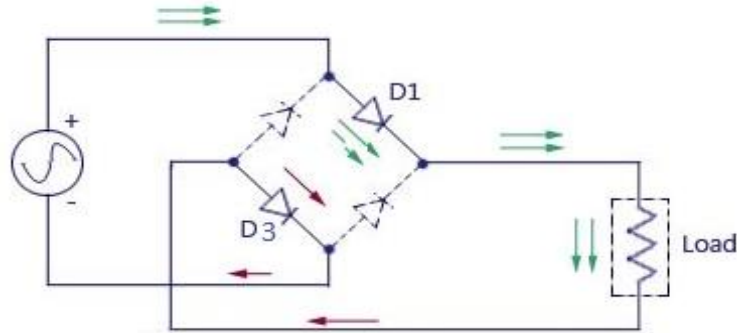


Rectified Output Voltage/Current Waveforms

During the first half cycle

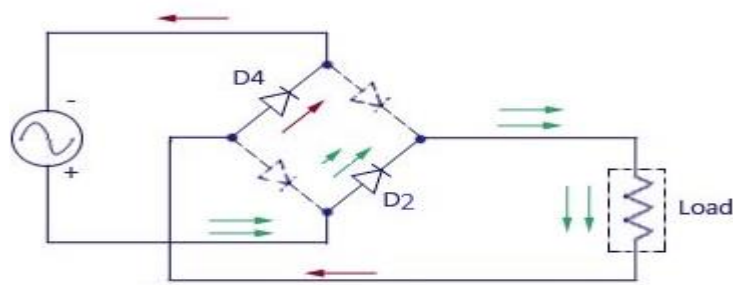
During first half cycle of the input voltage, the upper end of the transformer secondary winding is positive with respect to the lower end. Thus during the first half cycle diodes D1 and D3 are

forward biased and current flows through arm AB, enters the load resistance R_L , and returns back flowing through arm DC. During this half of each input cycle, the diodes D_2 and D_4 are reverse biased and current is not allowed to flow in arms AD and BC. The flow of current is indicated by solid arrows in the figure above. We have developed another diagram below to help you understand the current flow quickly. See the diagram below ó the double arrows indicate beginning of current flow from source (transformer secondary) to the load resistance. The red arrows indicate return path of current from load resistance to the source, thus completing the circuit.



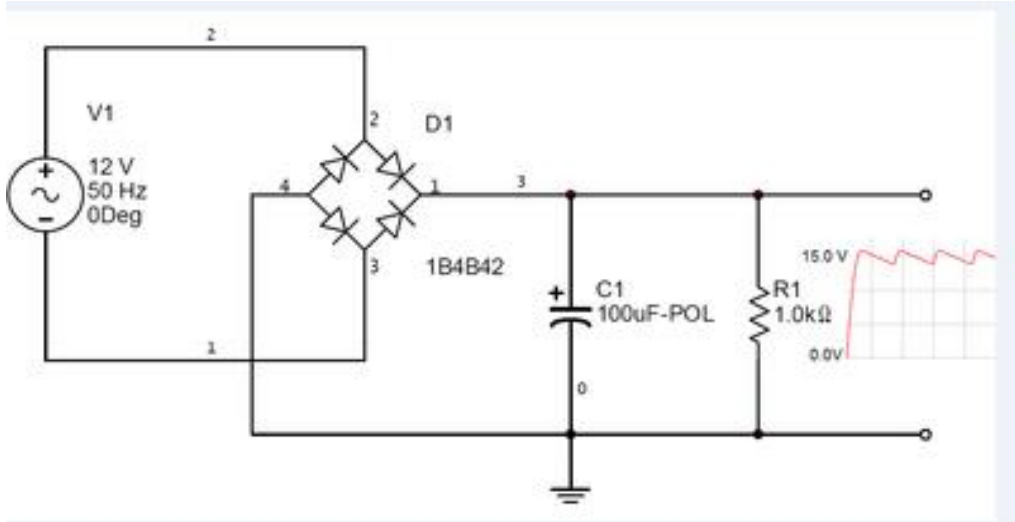
During the second half cycle

During second half cycle of the input voltage, the lower end of the transformer secondary winding is positive with respect to the upper end. Thus diodes D_2 and D_4 become forward biased and current flows through arm CB, enters the load resistance R_L , and returns back to the source flowing through arm DA. Flow of current has been shown by dotted arrows in the figure. Thus the direction of flow of current through the load resistance R_L remains the same during both half cycles of the input supply voltage. See the diagram below ó the green arrows indicate beginning of current flow from source (transformer secondary) to the load resistance. The double arrows indicate return path of current from load resistance to the source, thus completing the circuit.



Path of current in 2nd Half Cycle

Practical Circuit Diagram:

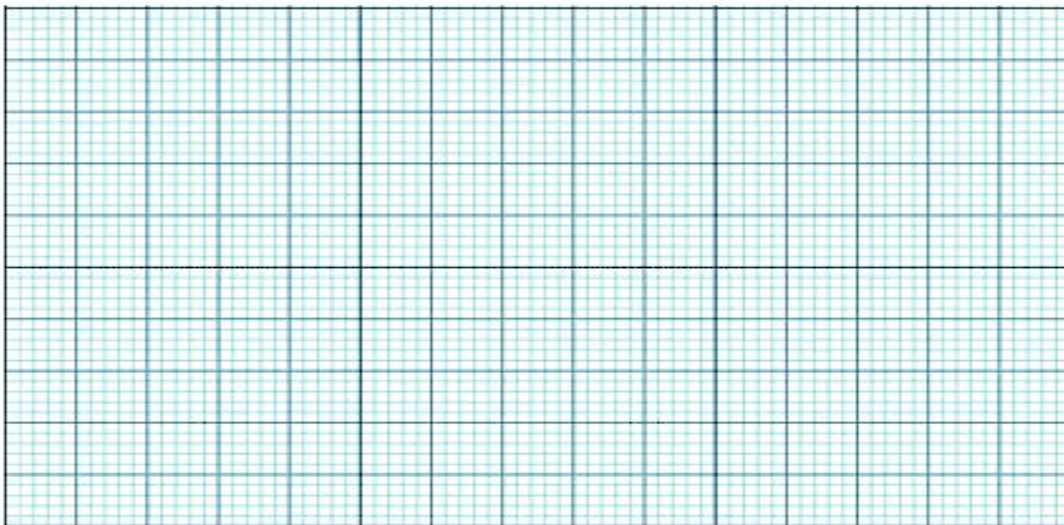


Procedure:

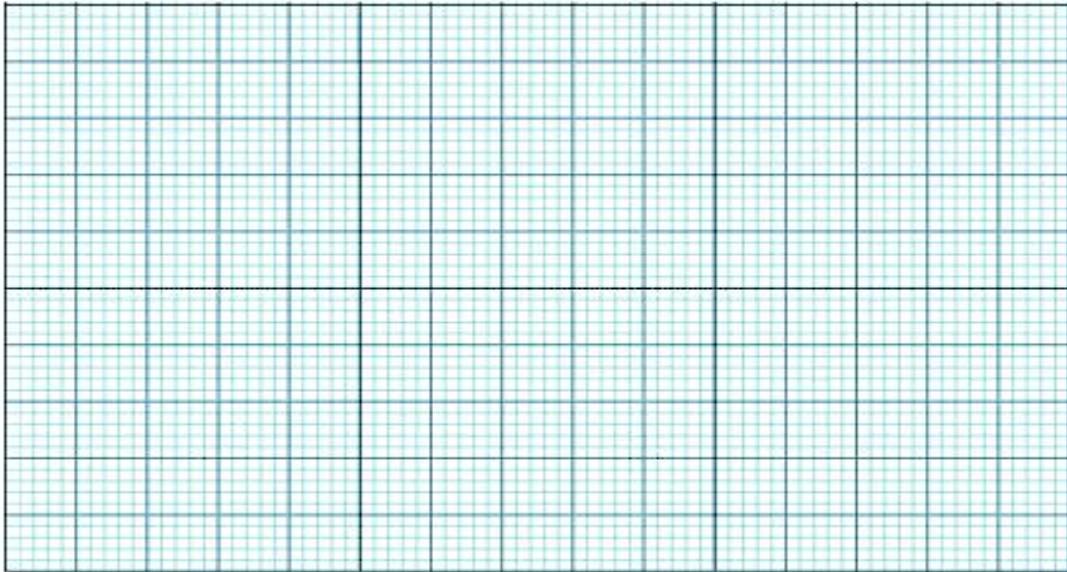
1. Connect the circuit as shown in above figure.
2. Apply an input of 12 volts AC supply.
3. Keeping the capacitor switch open, observe the output of the rectifier on CRO, and measure the output parameters. Draw the input and output waveforms on the graph sheet.
4. Switch on the capacitor (filter) , and observe the output DC voltage, and plot it on the graph.

Waveforms: [1] Without C-filter:

Input Waveform at secondary of transformer:

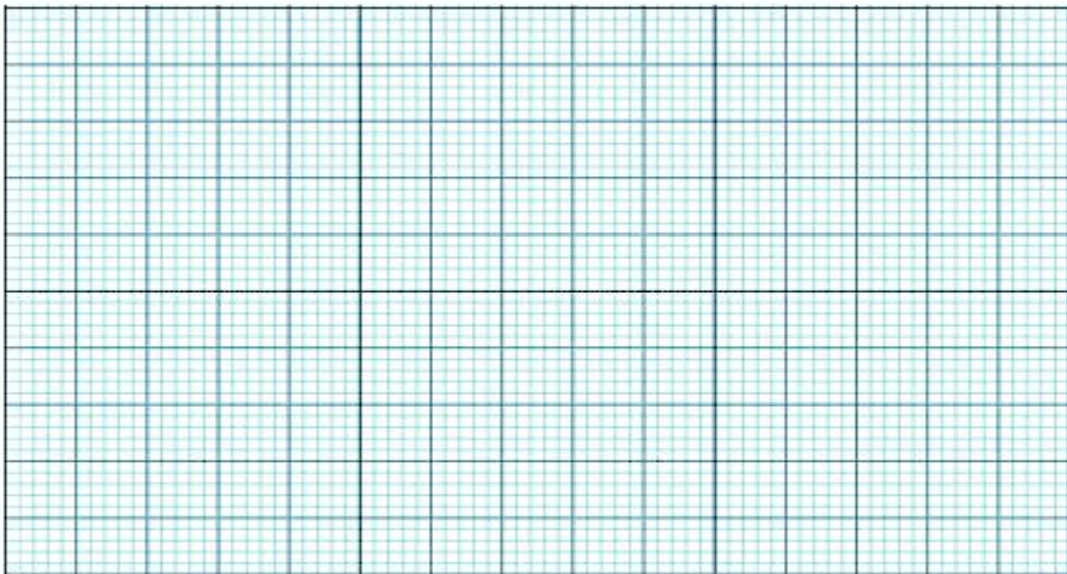


Output waveform

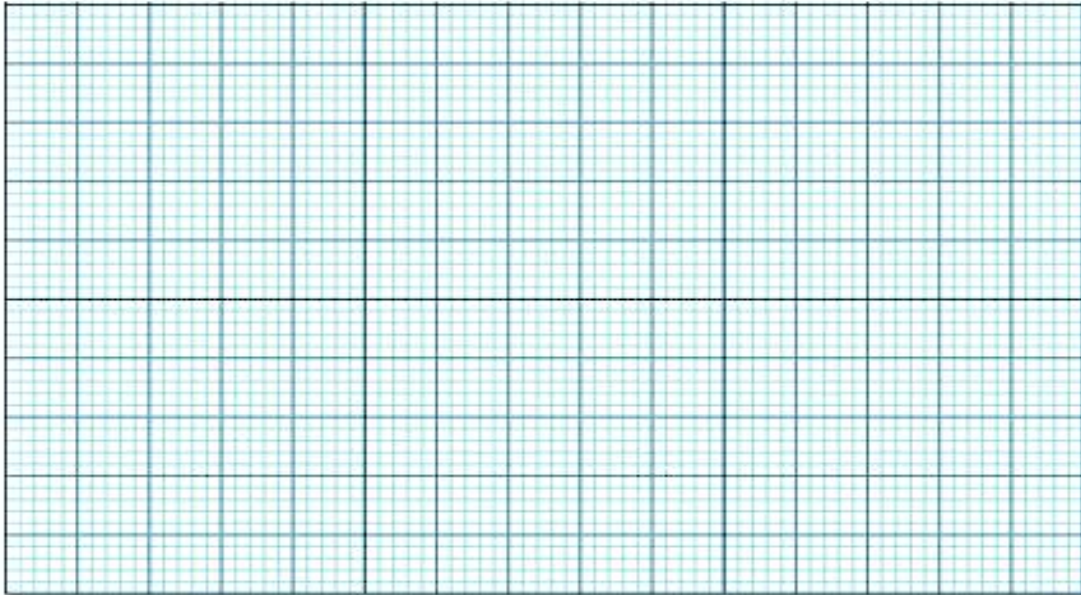


[2] Waveforms with C-Filter:

Input waveform:



Output waveform with C-filter:



Observations:

[1] Without filter capacitor

AC Input voltage (rms) $V_{rms} =$ _____

DC output voltage $V_{DC} =$ _____

AC output voltage (Ripple voltage) $V_r:$ _____

Ripple factor: $(V_r/V_{DC}) =$ _____

[2] With filter capacitor

AC Input voltage (rms) $V_{rms} =$ _____

DC output voltage $V_{DC} =$ _____

AC output voltage (Ripple voltage) $V_r:$ _____

Ripple factor: $(V_r/V_{DC}) =$ _____

Conclusion:

Questions:

[1] Define ripple factor

[2] What is the effect of load resistance on ripple voltage in presence of filter capacitor?

[3] What is the effect of value of filter capacitor on ripple voltage?

[4] What is the PIV necessary for the diode if transformer of 24V is used ?

[5] What is the mathematical relationship between rms input AC voltage and DC output voltage in half wave rectifier with and without filter capacitor?

Experiment No.4: Diode Clippers

Aim : To design clipping circuits using semiconductor diode.

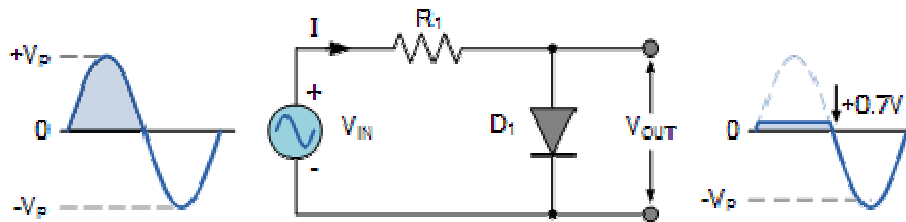
I. Positive Diode Clipping Circuits

Theory: In this diode clipping circuit, the diode is forward biased (cathode more positive than anode) during the positive half cycle of the sinusoidal input waveform. For the diode to become forward biased, it must have the input voltage magnitude greater than +0.7 volts (0.3 volts for a germanium diode).

When this happens the diodes begins to conduct and holds the voltage across itself constant at 0.7V until the sinusoidal waveform falls below this value. Thus the output voltage which is taken across the diode can never exceed 0.7 volts during the positive half cycle.

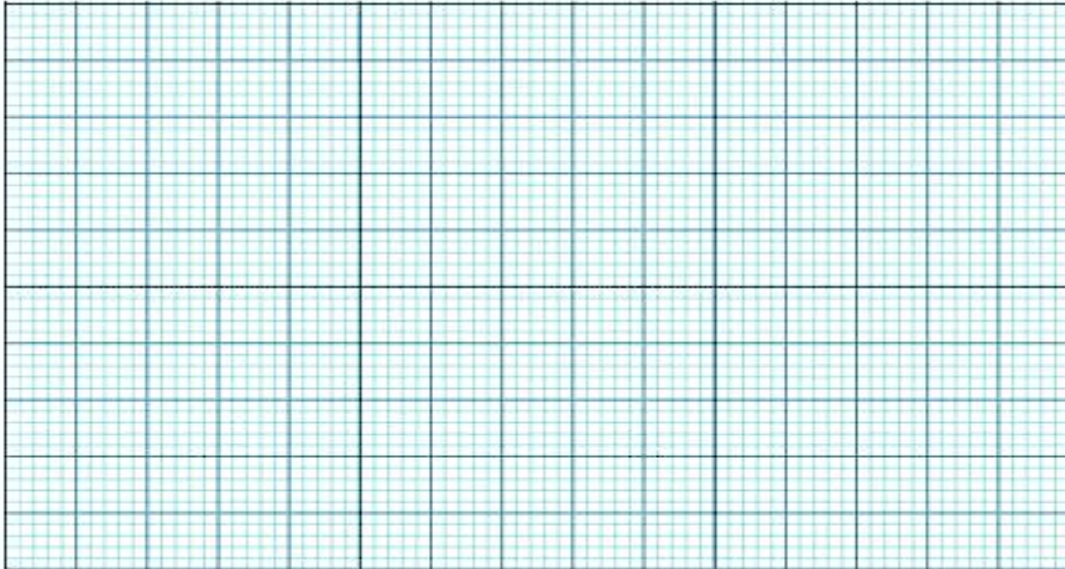
During the negative half cycle, the diode is reverse biased (anode more positive than cathode) blocking current flow through itself and as a result has no effect on the negative half of the sinusoidal voltage which passes to the load unaltered. Then the diode limits the positive half of the input waveform and is known as a positive clipper circuit.

Circuit Diagram



Procedure:

1. Connect the circuit as shown in figure.
2. Apply 6 volts p-p AC supply as shown.
3. Connect the CRO and observe the input and output waveforms.
4. Plot the same in the graph.

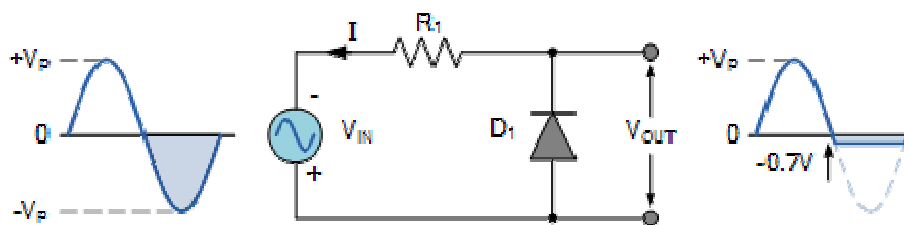


II. Negative Diode Clipping Circuits

Theory:

Here the reverse is true. The diode is forward biased during the negative half cycle of the sinusoidal waveform and limits or clips it to -0.7 volts while allowing the positive half cycle to pass unaltered when reverse biased. As the diode limits the negative half cycle of the input voltage it is therefore called a negative clipper circuit.

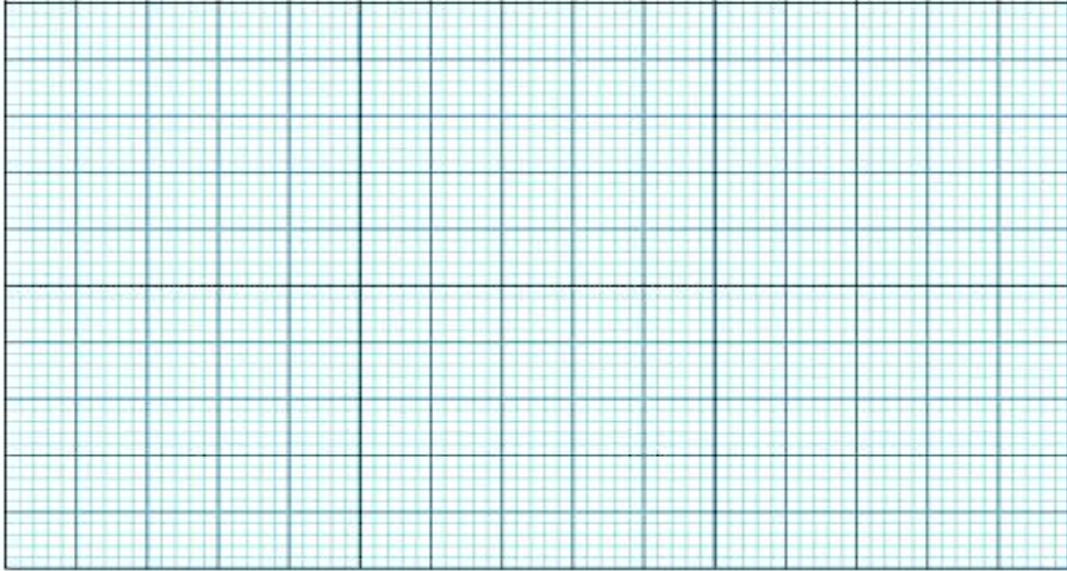
Circuit Diagram



Procedure:

1. Connect the circuit as shown in figure.

2. Apply 6 volts p-p AC supply as shown.
3. Connect the CRO and observe the input and output waveforms.
4. Plot the same in the graph.



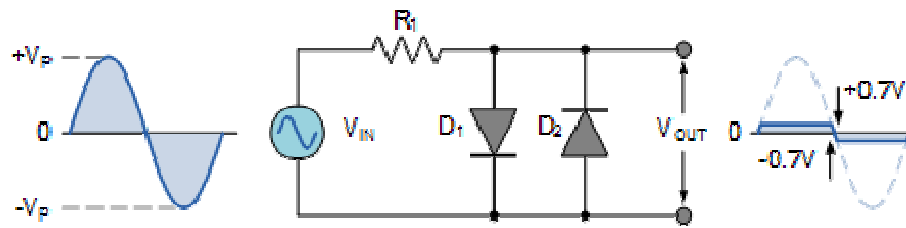
III. Clipping of Both Half Cycles

Theory:

If we connected two diodes in inverse parallel as shown, then both the positive and negative half cycles would be clipped as diode D_1 clips the positive half cycle of the sinusoidal input waveform while diode D_2 clips the negative half cycle. Then diode clipping circuits can be used to clip the positive half cycle, the negative half cycle or both.

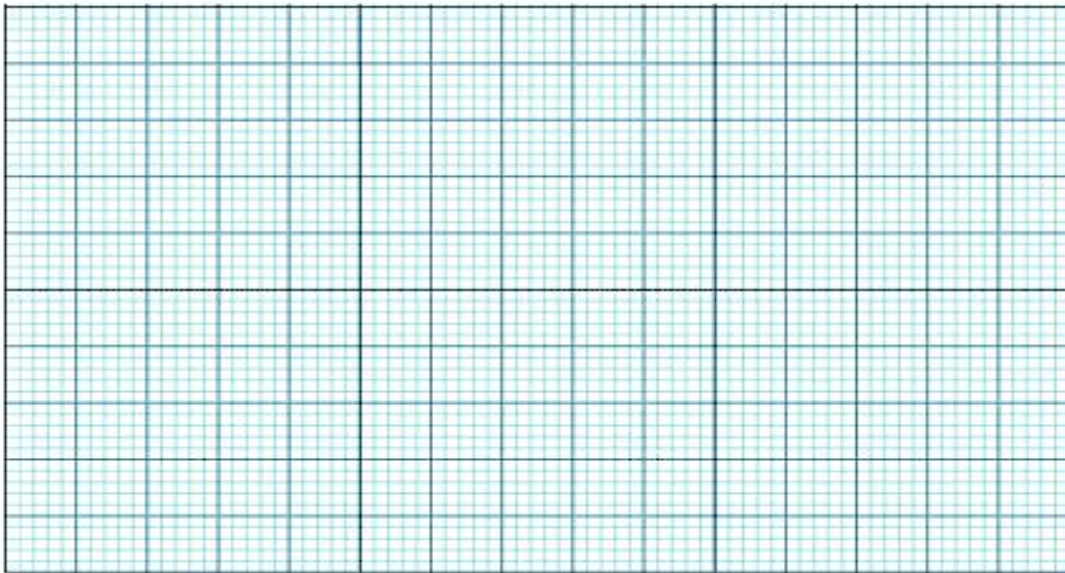
For ideal diodes the output waveform above would be zero. However, due to the forward bias voltage drop across the diodes the actual clipping point occurs at +0.7 volts and -0.7 volts respectively. But we can increase this $\pm 0.7V$ threshold to any value we want up to the maximum value, (V_{PEAK}) of the sinusoidal waveform either by connecting together more diodes in series creating multiples of 0.7 volts, or by adding a voltage bias to the diodes.

Circuit Diagram



Procedure:

1. Connect the circuit as shown in figure.
2. Apply 6 volts p-p AC supply as shown.
3. Connect the CRO and observe the input and output waveforms.
4. Plot the same in the graph.



Biased Diode Clipping Circuits

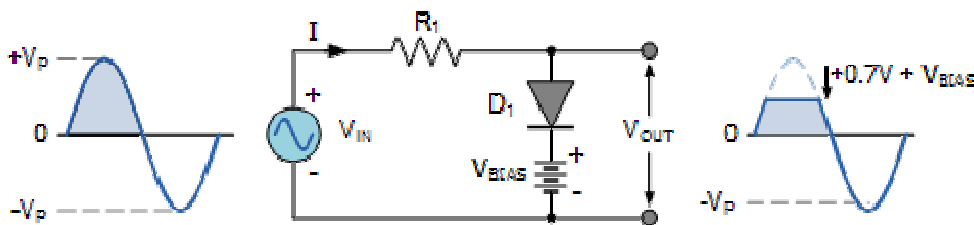
To produce diode clipping circuits for voltage waveforms at different levels, a bias voltage, V_{BIAS} is added in series with the diode as shown. The voltage across the series combination must be greater than $V_{BIAS} + 0.7V$ before the diode becomes sufficiently forward biased to conduct. For example, if the V_{BIAS} level is set at 4.0 volts, then the sinusoidal voltage at the diode's anode terminal must be greater than $4.0 + 0.7 = 4.7$ volts for it to become forward biased. Any anode voltage levels above this bias point are clipped off.

IV. Positive Bias Diode Clipping

Theory:

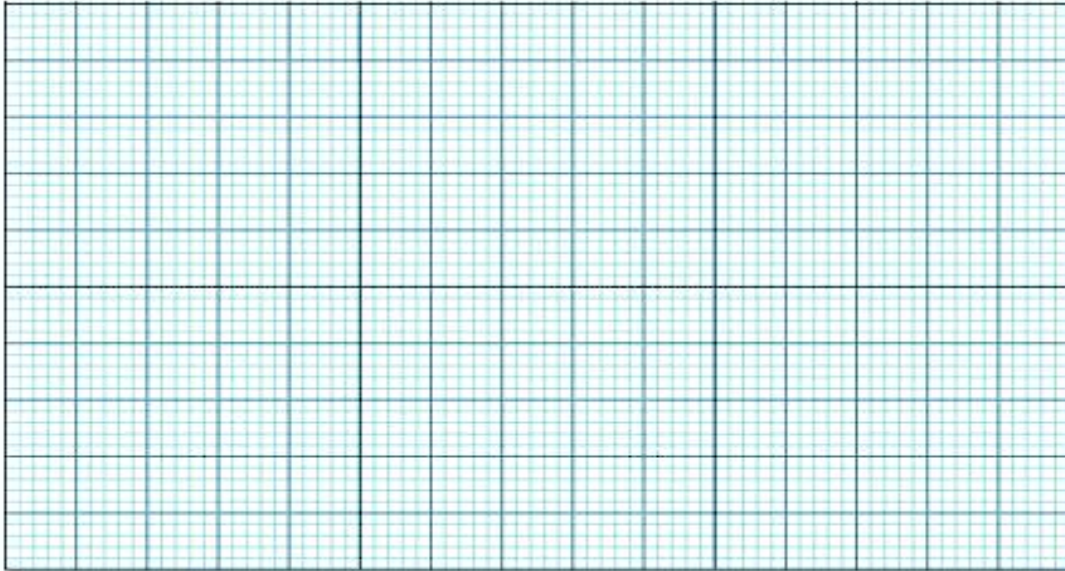
Likewise, by reversing the diode and the battery bias voltage, when a diode conducts the negative half cycle of the output waveform is held to a level $-V_{BIAS} - 0.7V$ as shown.

Circuit Diagram



Procedure:

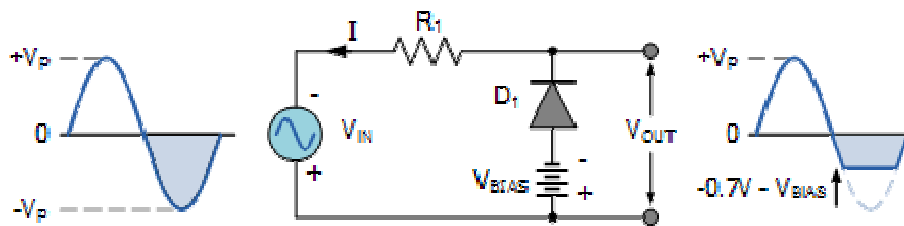
1. Connect the circuit as shown in figure.
2. Apply the bias DC voltage for the required value with proper polarity.
3. Apply 6 volts p-p AC supply as shown.
4. Connect the CRO and observe the input and output waveforms.
5. Plot the same in the graph.



V. Negative Bias Diode Clipping

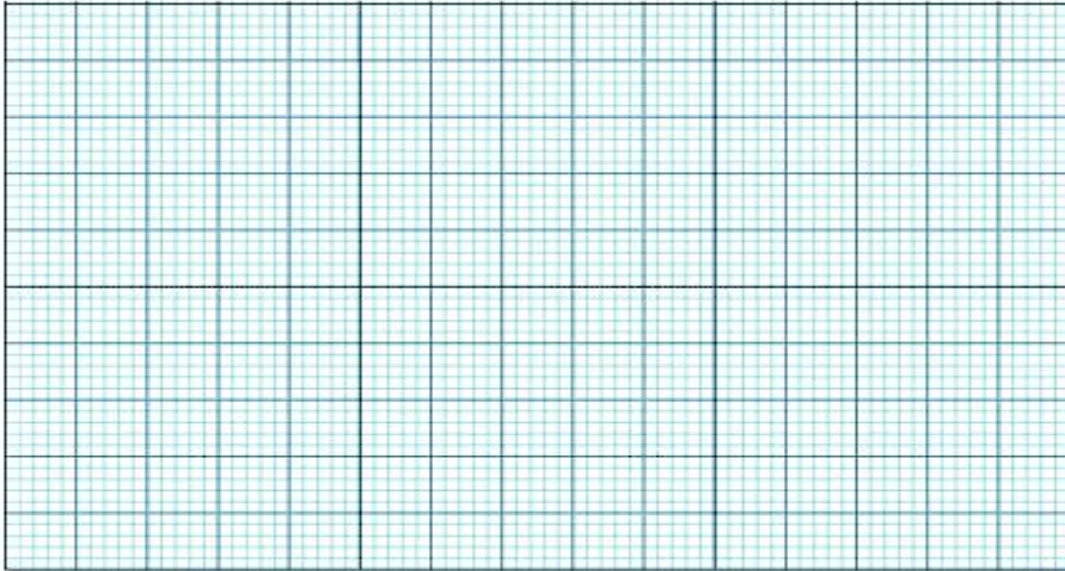
Theory: A variable diode clipping or diode limiting level can be achieved by varying the bias voltage of the diodes. If both the positive and the negative half cycles are to be clipped, then two biased clipping diodes are used. But for both positive and negative diode clipping, the bias voltage need not be the same. The positive bias voltage could be at one level, for example 4 volts, and the negative bias voltage at another, for example 6 volts as shown.

Circuit Diagram:



Procedure:

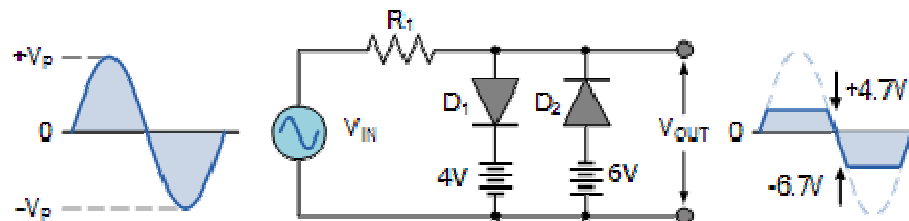
1. Connect the circuit as shown in figure.
2. Apply the bias DC voltage for the required value with proper polarity.
3. Apply 6 volts p-p AC supply as shown.
4. Connect the CRO and observe the input and output waveforms.
5. Plot the same in the graph.



VI. Diode Clipping of Different Bias levels

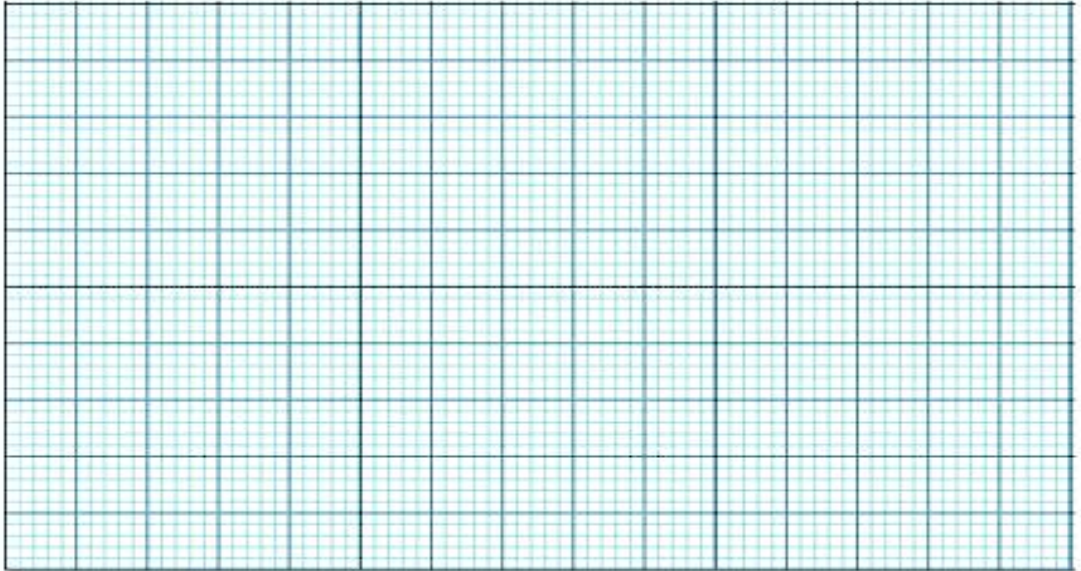
Theory: When the voltage of the positive half cycle reaches +4.7 V, diode D_1 conducts and limits the waveform at +4.7 V. Diode D_2 does not conduct until the voltage reaches -6.7V. Therefore, all positive voltages above +4.7 V and negative voltages below -6.7 V are automatically clipped.

Circuit Diagram:



Procedure:

1. Connect the circuit as shown in figure.
2. Apply the bias DC voltage for the required value with proper polarity.
3. Apply 6 volts p-p AC supply as shown.
4. Connect the CRO and observe the input and output waveforms.
5. Plot the same in the graph.



Conclusion:

Questions:

[1] List important specifications of the diode

[2] What is breakdown voltage? What is the breakdown voltage of diode 1N4001 and 1N4007?

[3] What is the highest forward current in the diode 1N4007 and 1N5002?

[4] List different types of the diode

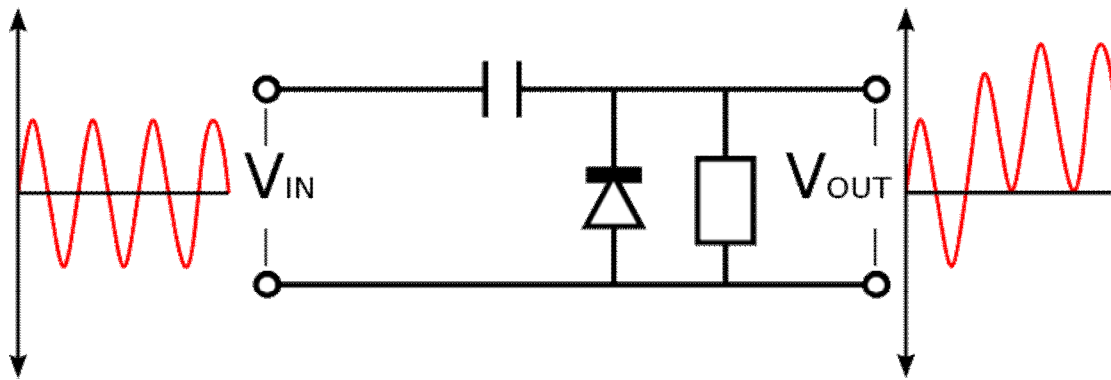
[5] List applications of the diode?

Experiment No.5: Diode Clampers

Aim: To study the clamping circuit using diode.

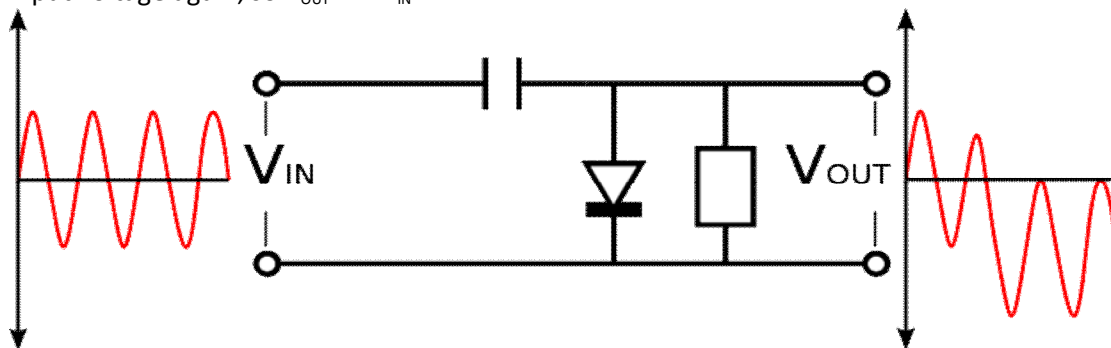
Theory: A clamper is an electronic circuit that fixes either the positive or the negative peak excursions of a signal to a defined value by shifting its DC value. The clamper does not restrict the peak-to-peak excursion of the signal, it moves the whole signal up or down so as to place the peaks at the reference level. A diode clamp (a simple, common type) consists of a diode, which conducts electric current in only one direction and prevents the signal exceeding the reference value; and a capacitor which provides a DC offset from the stored charge. The capacitor forms a time constant with the resistor load which determines the range of frequencies over which the clamper will be effective.

A positive unbiased clamp:



In the negative cycle of the input AC signal, the diode is forward biased and conducts, charging the capacitor to the peak positive value of V_{IN} . During the positive cycle, the diode is reverse biased and thus does not conduct. The output voltage is therefore equal to the voltage stored in the capacitor plus the input voltage, so $V_{OUT} = 2V_{IN}$.

A negative unbiased clamp: A negative unbiased clamp is the opposite of the equivalent positive clamp. In the positive cycle of the input AC signal, the diode is forward biased and conducts, charging the capacitor to the peak value of V_{IN} . During the negative cycle, the diode is reverse biased and thus does not conduct. The output voltage is therefore equal to the voltage stored in the capacitor plus the input voltage again, so $V_{OUT} = -2V_{IN}$



Positive Clamping

Procedure:

1. Connect the circuit as shown in figure 1.
2. Apply square wave signal of 2 volt peak to peak.
3. Observe the output on CRO.
4. Draw the input and output signals on the graph.
5. You can repeat this with different signals like sinusoidal, triangular.

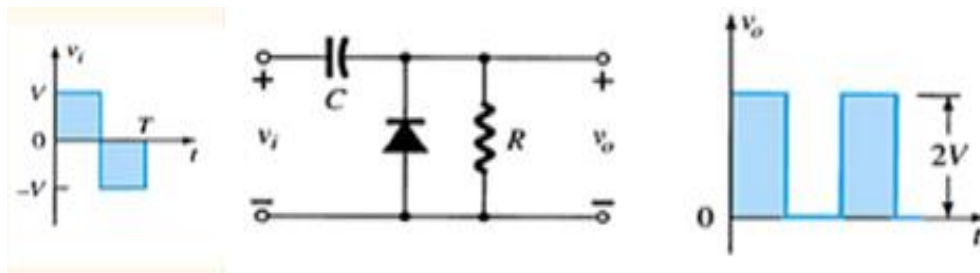
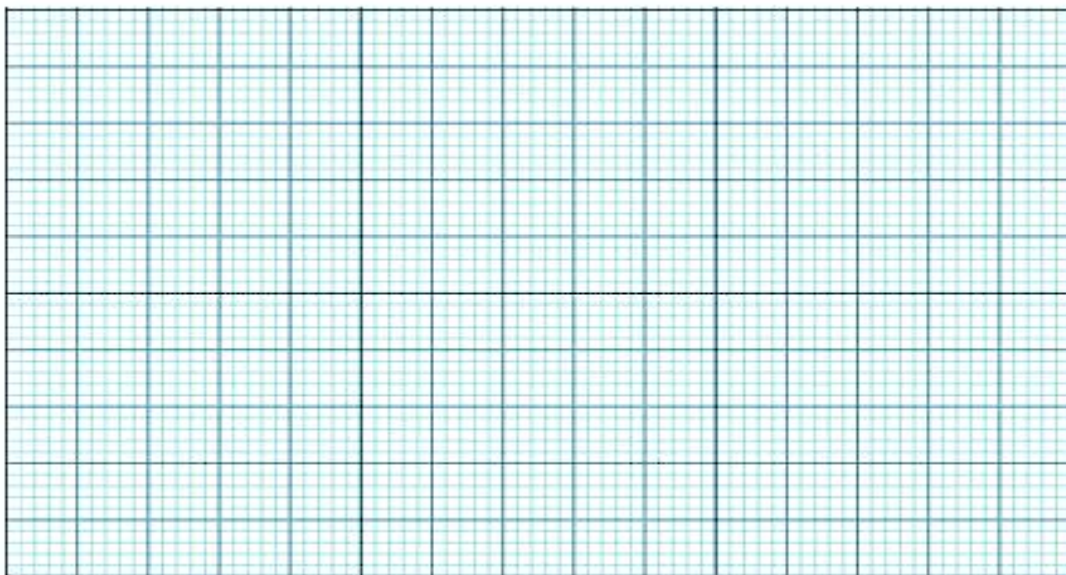


Fig.1



Observations:

Negative Clamping:

Procedure:

1. Connect the circuit as shown in figure 2.
2. Apply square wave signal of 2 volt peak to peak.
3. Observe the output on CRO.
4. Draw the input and output signals on the graph.
5. You can repeat this with different signals.

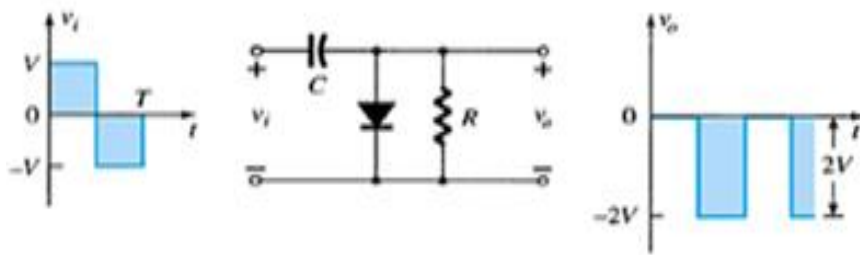
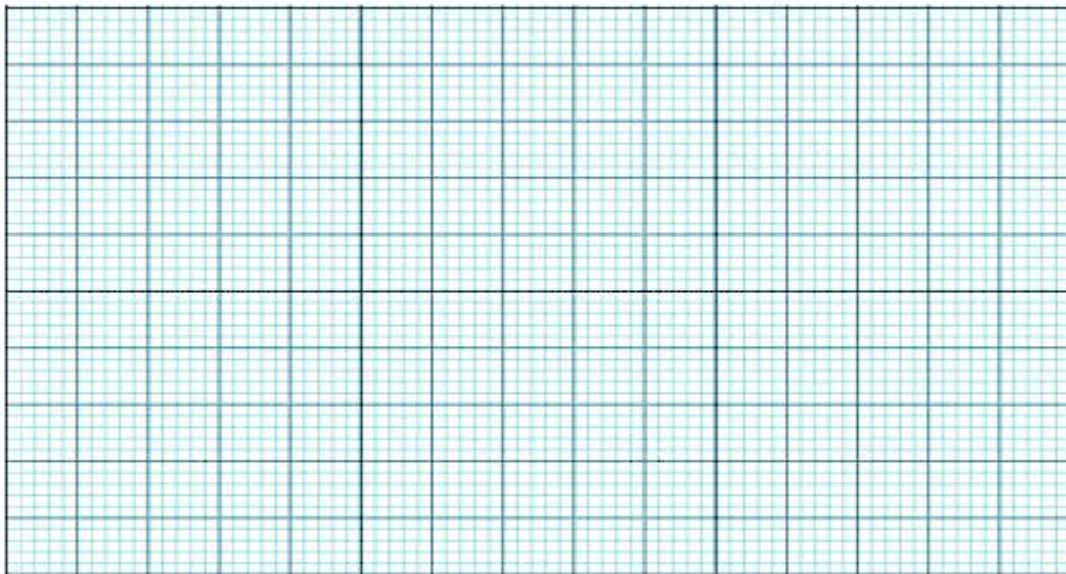


Fig.2.



Observations:

Experiment No.6: V-I CHARACTERISTICS OF ZENER DIODE

AIM: To draw the V-I characteristics of a given Zener diode and to determine the reverse breakdown voltage forward knee voltage and Zener resistance.

APPARATUS: Zener diode, 1KW resistor, DC regulated power supply, voltmeter, milliammeter.

THEORY: A Zener diode is essentially a heavily doped p-n junction diode. Its symbol is shown in figure (1).

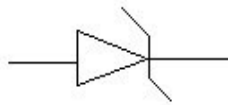


Figure (1)

When the Zener diode is forward biased, the forward current increases with the increase in applied voltage. When it is reverse biased, a small reverse current flows until the breakdown voltage is reached. In the vicinity of breakdown region, the reverse current starts rising rapidly because of avalanche effect. Finally a sharp increase in current occurs when the Zener breakdown voltage (V_z) is reached. In this region, a small voltage change results in a large current change. This voltage limiting characteristics of a Zener diode makes it a good voltage regulator.

PROCEDURE:

FORWARD CHARACTERISTICS:

Connections are made as shown in figure (2).

The voltage is varied gradually and the corresponding current values are noted down.

REVERSE CHARACTERISTICS:

Connections are made as shown in figure (3).

The voltage is varied gradually and the corresponding current values are noted down.

A graph can be plotted with the voltage along X-axis and the current along the Y-axis. During the forward bias, the voltage at which current increases sharply is called forward knee voltage (V_k). In the reverse bias graph, extrapolating straight line portion to the X-axis will yield Zener breakdown voltage. The slope on the linear part of the curve gives Zener resistance, $R_z = DV/DI$

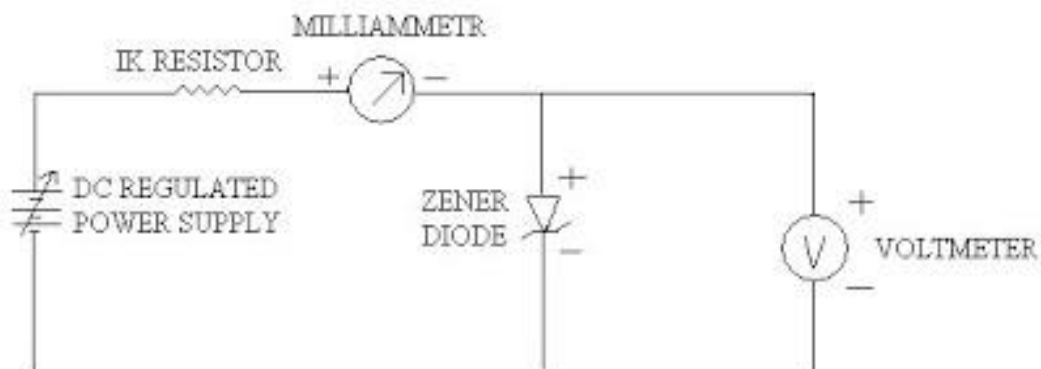


Figure (2)

OBSERVATIONS OF FORWARD CHARACTERISTICS:

Voltage (V)	Current(mA)
0	
2	
4	
6	
8	
10	
12	
15	
20	

REVERSE CHARACTERISTICS:

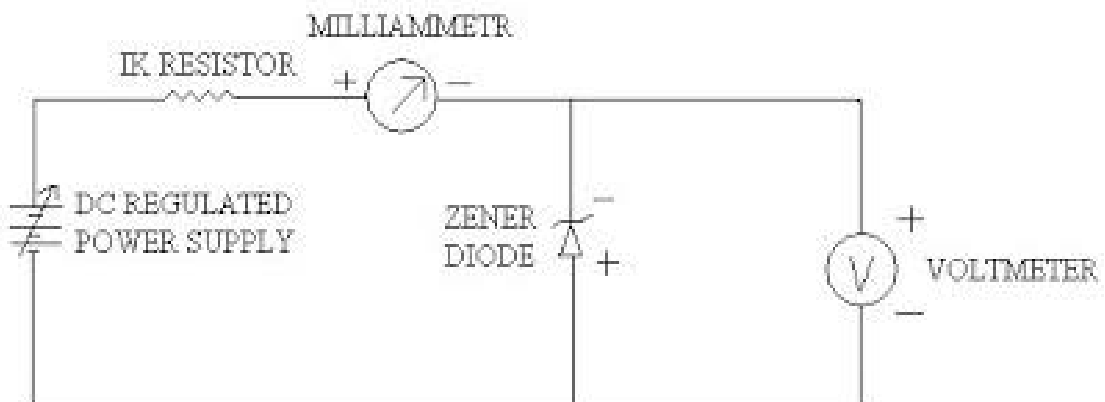
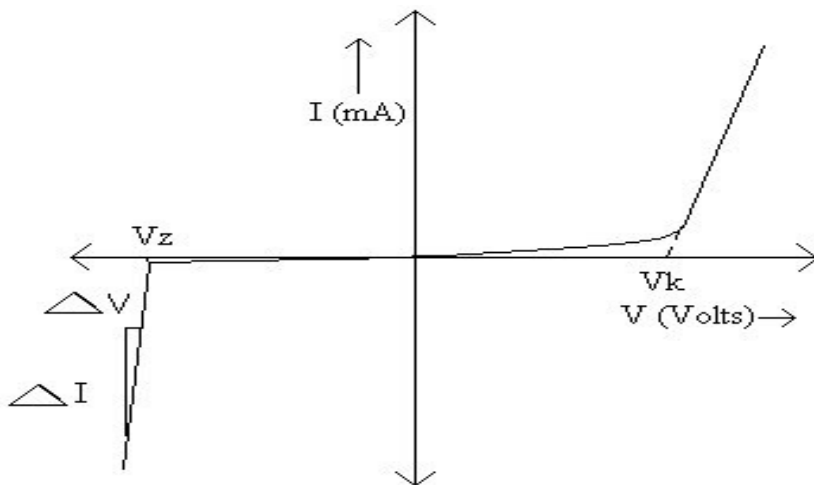


Figure (3)

OBSERVATIONS

Voltage (V)	Current(mA)
0	
2	
4	
5	
6	
7	
8	
9	
10	
12	
13	
14	
15	

Model Graph:



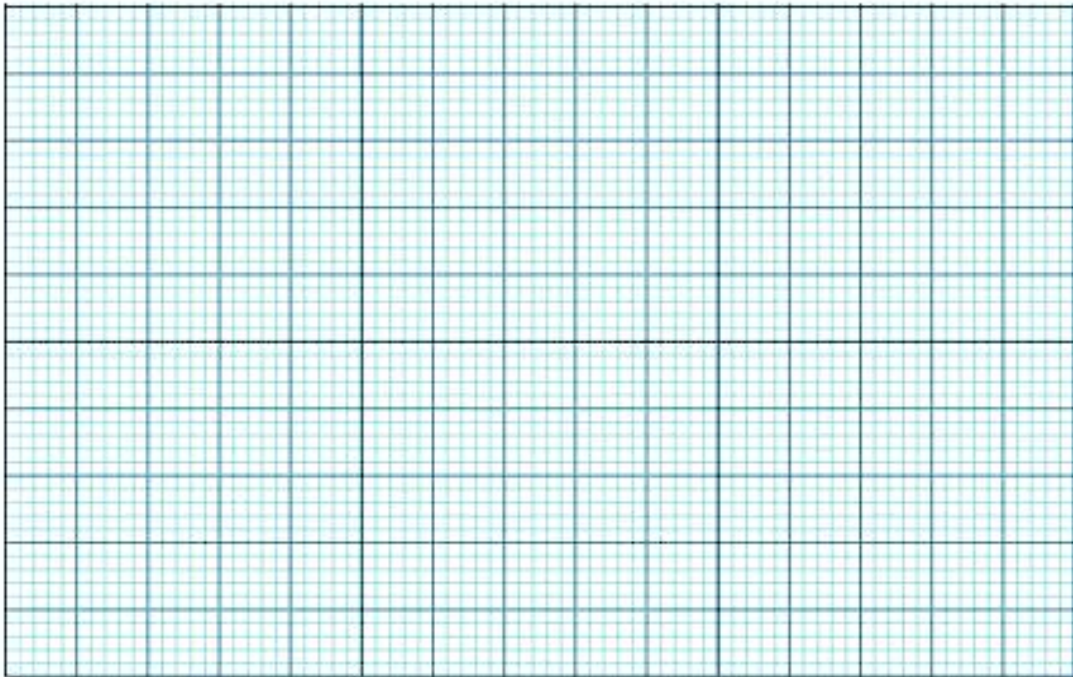
CALCULATIONS:

From I-V characteristics graph,

$$\hat{V} =$$

$$\hat{I} =$$

$$R_Z = \hat{V} / \hat{I} =$$



RESULTS:

I-V characteristics of a Zener diode are drawn.

The forward knee voltage (V_k) = Volts.

The Zener breakdown voltage (V_z) = Volts.

The Zener Resistance (R_z) = Ohms

Experiment No.7: Zener Diode Characteristics using COM3

Procedure For COM3 Simulation:

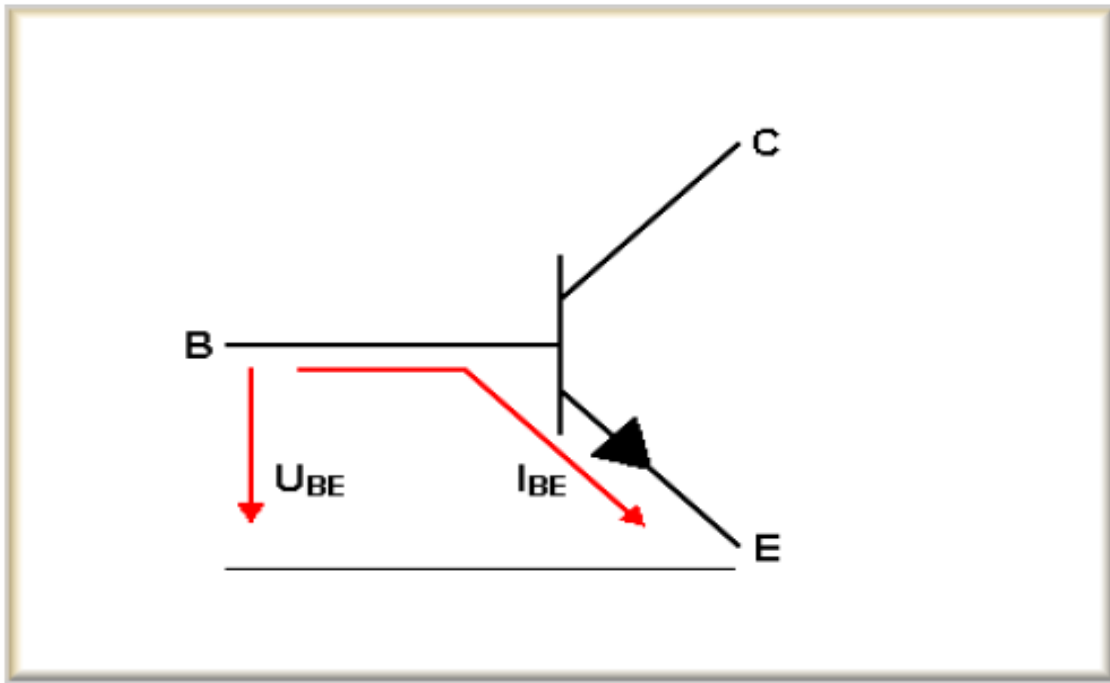
1. Carefully connect the EC1-COM3 board to the Master board by placing it on Master board and gently pushing it into the socket with the help of axial force produced by your two thumbs together holding the master board with two hands.
2. Click on the COM3 Icon, it will detect the hardware part (Master COM 3 board & EC1 board).
3. Choose the experiment to be conducted by clicking on the list provided, an LED glows on the corresponding circuit on COM3 board.
4. Carefully listen to the directions given by the computer, and make circuit connections on the board with the help of patch chords.
5. Vary different parameters like Voltage, current, potentiometer, etc.
6. If the connections are correct, the COM3 software will allow you to go to the next step, otherwise it will ask you to correct your circuit connection.
7. Repeat point 4 and 5 unless it allows you to proceed for the next step.
8. Once the experiment is completed save the experiment file in your folder.
9. Switch off the supply and Remove the circuit connections carefully.
10. Remove the Com3 Board from the Master board Carefully and place it into its box safely.
11. Shut down the personal computer.

Experiment No.8: Input Characteristics of Bipolar Junction Transistor

Procedure For COM3 Simulation:

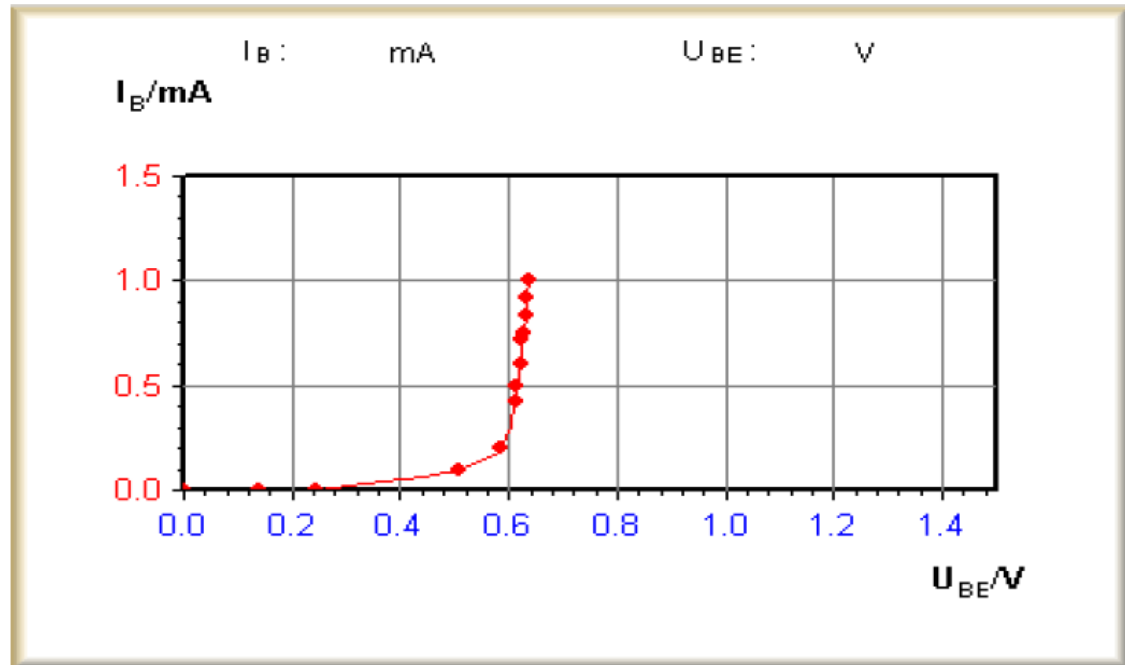
1. CAREFULLY connect the EC1-COM3 board to the Master board by placing it on Master board and gently pushing it into the socket with the help of axial force produced by your two thumbs together holding the master board with two hands.
2. Click on the COM3 Icon, it will detect the hardware part (Master COM 3 board & EC1 board).
3. Choose the experiment to be conducted by clicking on the list provided, an LED glows on the corresponding circuit on COM3 board.
4. Carefully listen to the directions given by the computer, and make circuit connections on the board with the help of patch chords.
5. Vary different parameters like Voltage, current, potentiometer, etc.
6. If the connections are correct, the COM3 software will allow you to go to the next step, otherwise it will ask you to correct your circuit connection.
7. Repeat point 4 and 5 unless it allows you to proceed for the next step.
8. Once the experiment is completed save the experiment file in your folder.
9. Switch off the supply and Remove the circuit connections carefully.
10. Remove the Com3 Board from the Master board CAREFULLY and place it into its box safely.
11. Shut down the personal computer.

5.1 General information



The input characteristic of a transistor indicates the ratio between the base-emitter current and the base-emitter voltage.

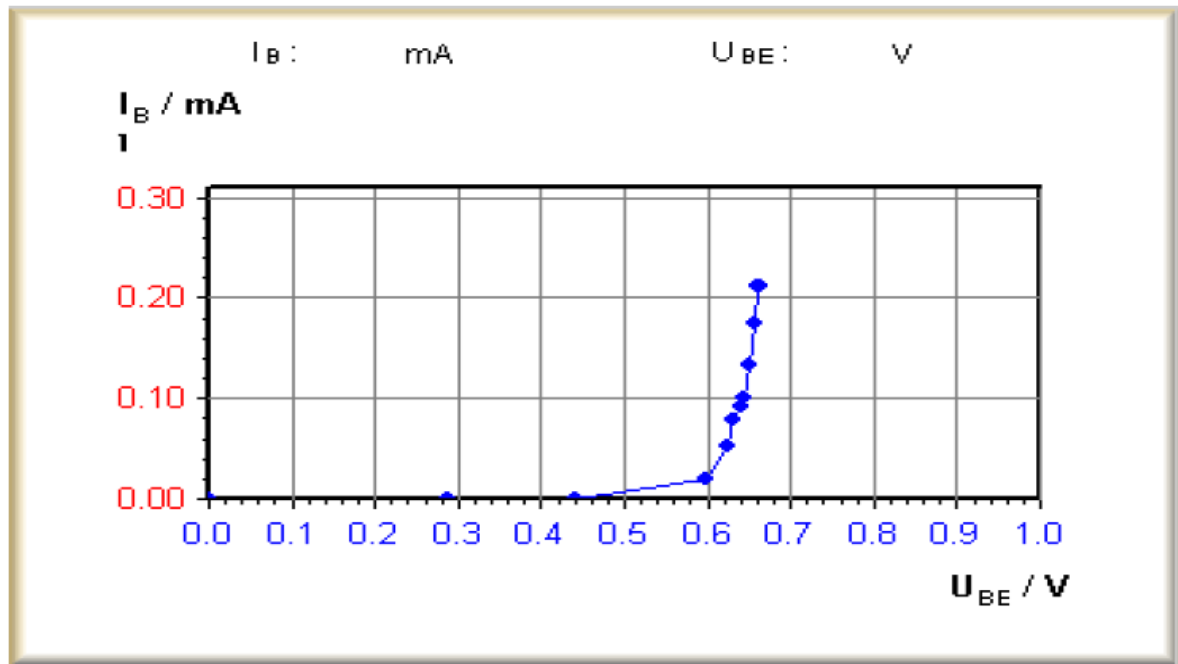
5.2 Measurement configuration and procedure 1



The first measurement is performed with an open collector, i.e. no voltage is applied to the collector. Consequently, only the current flow from the base to the emitter is investigated.

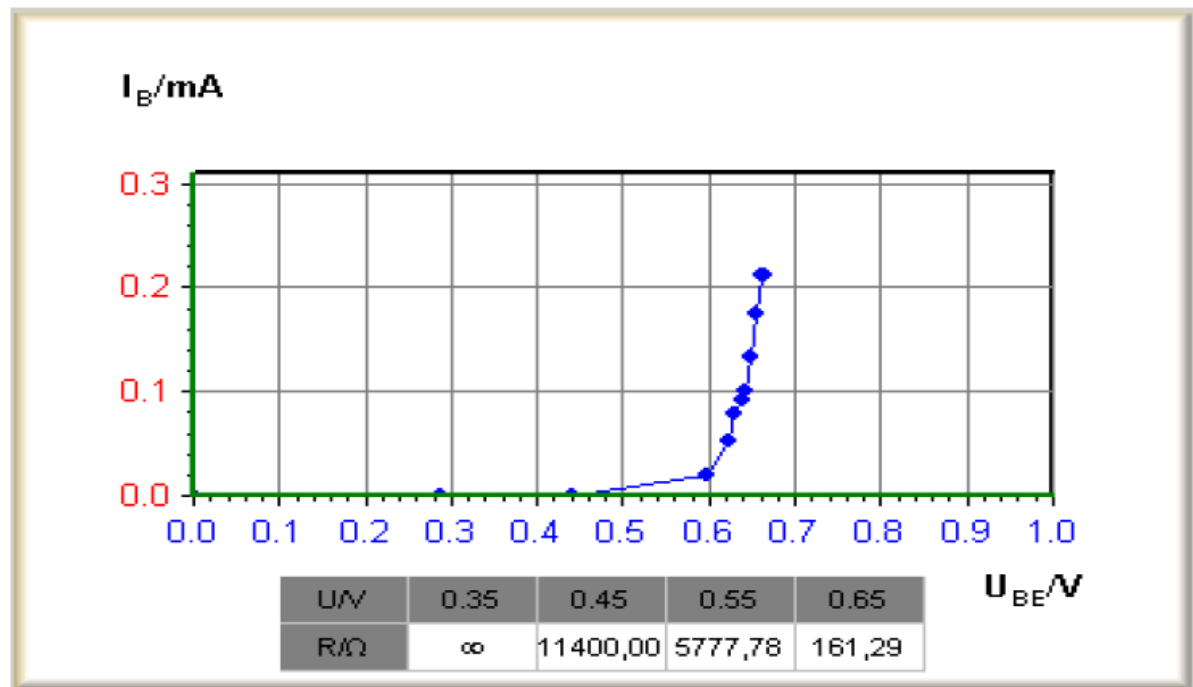
Note that the base-emitter diode of the npn transistor is in the forward state when the base voltage is negative.

5.3 Measurement configuration and procedure 2



The second measurement is performed with a closed collector, i.e. a potential is applied to the collector. Check whether the collector-emitter voltage influences the input characteristic.

5.4 Input resistance



Input resistances can be divided into two different categories:

- static input resistance¹
- differential input resistance.²

Differential input resistances are used more commonly.

¹ **Static input resistance**

The static input resistance is the ratio between the input voltage and the input current:

$$R = U_{BE} / I_B \quad (U_{CE} = \text{constant})$$

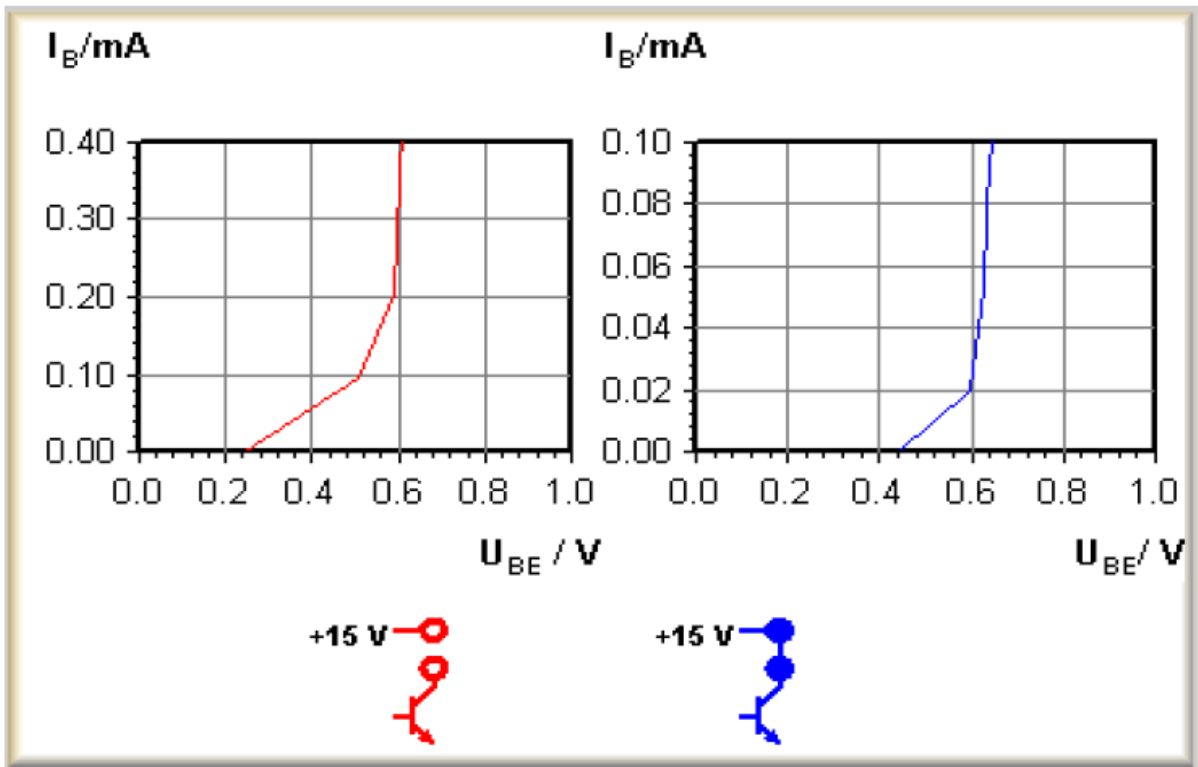
² **Differential input resistance**

The differential input resistance is the ratio between the change in the voltage and the change in the current:

$$r_e = \Delta U_{BE} / \Delta I_B \quad (U_{CE} = \text{constant})$$

ΔU_{BE} and ΔI_B are determined by plotting a tangent on the control characteristic corresponding to the operating point

5.5 Evaluation



The input characteristics with an open and closed collector do not differ from each other considerably, if at all. The scaling is dependent on the value of the resistor¹ at the emitter terminal.

The input characteristic strongly resembles the diode characteristic. This can be explained by the fact that the base-emitter branch consists of a diode.

¹ The resistor at the emitter terminal produces a negative current feedback which protects the transistor (refer to the chapter titled "Power dissipation of a transistor")

5.6 Knowledge check

In the assignment at right check your knowledge of the material.

Check your knowledge



Why does the input characteristic of an npn transistor correspond to a diode characteristic?

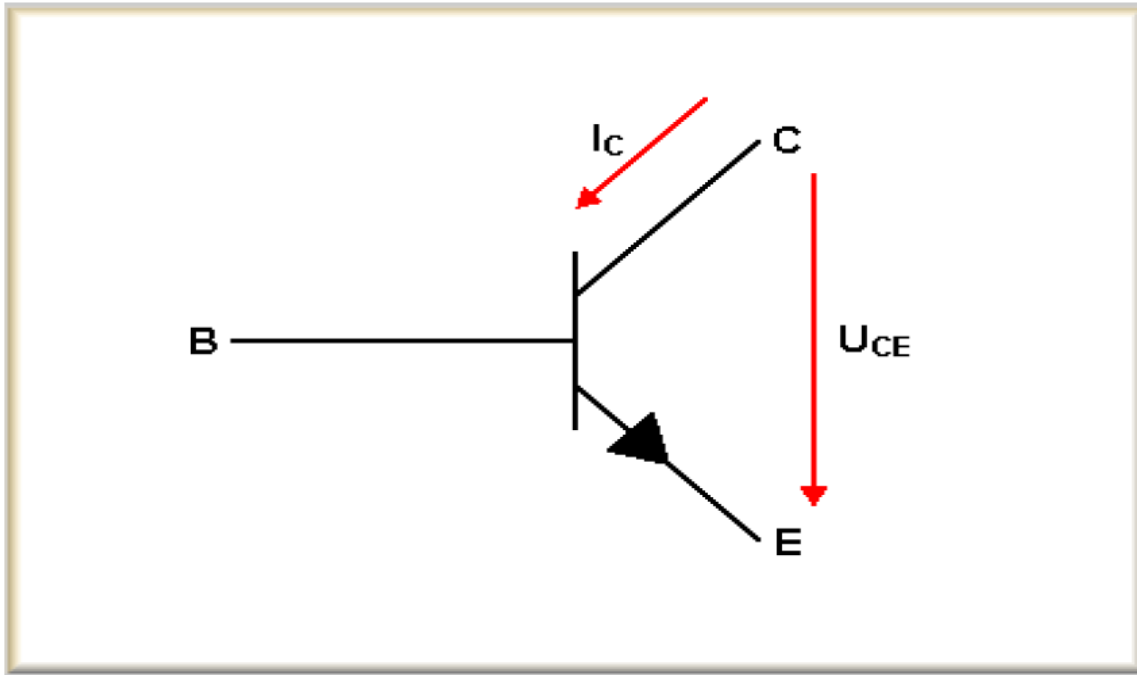
- The base-emitter branch comprises a diode in the reverse state.
- The base-emitter branch comprises a diode in the forward state.

Experiment No.9: Output Characteristics of Bipolar Junction Transistor

Procedure For COM3 Simulation:

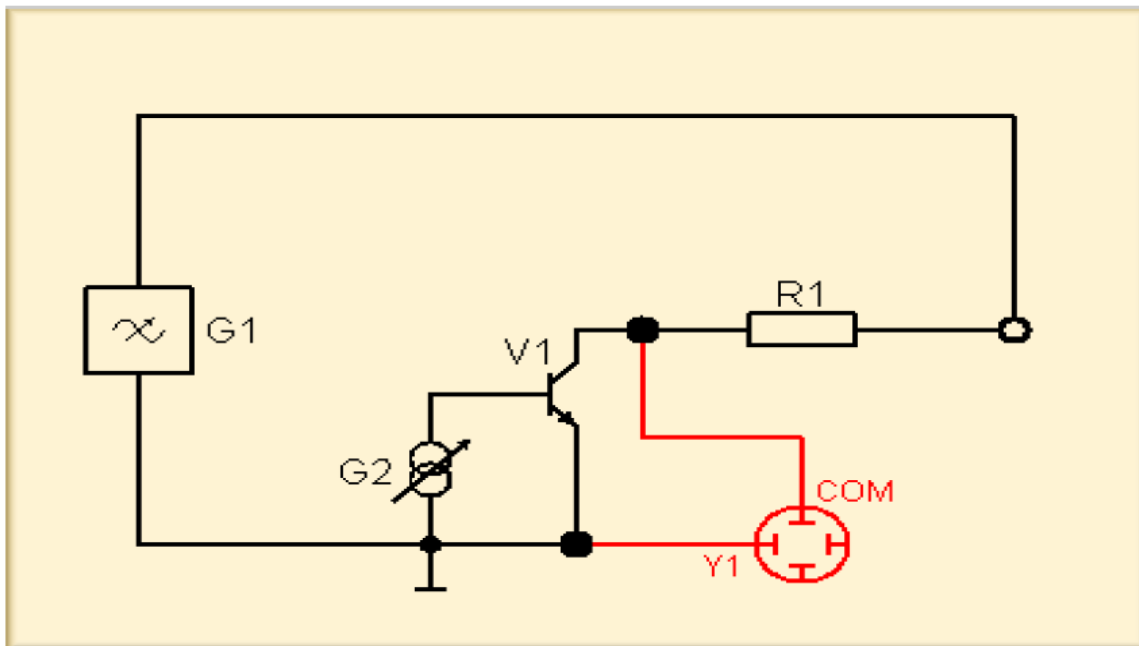
1. Carefully connect the EC1-COM3 board to the Master board by placing it on Master board and gently pushing it into the socket with the help of axial force produced by your two thumbs together holding the master board with two hands.
2. Click on the COM3 Icon, it will detect the hardware part (Master COM 3 board & EC1 board).
3. Choose the experiment to be conducted by clicking on the list provided, an LED glows on the corresponding circuit on COM3 board.
4. Carefully listen to the directions given by the computer, and make circuit connections on the board with the help of patch chords.
5. Vary different parameters like Voltage, current, potentiometer, etc.
6. If the connections are correct, the COM3 software will allow you to go to the next step, otherwise it will ask you to correct your circuit connection.
7. Repeat point 4 and 5 unless it allows you to proceed for the next step.
8. Once the experiment is completed save the experiment file in your folder.
9. Switch off the supply and Remove the circuit connections carefully.
10. Remove the Com3 Board from the Master board Carefully and place it into its box safely.
11. Shut down the personal computer.

General information



The output characteristic indicates the dependence of the emitter current on the collector-emitter voltage. The base current influences the characteristic. For this reason, a separate characteristic is obtained for each base current. A family of these characteristics in a diagram is termed output characteristic family.

Measurement configuration and procedure

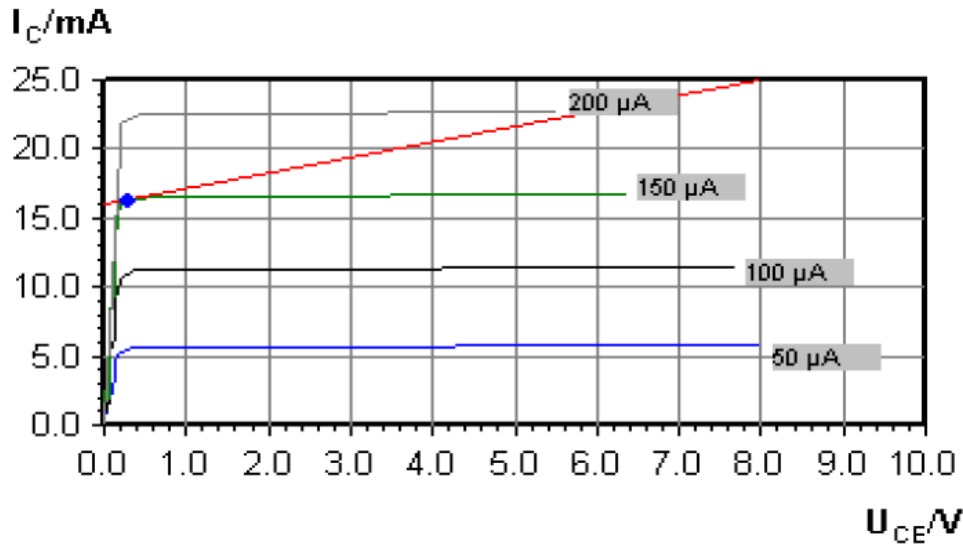


The collector current and collector-emitter voltage are measured dynamically. The measurement is repeated at various base currents. In each case, the base current is indicated on the experiment panel.

6.3 Output resistance

Dynamic output resistance r_a (0.3 V) / Ω :

1000,00



The differential output resistance indicates the ratio between the changes in the collector voltage and current:

$$r_a = \Delta U_{CE} / \Delta I_C \quad (I_B = \text{constant})$$

ΔU_{CE} and ΔI_C are determined by means of a tangent applied to the output characteristic corresponding to the operating point.

Summary

The list on the right gives a survey of the most important items dealt with in this chapter.

Summary of this chapter

Collector voltages

At low collector voltages, the collector current rises sharply. High collector voltages give rise to a nearly constant collector current in accordance with the value of the base current.



Output characteristic of a transistor

- ▶ The output characteristic family indicates the ratio between the emitter current and collector-emitter voltage.
- ▶ The base current influences the characteristic, so that several different characteristics can be obtained.
- ▶ The current can be produced even from a low collector-emitter voltage onwards.
- ▶ The differential output resistance is calculated as follows:

$$r_a = \Delta U_{CE} / \Delta I_C \quad (I_B = \text{constant})$$

Experiment No.10

BJT in Common Mode Configuration

AIM: To observe and draw the input and output characteristics of a transistor connected in common base configuration.

APPARATUS: Transistor (BC107 or SL100)

Regulated power supply (0-30V, 1A)

Voltmeter (0-20V)

Ammeters (0-200mA)

Resistors, 100 Ω , 100K Ω

Bread board and connecting wires

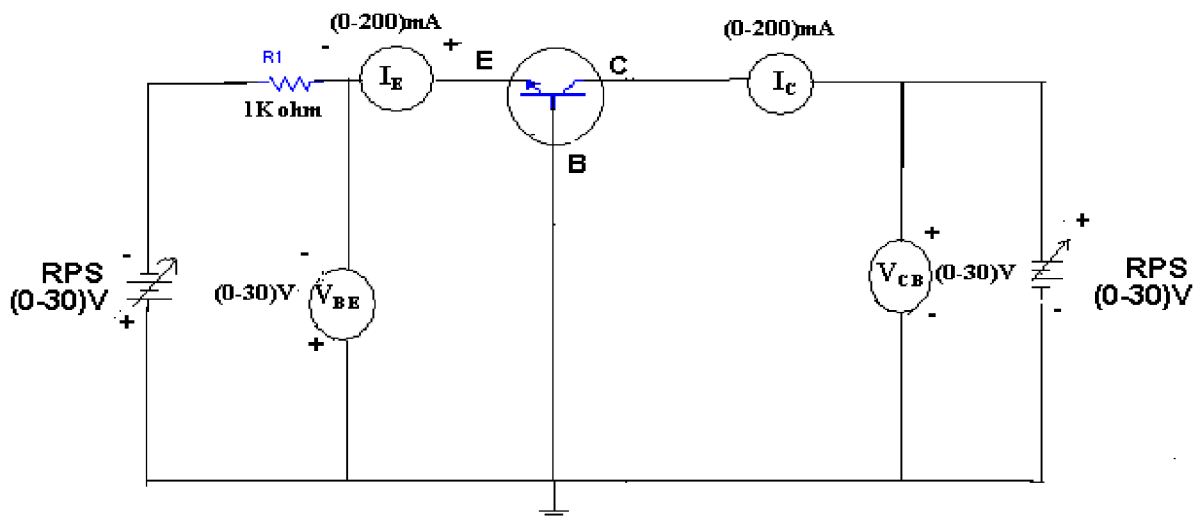
THEORY:

A transistor is a three terminal active device. The terminals are emitter, base, collector. In CB configuration, the base is common to both input (emitter) and output (collector). For normal operation, the E-B junction is forward biased and C-B junction is reverse biased. In CB configuration, I_E is +ve, I_c is δ ve and I_B is δ ve. So, $V_{EB}=f1(V_{CB},I_E)$ and $I_c=f2(V_{CB},I_B)$

With an increasing the reverse collector voltage, the space-charge width at the output junction increases and the effective base width $\Delta W\phi$ decreases. This phenomenon is known as "Early effect". Then, there will be less chance for recombination within the base region. With increase of charge gradient with in the base region, the current of minority carriers injected across the emitter junction increases. The current amplification factor of CB configuration is given by,

$$\alpha = I_c / I_E$$

CIRCUIT DIAGRAM



PROCEDURE:

INPUT CHARACTERISTICS:

1. Connections are made as per the circuit diagram.
2. For plotting the input characteristics, the output voltage V_{CE} is kept constant at 0V and for different values of V_{EB} note down the values of I_E .
3. Repeat the above step keeping V_{CB} at 2V, 4V, and 6V. All the readings are tabulated.
4. A graph is drawn between V_{EB} and I_E for constant V_{CB} .

OBSERVATIONS:

INPUT CHARACTERISTICS:

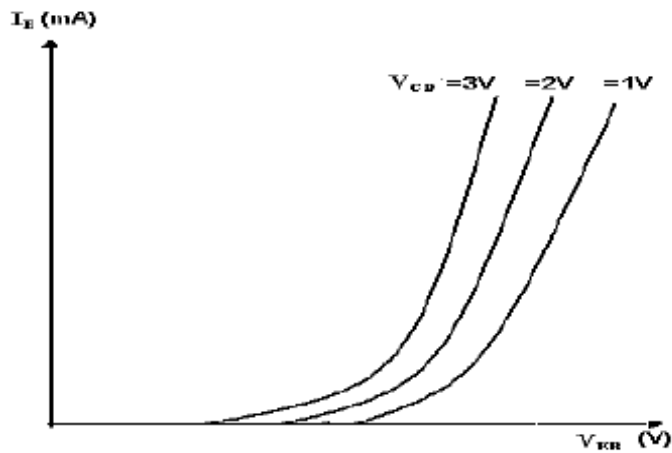
S. No	$V_{CB}=0V$		$V_{CB}=1V$		$V_{CB}=2V$	
	$V_{EB}(V)$	$I_E(mA)$	$V_{EB}(V)$	$I_E(mA)$	$V_{EB}(V)$	$I_E(mA)$

OUTPUT CHARACTERISTICS:

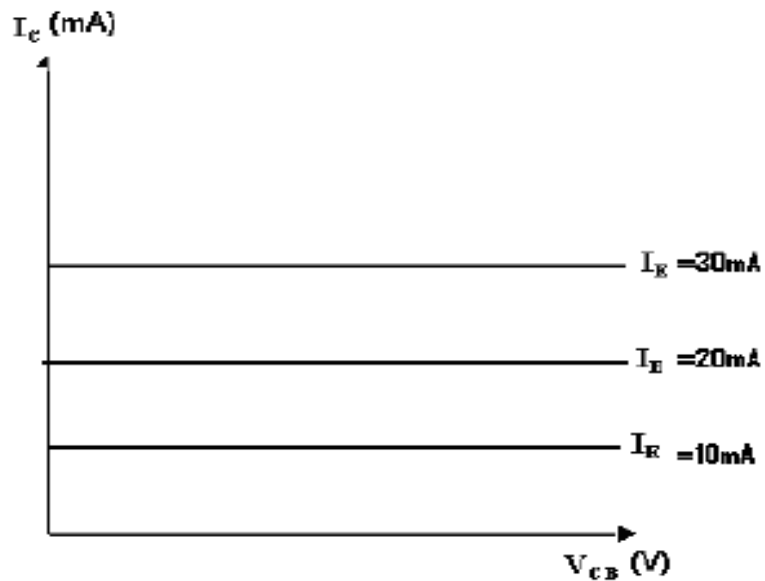
PROCEDURE

1. Connections are made as per the circuit diagram.

INPUT CHARACTERISTICS



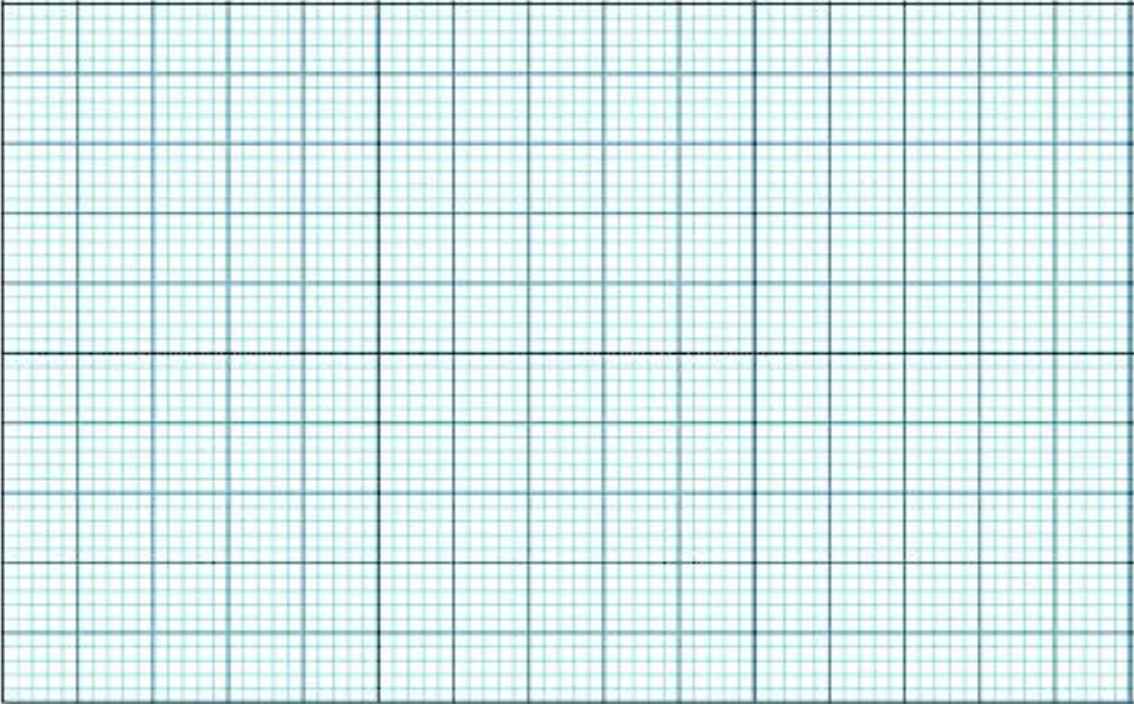
OUTPUT CHARACTERISTICS



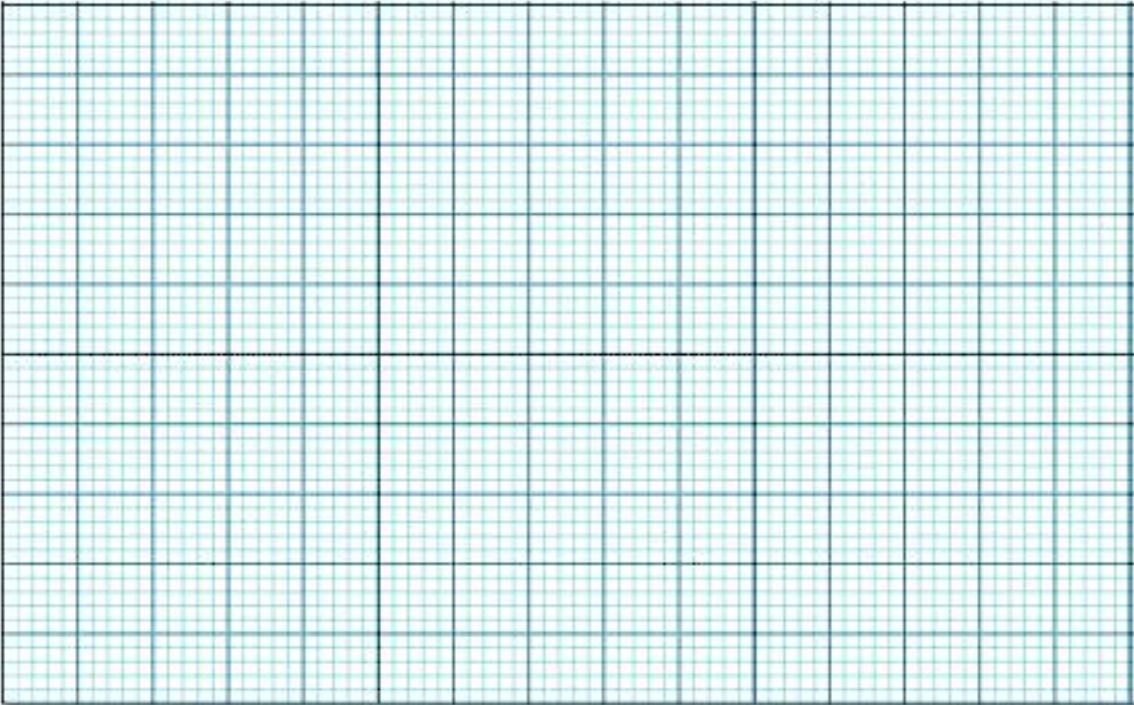
PRECAUTIONS:

1. The supply voltages should not exceed the rating of the transistor.
2. Meters should be connected properly according to their polarities.

INPUT CHARACTERISTICS GRAPH:



OUTPUT CHARACTERISTICS GRAPH:



VIVA QUESTIONS:

1. What is the range of β for the transistor?
2. Draw the input and output characteristics of the transistor in CB configuration?
3. Identify various regions in output characteristics?
4. What is the relation between β and α ?
5. What are the applications of CB configuration?
6. What are the input and output impedances of CB configuration?
7. Define α (alpha)?
8. What is EARLY effect?
9. Draw diagram of CB configuration for PNP transistor?
10. What is the power gain of CB configuration?

EXPERIMENT No.11: Emitter Follower

Aim: To calculate the Voltage gain, Current gain, input resistance and output.

Apparatus:

Transistor BC107

Resistors

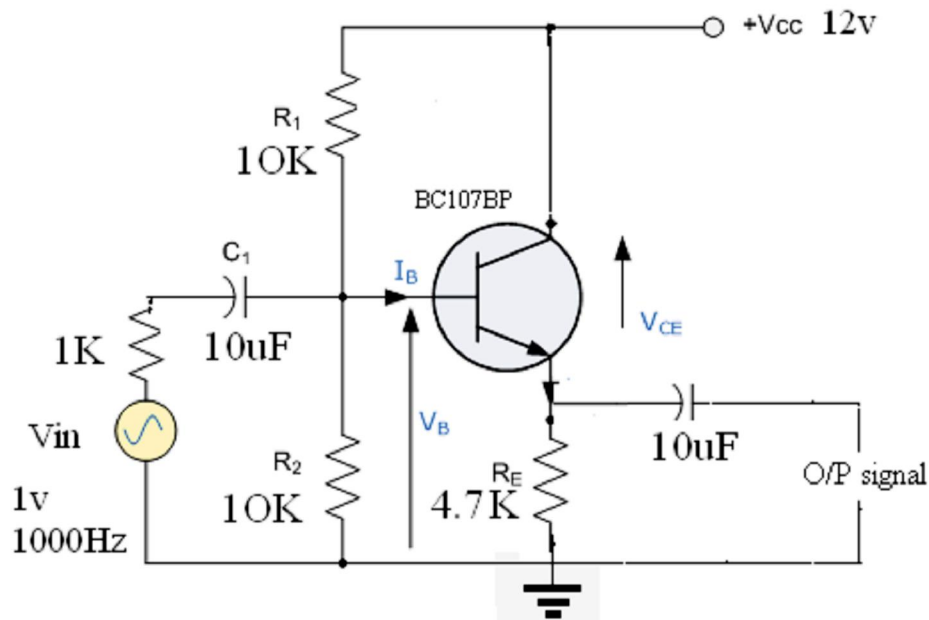
Capacitors

CRO

Function Generator.

Multi meter

CIRCUIT DIAGRAM:



THEORY: EMITTER FOLLOWER

The common collector circuit is also known as emitter follower. The ac output voltage from a CC circuit is essentially the same as the input voltage; there is no voltage gain or phase shift. Thus, the CC circuit can be said to have a voltage gain of 1. The fact that the CC output voltage follows the changes in signal voltage gives the circuit its other name emitter follower. The input impedance of a CC amplifier is high. Output impedance is low and the Voltage gain is almost unity. Because of these Characteristics the CC circuit is normally used as a buffer amplifier, placed between a high impedance signal source and a low impedance load.

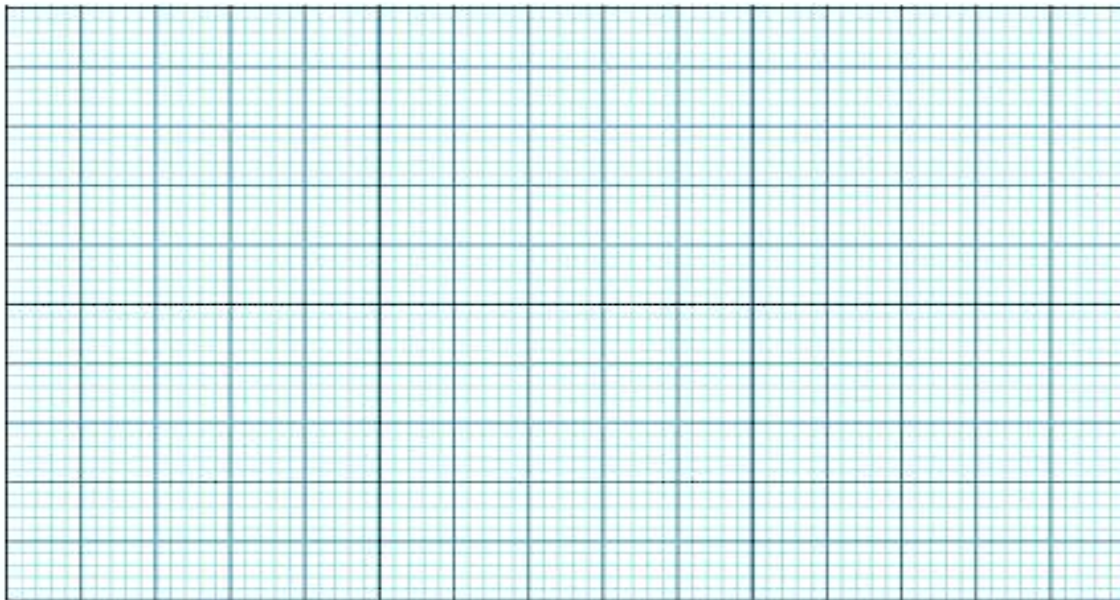
PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Apply V_s 1v 1 KHz signal from the signal generator.
3. Observe corresponding output from the CRO and then calculate voltage gain using the formula $A_v = V_o/V_i$.
4. Measure voltage across AB terminals and then calculate input current by using the formula $I_{in} = V_{ab}/R_{ab}$.
5. Measure current flowing through resistor at Source (or Emitter) terminal and note down it as I_{out} .
6. Calculate Current gain using the formula $A_I = I_{in}/I_{out}$.
7. Calculate input resistance using the formula $R_{in} = V_{in}/I_{in}$.

PRECAUTIONS:

1. Wires should be checked for good continuity
2. BJT terminals must be identified and connected carefully.

Input & Output Graph:



RESULT: