



DEPARTMENT OF ECE
BAPATLA ENGINEERING COLLEGE
BAPATLA
Electronic Devices
(EC-251) Lab Manual

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List of Experiments

1. Study of CRO
2. Characteristics of Silicon and Germanium diodes
3. Characteristics of Zener diode and regulator
4. Characteristics of Common Base Configuration
5. Characteristics of Common Emitter Configuration
6. Characteristics of Emitter Follower circuit
7. Characteristics of JFET
8. Characteristics of UJT
9. Design and verification of self bias circuit
10. Characteristics of Silicon Controlled Oscillator
11. Characteristics of DIAC
12. Characteristics of Thermistor
13. Characteristics of Source Follower circuit
14. Design and Verification of Collector to Base bias circuit
15. Characteristics of Photo transistor

1. STUDY OF CRO

AIM: To observe front panel control knobs and to find amplitude, time period and frequency for given waveforms.

APPARATUS:

CRO

Function generator and probes

PROCEDURE

1. Understand the significance of each and every knob on the CRO.
2. From the given function generator feed in a sinusoidal wave and adjust the time base knob and the amplitude knob to observe the waveform as a function of time.
3. Measure the time period and amplitude (peak to peak) of the signal. Find the frequency and verify if the same frequency is given from the function generator.
4. Observe two waveforms simultaneously on the two channels of a CRO.
5. Repeat the above steps for pulse and triangular waveforms.
6. Report the readings and the waveforms taken.

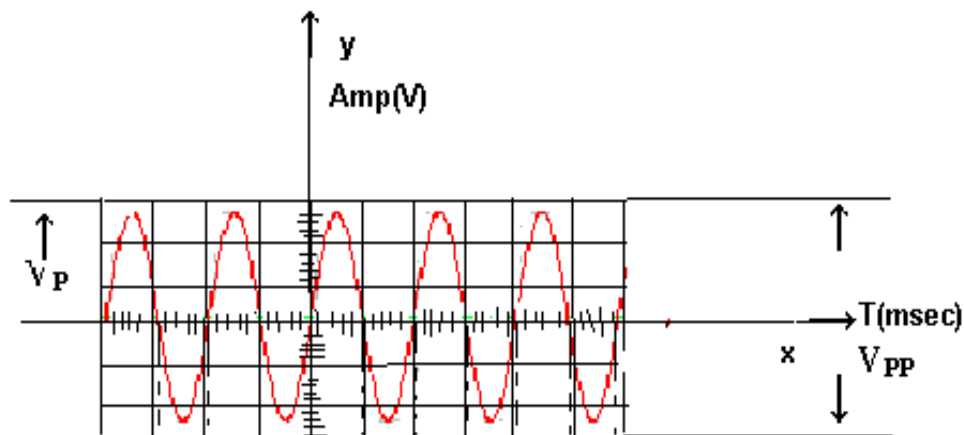
MEASUREMENTS:

Amplitude = no. of vertical divisions * Volts/div.

Time period = no. of horizontal divisions * Time/div.

Frequency = $(1/T)$ Hz

MODEL GRAPHS:



APPLICATIONS OF CRO:

1. Measurement of current
2. Measurement of voltage
3. Measurement of power
4. Measurement of frequency
5. Measurement of phase angle
6. To see transistor curves
7. To trace and measuring signals of RF, IF and AF in radio and TV.
8. To trace visual display of sine waves.

VIVA Questions:

1. How do you measure frequency using the CRO?
2. Can you measure signal phase using the CRO?
3. Suggest a procedure for signal phase measurement using the data from CRO?
4. Can you comment on the wavelength of a signal using CRO?
5. How many channels are there in a CRO?
6. Can you measure DC voltage using a CRO?

2. P-N Junction Diode Characteristics

AIM:- To find out the V-I characteristics of silicon and germanium diodes in Forward and Reverse bias configurations.

APPARATUS:-

P-N Diodes DR25, BY126

Regulated Power supply (0-30v)

Resistor 1K Ω

Ammeters (0-200 mA, 0-200 μ A), Voltmeter (0-20 V)

Bread board and Connecting wires

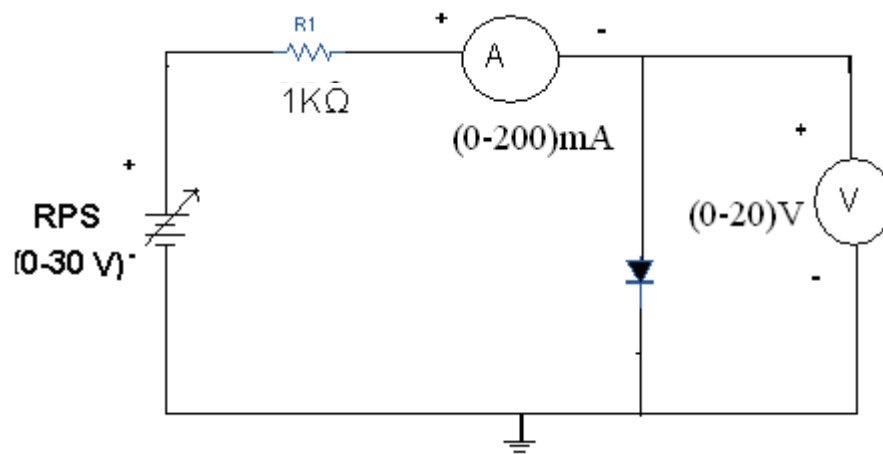
THEORY:-

A p-n junction diode conducts only in one direction. The V-I characteristics of the diode are curve between voltage across the diode and current through the diode. When external voltage is zero, circuit is open and the potential barrier does not allow the current to flow. Therefore, the circuit current is zero. When P-type (Anode is connected to +ve terminal and n- type (cathode) is connected to –ve terminal of the supply voltage, is known as forward bias. The potential barrier is reduced when diode is in the forward biased condition. At some forward voltage, the potential barrier altogether eliminated and current starts flowing through the diode and also in the circuit. The diode is said to be in ON state. The current increases with increasing forward voltage.

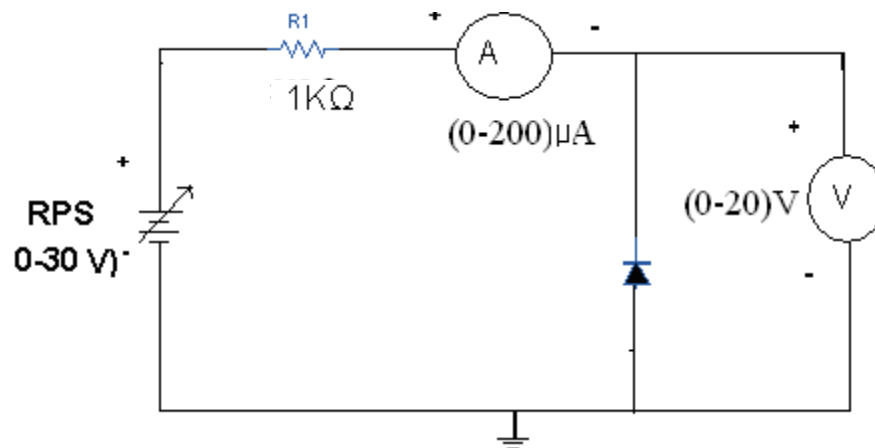
When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected to the –ve terminal of the supply voltage is known as reverse bias and the potential barrier across the junction increases. Therefore, the junction resistance becomes very high and a very small current (reverse saturation current) flows in the circuit. The diode is said to be in OFF state. The reverse bias current is due to minority charge carriers.

CIRCUIT DIAGRAM:-

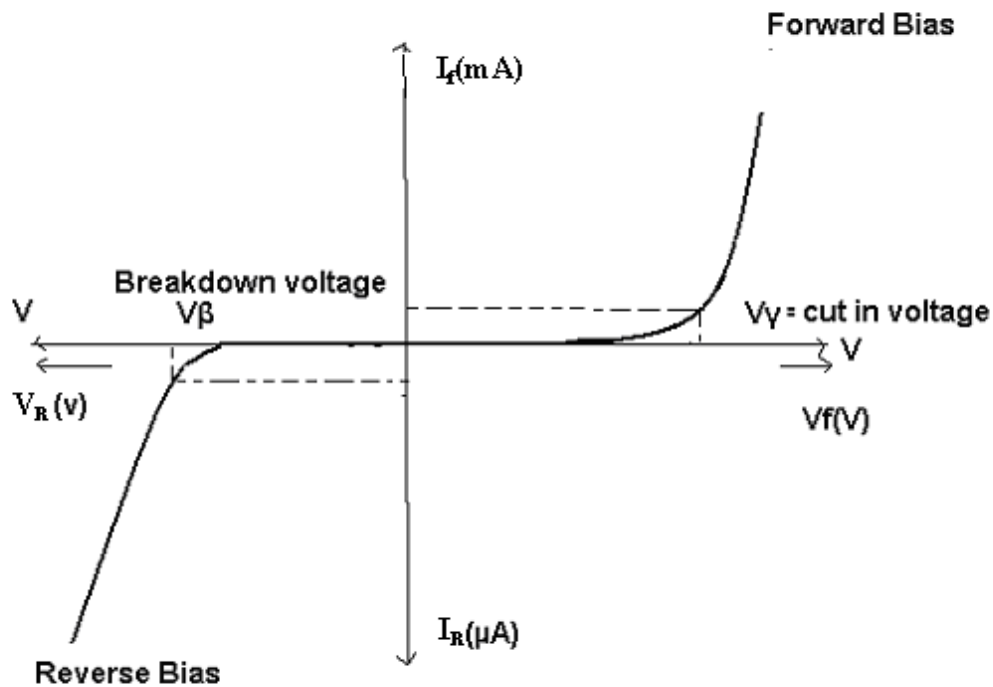
FORWARD BIAS:-



REVERSE BIAS:-



MODEL WAVEFORM:-



PROCEDURE:-

FORWARD BIAS:-

1. Connections are made as per the circuit diagram.
2. For forward bias, the RPS +ve is connected to the anode of the silicon diode and RPS –ve is connected to the cathode of the diode.
3. Switch on the power supply and increases the input voltage (supply voltage) in steps.
4. Note down the corresponding current flowing through the diode and voltage across the diode for each and every step of the input voltage.

5. The readings of voltage and current are tabulated and a graph is plotted between voltage and current.

6. Repeat the above procedure for Germanium diode also and tabulate the results.

OBSERVATION:-

S.NO	APPLIED VOLTAGE (V)	VOLTAGE ACROSS DIODE (V)	DIODE CURRENT (mA)

PROCEDURE:-

REVERSE BIAS:-

1. Connections are made as per the circuit diagram
- 2 . For reverse bias, the RPS +ve is connected to the cathode of the silicon diode and RPS –ve is connected to the anode of the diode.
3. Switch on the power supply and increase the input voltage (supply voltage) in steps.
4. Note down the corresponding current flowing through the diode voltage across the diode for each and every step of the input voltage.
5. The readings of voltage and current are tabulated and graph is plotted between voltage and current.
7. Repeat the above procedure for the given Germanium diode also and tabulate the results obtained.

OBSERVATION:-

S.NO	APPLIED VOLTAGE (V)	VOLTAGE ACROSS DIODE (V)	DIODE CURRENT (μ A)

PRECAUTIONS:-

1. All the connections should be correct.
2. Parallax error should be avoided while taking the readings from the Analog meters.

VIVA QUESTIONS:-

1. Define depletion region of a diode?
2. What is meant by transition & space charge capacitance of a diode?
3. Is the V-I relationship of a diode Linear or Exponential?
4. Define cut-in voltage of a diode and specify the values for Si and Ge diodes?
5. What are the applications of a p-n diode?
6. Draw the ideal characteristics of P-N junction diode?
7. What is the diode equation?
8. What is PIV?
9. What is the break down voltage?
10. What is the effect of temperature on PN junction diodes?

3. ZENER DIODE CHARACTERISTICS

AIM: - a) To observe and draw the static characteristics of a zener diode

b) To find the voltage regulation of a given zener diode

APPARATUS: -

Zener diode (IZ5.1 or IZ9.1)

Regulated Power Supply (0-30v).

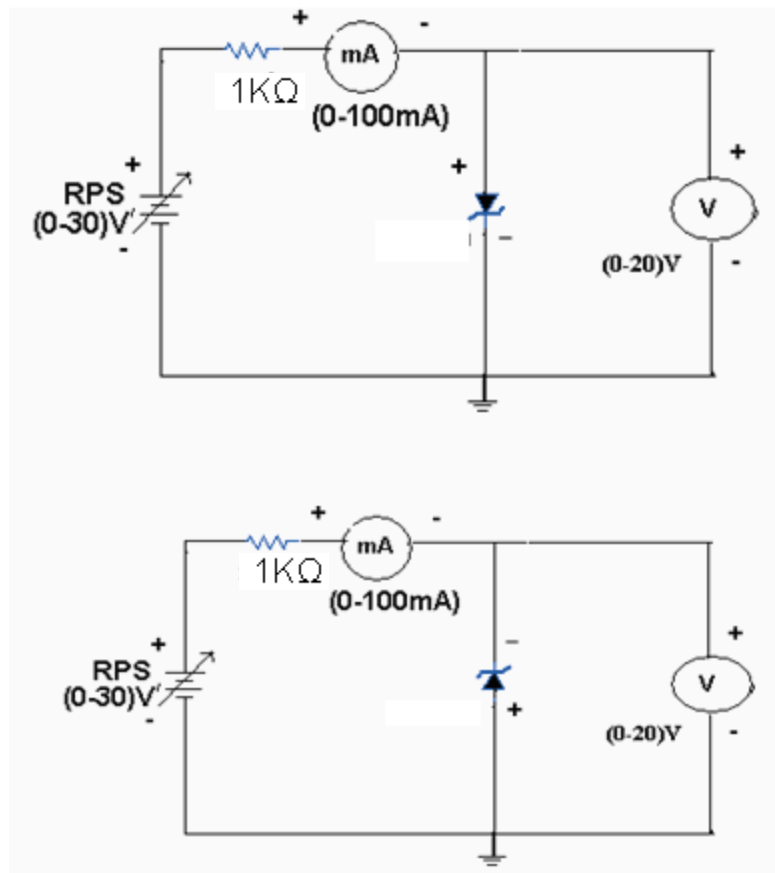
Voltmeter (0-20v) Ammeter (0-100mA)

Resistors (1Kohm)

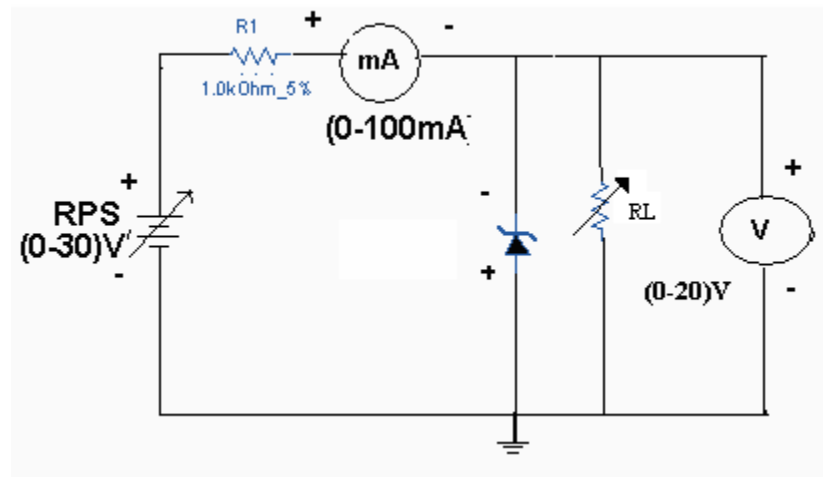
Bread Board and Connecting wires

CIRCUIT DIAGRAM:-

STATIC CHARACTERISTICS:-



REGULATION CHARACTERISTICS:-



Theory:-

A zener diode is heavily doped p-n junction diode, specially made to operate in the break down region. A p-n junction diode normally does not conduct when reverse biased. But if the reverse bias is increased, at a particular voltage it starts conducting heavily. This voltage is called Break down Voltage. High current through the diode can permanently damage the device

To avoid high current, we connect a resistor in series with zener diode. Once the diode starts conducting it maintains almost constant voltage across the terminals whatever may be the current through it, i.e., it has very low dynamic resistance. It is used in voltage regulators.

PROCEDURE:-

Static characteristics:-

1. Connections are made as per the circuit diagram.
2. The Regulated power supply voltage is increased in steps.
3. The zener current (I_z), and the zener voltage (V_z) are observed and then noted in the tabular form.
4. A graph is plotted between zener current (I_z) and zener voltage (V_z).

5. Do the above steps for forward as well as reverse bias connections as shown in the circuit diagrams.

Regulation characteristics:-

1. Connections are made as per the circuit diagram
2. The load resistance is fixed to known value and the zener voltage (V_Z), and Zener current (I_Z), are measured.
3. The load resistance is varied in steps and the corresponding values are noted down for each load resistance value.
4. All the readings are tabulated.

OBSERVATIONS:-

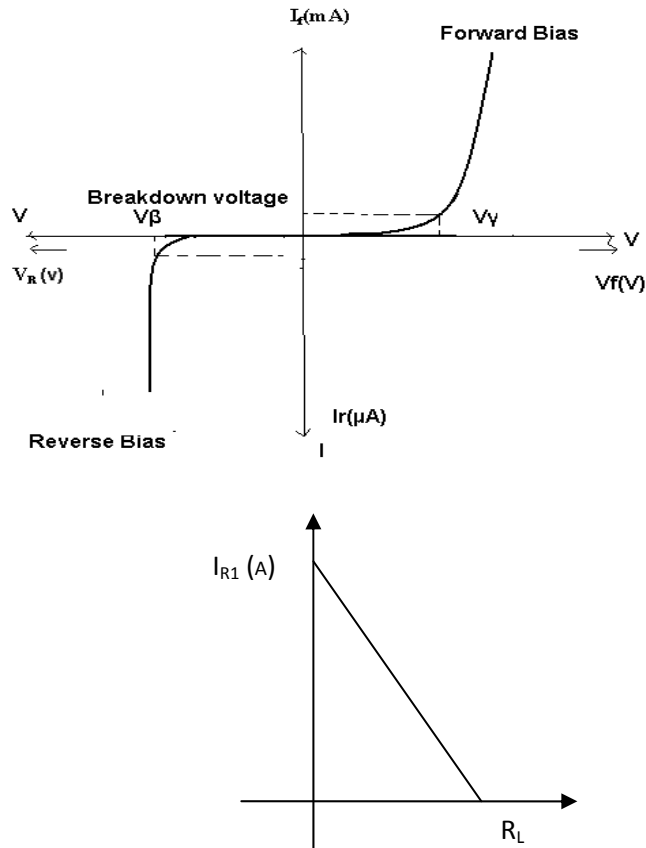
Static characteristics:-

S.NO	ZENER VOLTAGE(V_Z)	ZENER CURRENT(I_Z)

Regulation characteristics:-

S.NO	V_Z (VOLTS)	I_{R1} (amperes)	R_L (Ω)

MODEL WAVEFORMS:-



PRECAUTIONS:-

1. The terminals of the zener diode should be properly identified.
2. Should be ensured that the applied voltages & currents do not exceed the diode ratings.

VIVAQUESTIONS:-

1. What type of temperature Coefficient does the zener diode have?
2. If the impurity concentration is increased, how the depletion width effected?
3. Does the dynamic impendence of a zener diode vary?
4. Explain briefly about avalanche and zener breakdowns?
5. Draw the zener equivalent circuit?
6. Differentiate between line regulation & load regulation?
7. In which region zener diode can be used as a regulator?
8. How the breakdown voltage of a particular diode can be controlled?
9. What type of temperature coefficient does the Avalanche breakdown has?
10. By what type of charge carriers the current flows in zener and avalanche breakdown diodes?

4. TRANSISTOR COMMON -BASE CONFIGURATION

AIM: 1.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, 100Ω, 100KΩ
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 –ve and I_B is –ve. So,

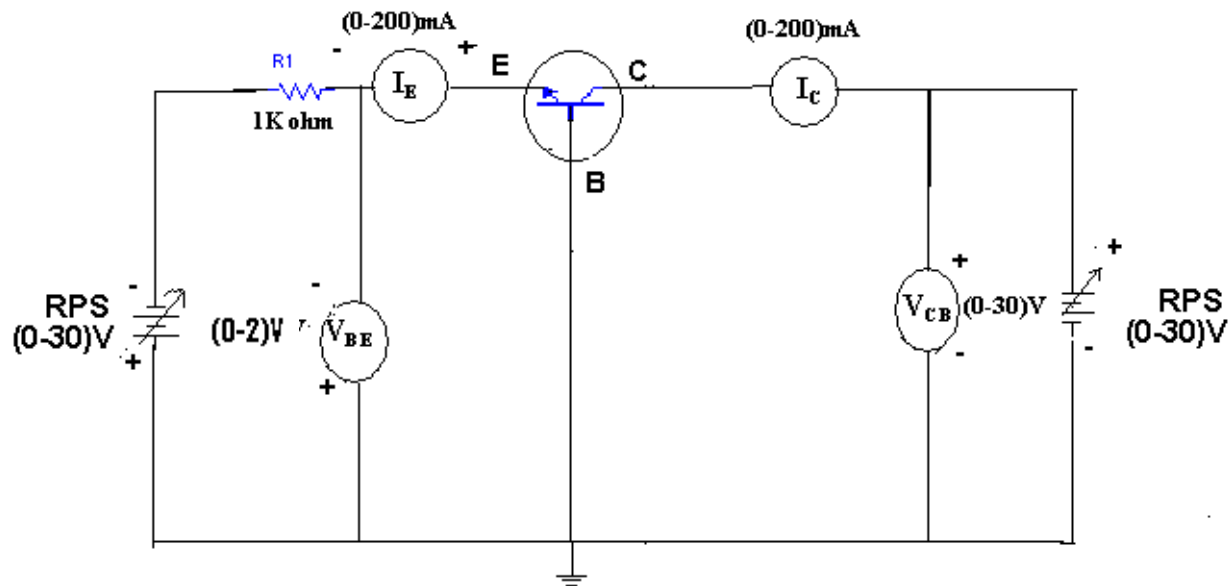
$$V_{EB}=f_1(V_{CB}, I_E) \text{ and}$$

$$I_C=f_2(V_{CB}, I_B)$$

With an increasing the reverse collector voltage, the space-charge width at the output junction increases and the effective base width 'W' 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 within the base region, the current of minority carriers injected across the emitter junction increases. The current amplification factor of CB configuration is given by,

$$\alpha = \Delta I_C / \Delta I_E$$

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_{BE} 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_{BE} and I_E for constant V_{CB} .

OUTPUT CHARACTERISTICS:

1. Connections are made as per the circuit diagram.
2. For plotting the output characteristics, the input I_E is kept constant at 10mA and for different values of V_{CB} , note down the values of I_C .
3. Repeat the above step for the values of I_E at 20 mA, 40 mA, and 60 mA, all the readings are tabulated.
4. A graph is drawn between V_{CB} and I_C for constant I_E .

OBSERVATIONS:

INPUT CHARACTERISTICS:

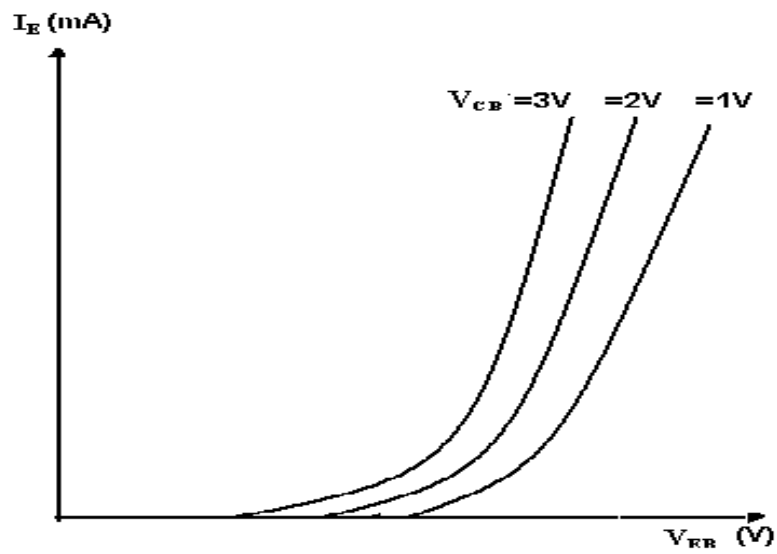
S.No	$V_{CB}=0V$		$V_{CB}=1V$		$V_{CB}=2V$	
	$V_{EB}(V)$	$I_E(mA)$	$V_{EB}(V)$	$I_E(mA)$	$V_{EB}(V)$	$I_E(mA)$

OUTPUT CHARACTERISTICS:

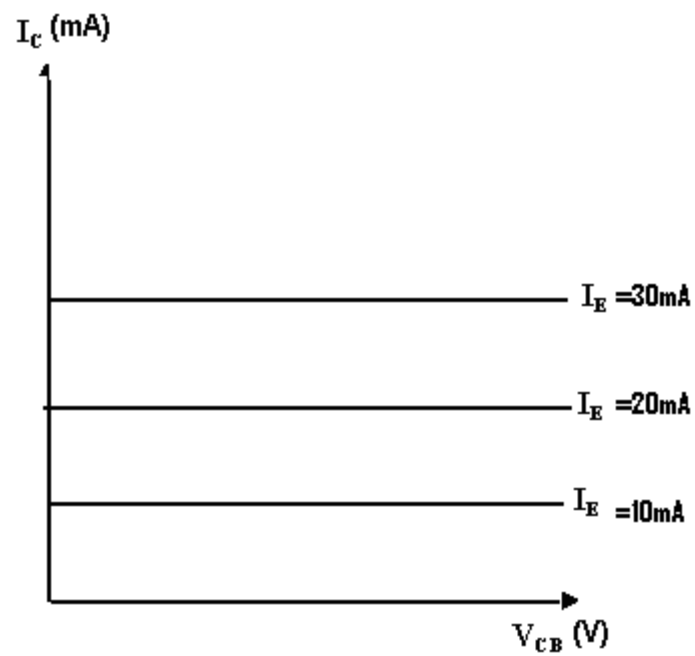
S.No	$I_E=10mA$		$I_E=20mA$		$I_E=30mA$	
	$V_{CB}(V)$	$I_C(mA)$	$V_{CB}(V)$	$I_C(mA)$	$V_{CB}(V)$	$I_C(mA)$

MODEL GRAPHS:

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.

VIVA QUESTIONS:

1. What is the range of α 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 α and β ?
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?

5. TRANSISTOR CE CHARACTERISTICS

AIM: To draw the input and output characteristics of transistor connected in CE configuration

APPARATUS:

Transistor (SL100 or BC107)
R.P.S (0-30V) 2Nos
Voltmeters (0-20V) 2Nos
Ammeters (0-200mA)
Resistors 100Kohm, 100ohm
Bread board and connecting wires

THEORY:

A transistor is a three terminal device. The terminals are emitter, base, collector. In common emitter configuration, input voltage is applied between base and emitter terminals and out put is taken across the collector and emitter terminals.

Therefore the emitter terminal is common to both input and output.

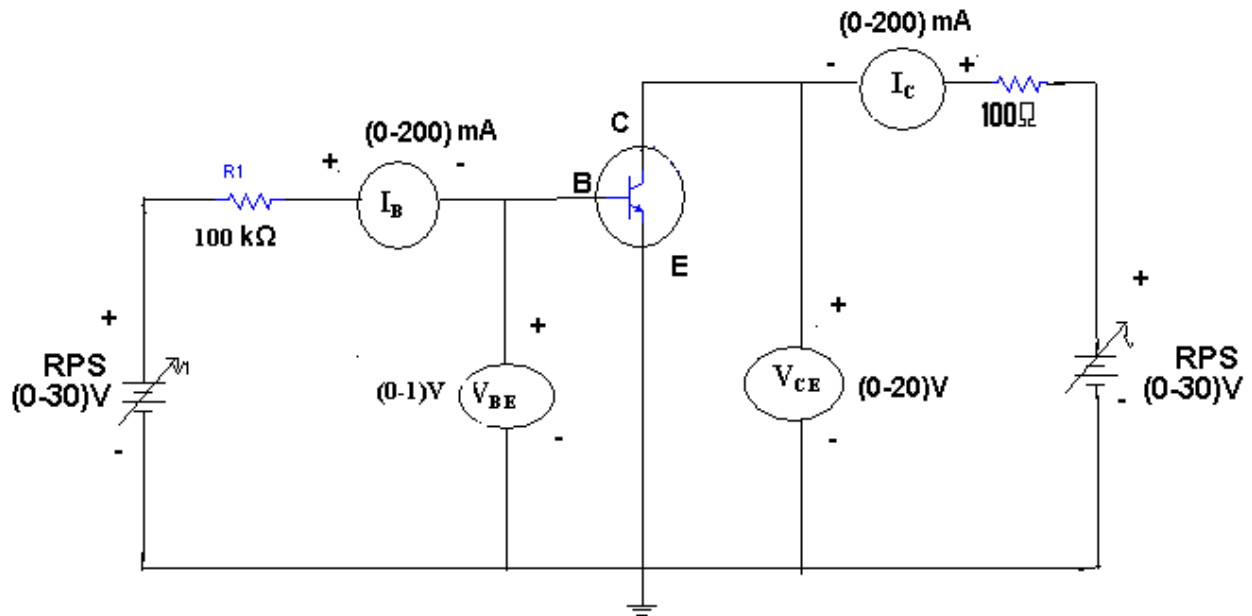
The input characteristics resemble that of a forward biased diode curve. This is expected since the Base-Emitter junction of the transistor is forward biased. As compared to CB arrangement I_B increases less rapidly with V_{BE} . Therefore input resistance of CE circuit is higher than that of CB circuit.

The output characteristics are drawn between I_C and V_{CE} at constant I_B , the collector current varies with V_{CE} upto few volts only. After this the collector current becomes almost constant, and independent of V_{CE} . The value of V_{CE} up to which the collector current changes with V_{CE} is known as Knee voltage. The transistor always operated in the region above Knee voltage, I_C is always constant and is approximately equal to I_B .

The current amplification factor of CE configuration is given by

$$B = \Delta I_C / \Delta I_B$$

CIRCUIT DIAGRAM:



PROCEDURE:

INPUT CHARACTERISTICS:

1. Connect the circuit as per the circuit diagram.
2. For plotting the input characteristics the output voltage V_{CE} is kept constant at 1V and for different values of V_{BE} . Note down the values of I_C
3. Repeat the above step by keeping V_{CE} at 2V and 4V.
4. Tabulate all the readings.
5. plot the graph between V_{BE} and I_B for constant V_{CE}

OUTPUT CHARACTERISTICS:

1. Connect the circuit as per the circuit diagram
2. for plotting the output characteristics the input current I_B is kept constant at $10\mu A$ and for different values of V_{CE} note down the values of I_C
3. repeat the above step by keeping I_B at $75\mu A$ $100\mu A$
4. tabulate the all the readings
5. plot the graph between V_{CE} and I_C for constant I_B

OBSERVATIONS:

INPUT CHARACTERISTICS:

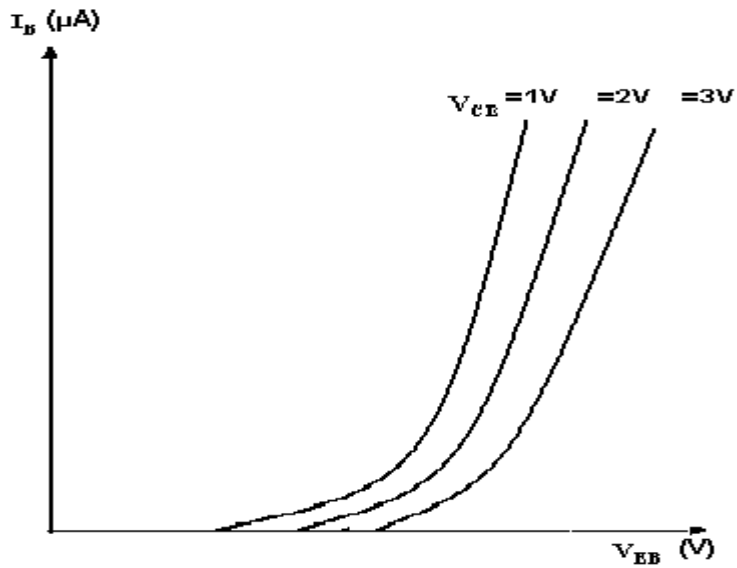
S.NO	$V_{CE} = 1V$		$V_{CE} = 2V$		$V_{CE} = 4V$	
	$V_{BE}(V)$	$I_B(\mu A)$	$V_{BE}(V)$	$I_B(\mu A)$	$V_{BE}(V)$	$I_B(\mu A)$

OUT PUT CHAREACTARISTICS:

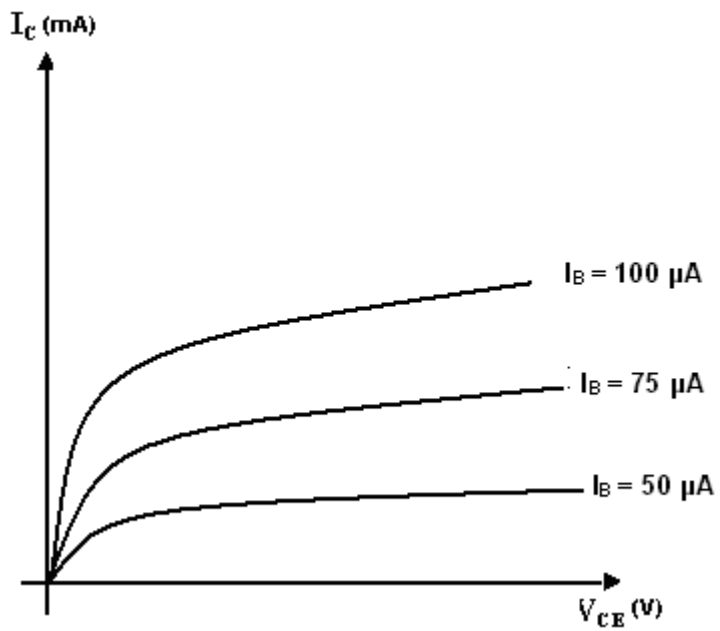
S.NO	$I_B = 50 \mu A$		$I_B = 75 \mu A$		$I_B = 100 \mu A$	
	$V_{CE}(V)$	$I_C(mA)$	$V_{CE}(V)$	$I_C(mA)$	$V_{CE}(V)$	$I_C(mA)$

MODEL GRAPHS:

INPUT CHARACTERISTICS:



OUTPUT CHARECTERSTICS:



PRECAUTIONS:

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

VIVA QUESTIONS:

1. What is the range of β for the transistor?
2. What are the input and output impedances of CE configuration?
3. Identify various regions in the output characteristics?
4. what is the relation between α and β
5. Define current gain in CE configuration?
6. Why CE configuration is preferred for amplification?
7. What is the phase relation between input and output?
8. Draw diagram of CE configuration for PNP transistor?
9. What is the power gain of CE configuration?
10. What are the applications of CE configuration?

6. CHARACTERISTICS OF EMITTER FOLLOWER CIRCUIT

AIM: To draw the input and output characteristics of transistor connected in CC (Common Collector) or Emitter follower configuration.

APPARATUS:

Transistor (SL100 or BC107)

R.P.S (0-30V) 2Nos

Voltmeters (0-20V) 2Nos

Ammeters (0-200 μ A)

(0-200mA)

Resistors 100Kohm

Bread board and connecting wires

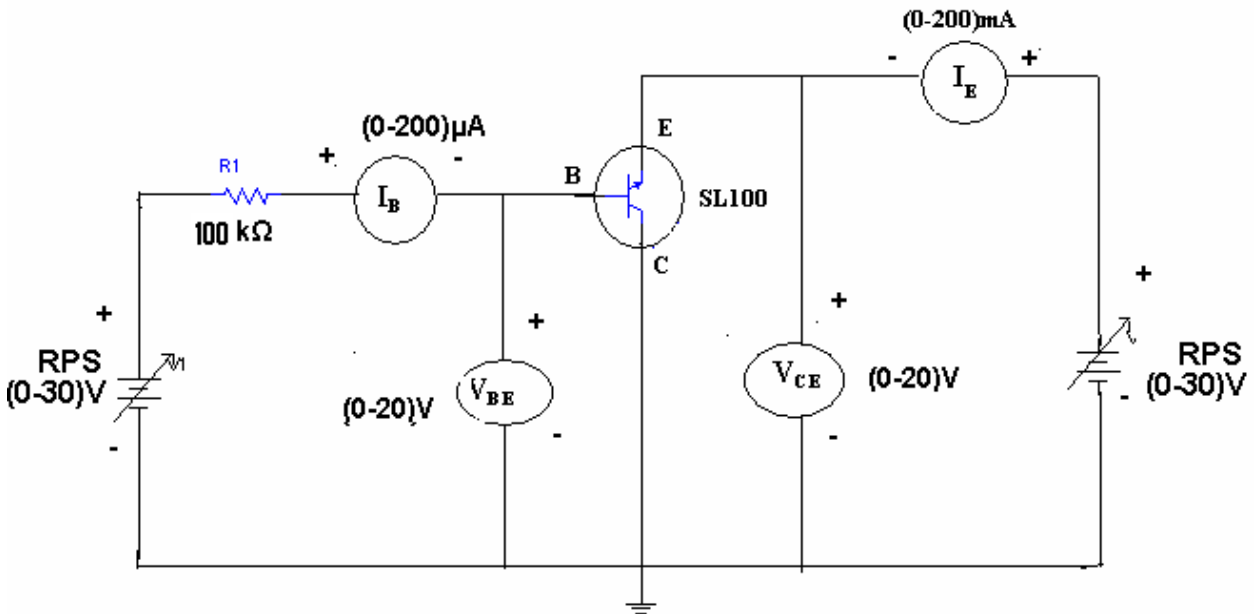
THEORY:

A transistor is a three terminal device. The terminals are emitter, base, collector. In emitter follower configuration, input voltage is applied between base and ground terminals and out put is taken across the emitter and collector terminals.

The input characteristics resemble that of a forward biased diode curve. This is expected since the Base-Emitter junction of the transistor is forward biased.

The output characteristics are drawn between I_E and V_{CE} at constant I_B . the emitter current varies with V_{CE} upto few volts only. After this the emitter current becomes almost constant, and independent of V_{CE} . The value of V_{CE} up to which the collector current changes with V_{CE} is known as Knee voltage. The transistor always operated in the region above Knee voltage, I_E is always constant and is approximately equal to I_B .

CIRCUIT DIAGRAM:



PROCEDURE:

INPUT CHARACTERISTICS:

1. Connect the circuit as per the circuit diagram.
2. For plotting the input characteristics the output voltage V_{CE} is kept constant at 2V and note down values of V_{BE} for each value of I_B
3. Change V_{CE} to 10 V and repeat the above step.
4. Disconnect the voltmeter from input circuit.
5. plot the graph between V_{BE} and I_B for constant V_{CE}

OUTPUT CHARACTERISTICS:

1. Connect the circuit as per the circuit diagram
2. With I_B set at 0μA, vary V_{CE} and note down the corresponding I_E value.
3. Set I_B at 40μA, 80μA and repeat the above step.
4. Plot the output characteristics between V_{CE} and I_E for constant I_B .

OBSERVATIONS:

INPUT CHARACTERISTICS:

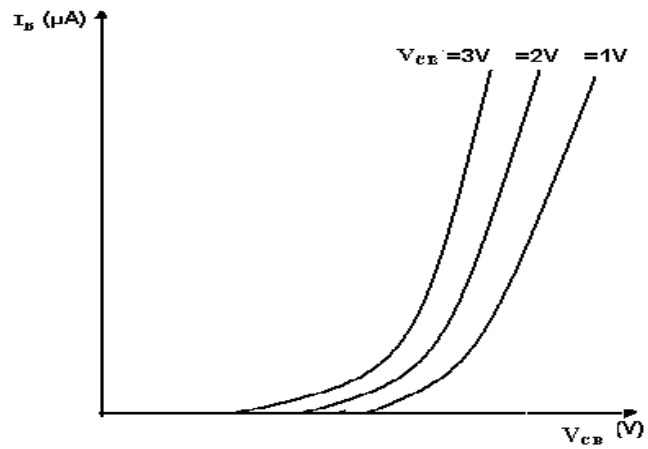
S.NO	$V_{CE} = 2V$		$V_{CE} = 4V$		$V_{CE} = 10 V$	
	$V_{CB}(V)$	$I_B(\mu A)$	$V_{CB}(V)$	$I_B(\mu A)$	$V_{CB}(V)$	$I_B(\mu A)$

OUT PUT CHAREACTARISTICS:

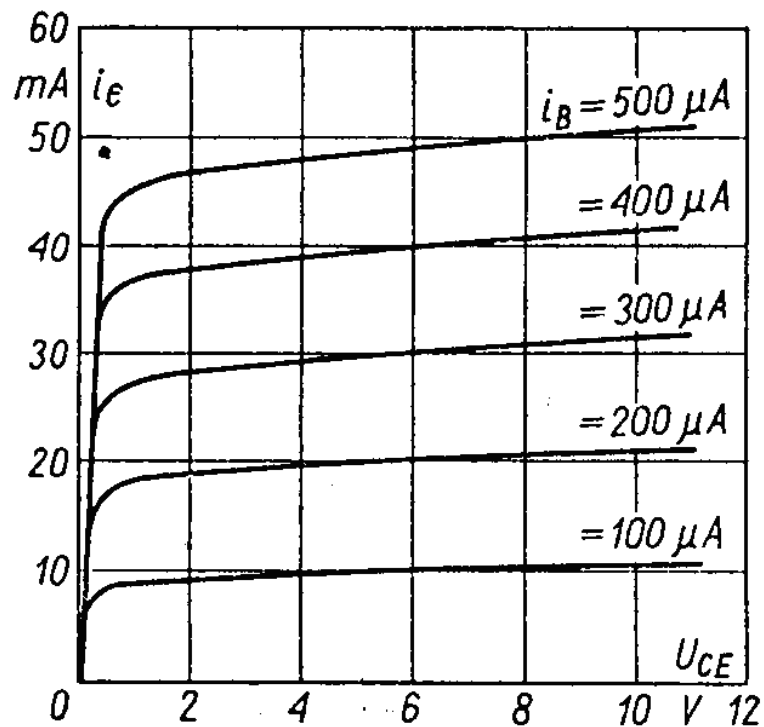
S.NO	$I_B = 0 \mu A$		$I_B = 30 \mu A$		$I_B = 40 \mu A$	
	$V_{CE}(V)$	$I_E(mA)$	$V_{CE}(V)$	$I_E(mA)$	$V_{CE}(V)$	$I_E(mA)$

MODEL GRAPHS:

INPUT CHARACTERISTICS:



OUTPUT CHARACTERISTICS:



PRECAUTIONS:

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

VIVA QUESTIONS:

1. What are the input and output impedances of CC configuration?
2. Identify various regions in the output characteristics?
3. Why CC configuration is preferred for buffering?
4. What is the phase relation between input and output?
5. Draw diagram of CC configuration for PNP transistor?
6. What are the applications of CC configuration?

7. Characteristics of JFET

AIM: 1. To obtain the drain and transfer characteristics of the given JFET transistor.

2. To calculate r_d , g_m and μ from the curves obtained.

APPARATUS:

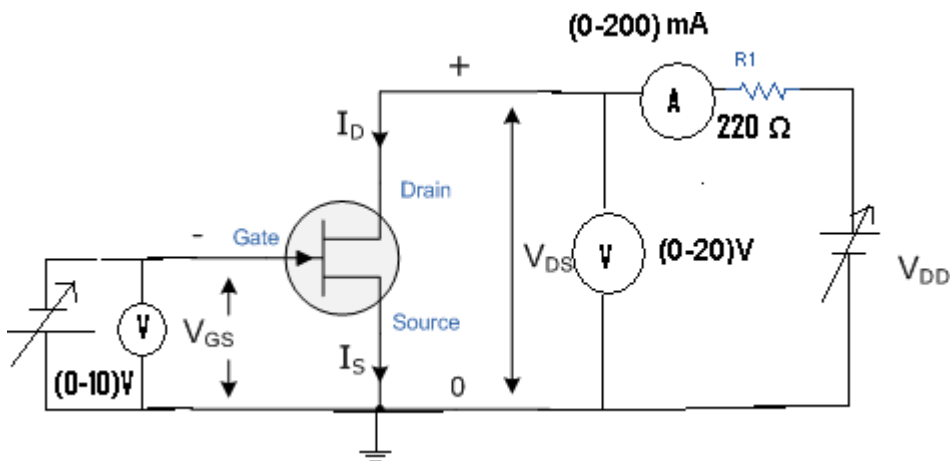
JFET transistor BFW10

R.P.S (0-30V) 2Nos

Resistors 220 ohm

Bread board and connecting wires

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keeping V_{GS} as 0V, vary V_{DS} in steps of 0.1V from 0 to 1 V and in steps of 2V from 1 to 15V.
3. Note down the drain current I_D for each step.
4. Now set V_{GS} to -1V, -2V and -3V and repeat the above steps for each V_{GS} value, record the readings in the table.

5. Keep V_{DS} at 4V and vary V_{GS} in steps of -5V till the drain current I_d is 0. Note I_d value for each value of V_{GS} .
6. With V_{DS} at 8V repeat the above step and record the readings in the table.
7. Plot the drain and transfer characteristics from tabulated readings.

OBSERVATIONS:

Drain Characteristics:

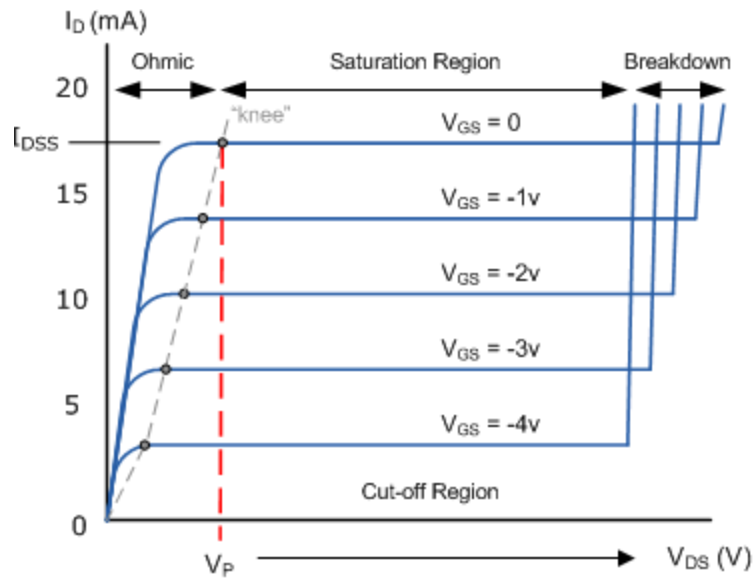
V_{DS}	$I_D (V_{GS}=0V)$	$I_D (V_{GS}=-1V)$	$I_D (V_{GS}=-2V)$

Transfer Characteristics:

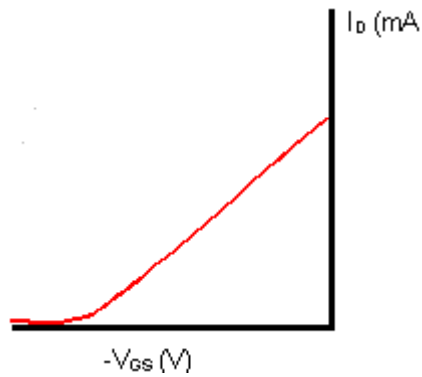
V_{GS}	$I_D (V_{DS}=4V)$	$I_D (V_{DS}=8V)$

MODEL GRAPHS:

Drain Characteristics:



Transfer Characteristics:



PRECAUTIONS:

1. The supply voltage should not exceed the rating of the FET.
2. Connections must be tight.

VIVA QUESTIONS:

1. What are the advantages of FET over transistor?
2. Is FET a current controlled device? Explain?
3. What is the operation of a N-channel JFET?
4. Can you compare JFET and a MOSFET?

8. UJT CHARACTERISTICS

AIM: To observe the characteristics of UJT and to calculate the Intrinsic Stand-Off Ratio (η).

APPARATUS:

Regulated Power Supply (0-30V, 1A) - 2Nos

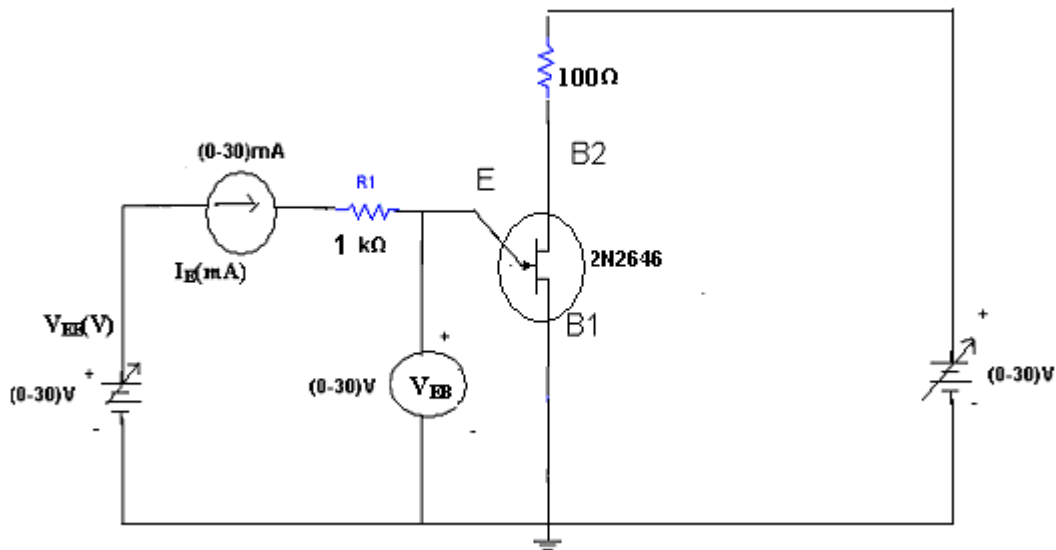
UJT 2N2646

Resistors 1k Ω , 100 Ω

Multimeters - 2Nos

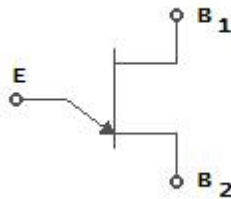
Breadboard and connecting Wires

CIRCUIT DIAGRAM



THEORY:

A Unijunction Transistor (UJT) is an electronic semiconductor device that has only one junction. The UJT Unijunction Transistor (UJT) has three terminals an emitter (E) and two bases (B1 and B2). The base is formed by lightly doped n-type bar of silicon. Two ohmic contacts B1 and B2 are attached at its ends. The emitter is of p-type and it is heavily doped. The resistance between B1 and B2, when the emitter is open-circuit is called interbase resistance. The original unijunction transistor, or UJT, is a simple device that is essentially a bar of N type semiconductor material into which P type material has been diffused somewhere along its length. The 2N2646 is the most commonly used version of the UJT.



Circuit symbol

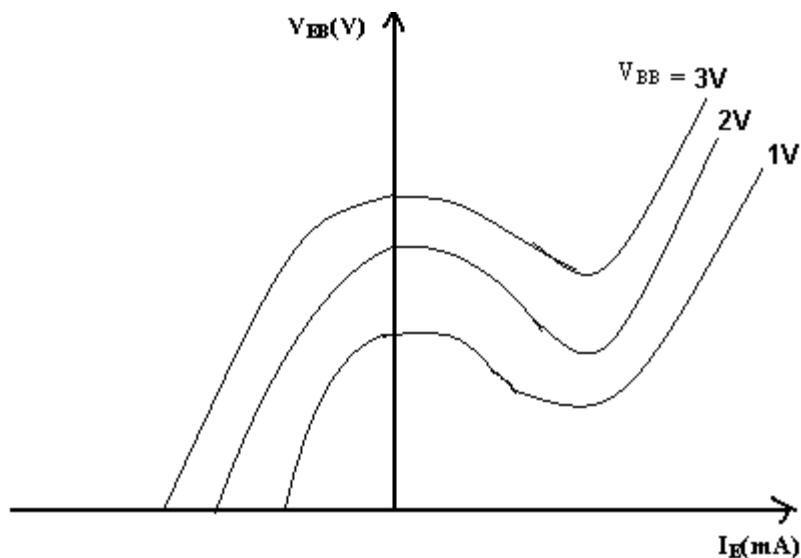
The UJT is biased with a positive voltage between the two bases. This causes a potential drop along the length of the device. When the emitter voltage is driven approximately one diode voltage above the voltage at the point where the P diffusion (emitter) is, current will begin to flow from the emitter into the base region. Because the base region is very lightly doped, the additional current (actually charges in the base region) causes (conductivity modulation) which reduces the resistance of the portion of the base between the emitter junction and the B2 terminal. This reduction in resistance means that the emitter junction is more forward biased, and so even more current is injected. Overall, the effect is a negative resistance at the emitter terminal. This is what makes the UJT useful, especially in simple oscillator circuits. When the

emitter voltage reaches V_p , the current starts to increase and the emitter voltage starts to decrease. This is represented by negative slope of the characteristics which is referred to as the negative resistance region, beyond the valley point, R_{B1} reaches minimum value and this region, V_{EB} proportional to I_E .

PROCEDURE:

1. Connection is made as per circuit diagram.
2. Output voltage is fixed at a constant level and by varying input voltage corresponding emitter current values are noted down.
3. This procedure is repeated for different values of output voltages.
4. All the readings are tabulated and Intrinsic Stand-Off ratio is calculated using $\eta = (V_p - V_D) / V_{BB}$
5. A graph is plotted between V_{EE} and I_E for different values of V_{BE} .

MODEL GRAPH:



OBSERVATIONS:

$V_{BB}=1V$		$V_{BB}=2V$		$V_{BB}=3V$	
$V_{EB}(V)$	$I_E(mA)$	$V_{EB}(V)$	$I_E(mA)$	$V_{EB}(V)$	$I_E(mA)$

CALCULATIONS:

$$V_P = \eta V_{BB} + V_D$$

$$\eta = (V_P - V_D) / V_{BB}$$

$$\eta = (\eta_1 + \eta_2 + \eta_3) / 3$$

VIVA QUESTIONS

1. What is the symbol of UJT?
2. Draw the equivalent circuit of UJT?
3. What are the applications of UJT?
4. Formula for the intrinsic stand off ratio?
5. What does it indicate the direction of arrow in the UJT?
6. What is the difference between FET and UJT?
7. Is UJT used as an oscillator? Why?
8. What is the Resistance between B_1 and B_2 called as?
9. What is its value of resistance between B_1 and B_2 ?
10. Draw the characteristics of UJT?

9. Design and Verification of Transistor Self bias circuit

AIM: To design a self bias circuit and observe stability by changing β of the transistor.

APPARATUS:

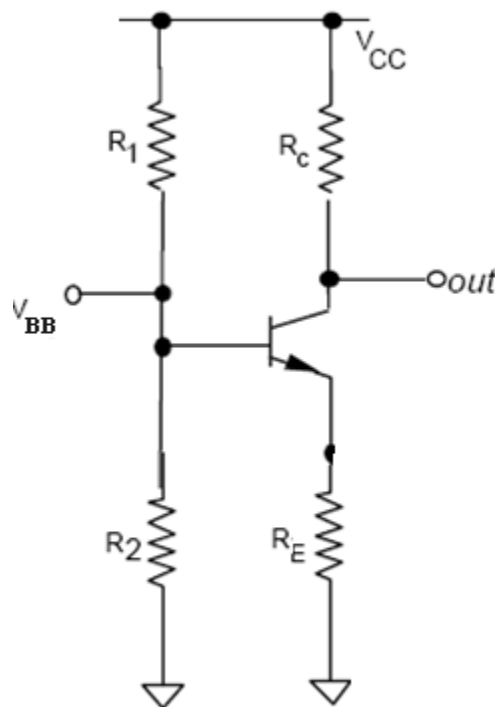
Transistors with different β values (SL100)

R.P.S (0-30V) 2Nos

Resistors (according to design values)

Bread board and connecting wires

CIRCUIT DIAGRAM:



Theory:

A self bias circuit stabilizes the bias point more appropriately than a fixed bias circuit. In this experiment CE configuration is used and a self bias circuit is designed and verified.

CALCULATIONS:

Given $V_{CC}=10V$, $R_E=220\ \Omega$, $I_C=4mA$, $V_{CE}=6V$, $V_{BE}=0.6V$, $h_{fe}=229$

$$R_C = (V_{CC} - V_{CE}) / I_C$$

$$I_B = I_C / \beta$$

$$R_B = \beta * R_E / 10$$

$$V_{BB} = I_B * R_B + V_{BE} + (I_B + I_C) R_E$$

$$R_1 = (V_{CC} / V_{BB}) * R_B$$

$$R_2 = R_B / (1 - V_{BB} / V_{CC})$$

PROCEDURE:

1. Assemble the circuit on a bread board with designed values of resistors and transistor.
2. Apply V_{CC} and measure V_{CE} , V_{BE} and V_{EE} and record the readings in table I.
3. Without changing the values of biasing resistors, change the transistor with other β values and repeat the above steps and record the readings in the table.

OBSERVATIONS:

β value	V_{CE}	V_{BE}	V_{EE}	$I_C = (V_{CC} - V_{CE}) / R_C$	$I_E = V_{EE} / R_E$

PRECAUTIONS:

1. The supply voltage should not exceed the rating of the transistor
2. Connections must be tight.

VIVA QUESTIONS:

1. What are the advantages of self bias?
2. What are the various other configurations available for bias?

10. SILICON-CONTROLLED RECTIFIER (SCR) CHARACTERISTICS

AIM: To draw the V-I Characteristics of SCR.

APPARATUS: SCR (TYN616)

Regulated Power Supply (0-30V)

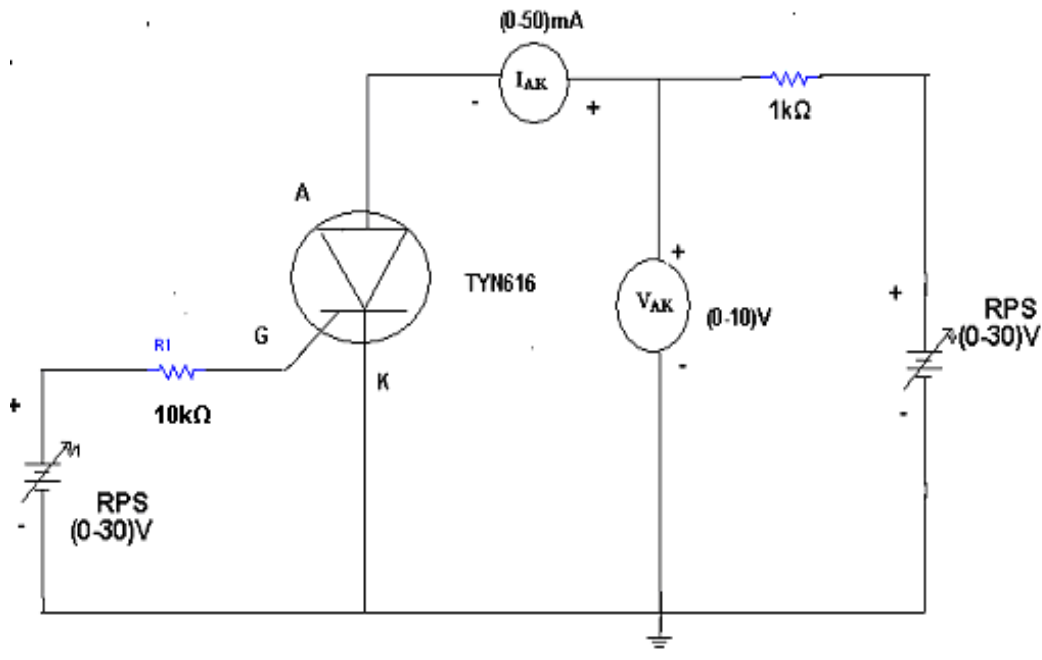
Resistors 10k Ω , 1k Ω

Ammeter (0-50) μ A

Voltmeter (0-10V)

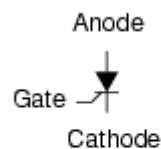
Bread board and connecting wires.

CIRCUIT DIAGRAM:



THEORY:

It is a four layer semiconductor device being alternate of P-type and N-type silicon. It consists of 3 junctions J_1 , J_2 , J_3 the J_1 and J_3 operate in forward direction and J_2 operates in reverse direction and three terminals called anode A, cathode K, and a gate G. The operation of SCR can be studied when the gate is open and when the gate is positive with respect to cathode.



Schematic symbol

When gate is open, no voltage is applied at the gate due to reverse bias of the junction J_2 no current flows through R_2 and hence SCR is at cut off. When anode voltage is increased J_2 tends to breakdown.

When the gate positive, with respect to cathode J_3 junction is forward biased and J_2 is reverse biased. Electrons from N-type material move across junction J_3 towards gate while holes from P-type material move across junction J_3 towards cathode. So gate current starts flowing, anode current increase is in extremely small current junction J_2 break down and SCR conducts heavily.

When gate is open the breakover voltage is determined on the minimum forward voltage at which SCR conducts heavily. Now most of the supply voltage appears across the load resistance. The holding current is the maximum anode current gate being open, when break over occurs.

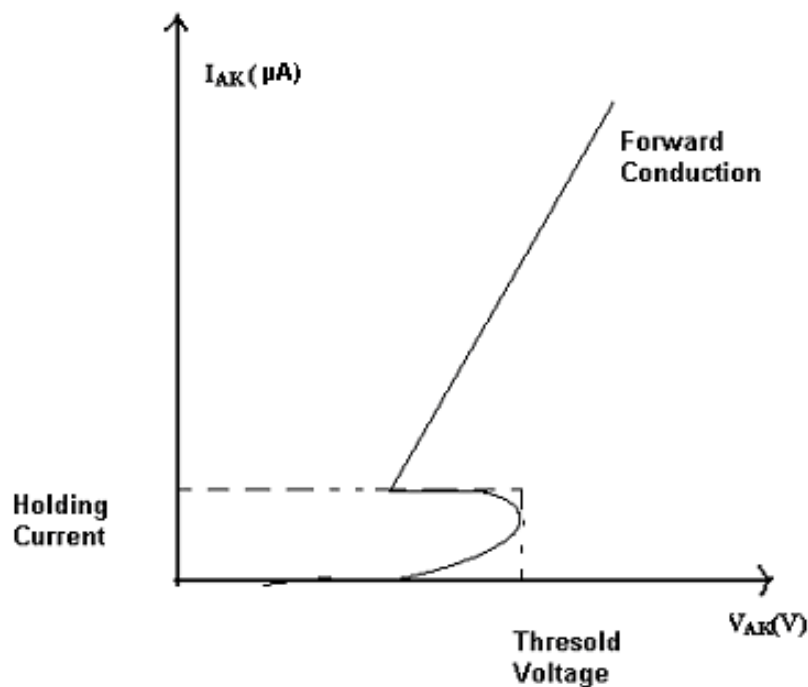
PROCEDURE:

1. Connections are made as per circuit diagram.
2. Keep the gate supply voltage at some constant value
3. Vary the anode to cathode supply voltage and note down the readings of voltmeter and ammeter. Keep the gate voltage at standard value.
4. A graph is drawn between V_{AK} and I_{AK} .

OBSERVATION

$V_{AK}(V)$	$I_{AK} (\mu A)$

MODEL WAVEFORM:



VIVA QUESTIONS

1. What the symbol of SCR?
2. IN which state SCR turns of conducting state to blocking state?
3. What are the applications of SCR?
4. What is holding current?
5. What are the important type's thyristors?
6. How many numbers of junctions are involved in SCR?
7. What is the function of gate in SCR?
8. When gate is open, what happens when anode voltage is increased?
9. What is the value of forward resistance offered by SCR?
10. What is the condition for making from conducting state to non conducting state?

11. Characteristics of DIAC

AIM: To obtain the V-I characteristics of the given DIAC device.

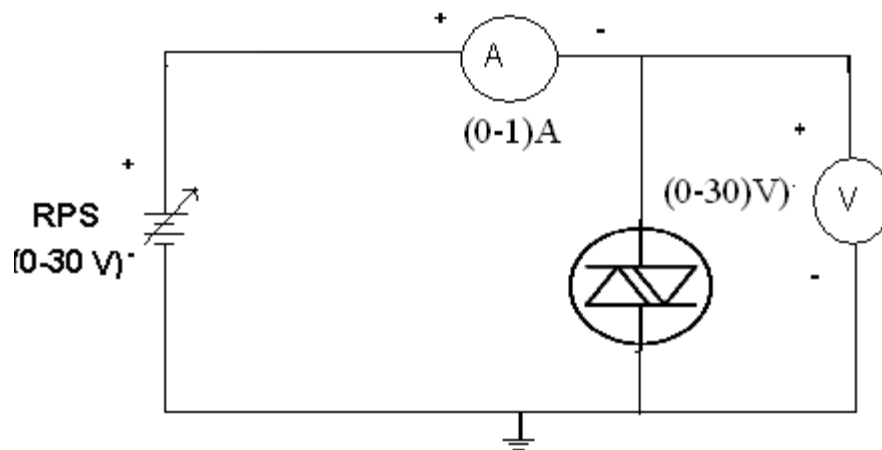
APPARATUS:

DIAC ST34BRP

R.P.S (0-30V), Ammeter and voltmeter

Bread board and connecting wires

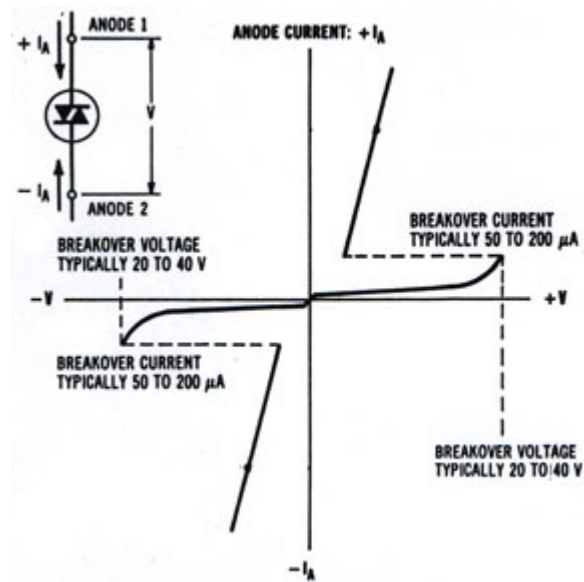
CIRCUIT DIAGRAM:



THEORY:

DIAC is a diode that can work on AC. The DIAC has symmetrical breakdown characteristics. The leads are interchangeable. It turns on around 30V. While conducting, it acts like a low resistance with a drop of around 3V. When not conducting, it acts like an open switch.

MODEL GRAPH:



PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Change the voltage V_{12} in steps till 30V and observe V_{B01} , the start of break over voltage. Observe the conduction of PnPn .
3. Change the voltage V_{12} in steps in the negative direction till -30V and observe V_{B02} , the start of break over voltage. Observe the conduction of PnPn' .
4. The characteristics are tabulated and plotted.

OBSERVATIONS:

V-I Characteristics:

V_a (V)	I_a

PRECAUTIONS:

1. The break down condition must be properly verified.
2. Connections must be tight.

VIVA QUESTIONS:

1. What are the applications of DIAC?
2. Why is DIAC a gateless TRIAC?
3. When does the DIAC conduct?
4. How many terminals are present in a DIAC?
5. Do you notice a similarity of operation as a Shockley diode? If so how?

12. Characteristics of thermistor

AIM:

1. To determine physical characteristics of a thermistor A and B.
2. To Calculate the resistance of the thermistor and temperature coefficient at 0, 25, 35, 50 and 75°C using equation $R=A * e^{(B/T)}$ and A, B values.

APPARATUS: Thermistors RT4201K

Resistors

CIRCUIT DIAGRAM:



Fig 1. Thermistor symbol

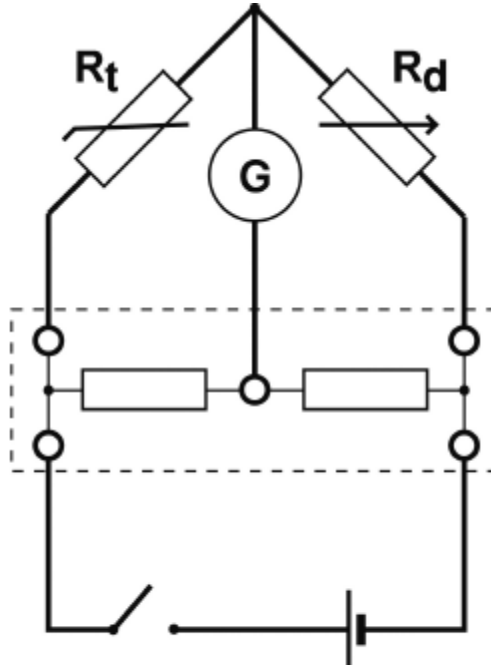


Fig. 2 The diagram of the circuit.

THEORY:

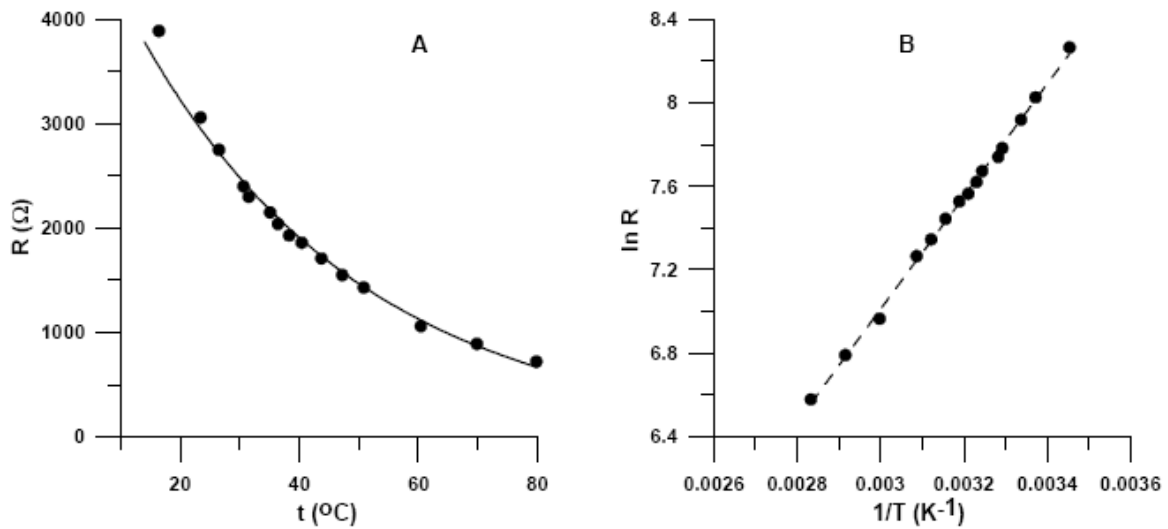
The thermistor is a resistor with a negative temperature coefficient.

$R = A * e^{(B/T)}$. To determine the thermistor characteristics, we need to estimate the A and B values from the V-I characteristics curve of the thermistor. It is mainly used for bridges in instrumentation and measurements.

PROCEDURE:

1. Connect the circuit according to the diagram in Fig 2.
2. Fill the beaker with cold water (15°C) and put in the thermistor, thermometer and mixer.
3. The diagram in Fig 2 represents so called Wheatstone bridge used to measure an unknown electrical resistance by balancing two legs of bridge circuit. In the shown diagram one leg includes the thermistor and a known resistor, in the second is the decade resistors box and a second known resistor. The bridge is balanced, when the current through the galvanometer G is zero. Because we use 2 resistors of identical value (one in each leg) at balance, the resistance of decade box is adjustable. So at a given temperature we change the resistance of decade box while no current flows in G. The value adjusted in the decade box directly indicates the resistance of thermistor.
4. Repeat the measurement in 15°C to 80°C in steps of 5 degrees, expected total number of cycles is 10-12.
5. In order to obtain physical characteristics of thermistor (A and B) calculate $1/T$ and $\ln R$ (See Table 1)
6. $\ln(R) = f(1/T)$. Join these points. The slope of the straight line represents B and the intercept corresponds to $\ln(A)$. Calculate A.
7. Calculate the resistance of the thermistor and temperature coefficient at 0, 25, 35, 50 and 75°C using equation $R = A * e^{(B/T)}$ and A, B values.
8. Experimental report requires a graphical representation of data. $R = f(t)$ and $\ln(R) = f(1/T)$ are as shown in fig 1.

MODEL GRAPHS:



OBSERVATIONS:

Thermistor Characteristics:

No.	t ($^{\circ}\text{C}$)	T (K)	$1/T$ (K^{-1})	R (Ω)	$\ln R$
1					
2					
3					
..					
..					
12					

Figure 1: Experimental data

t ($^{\circ}\text{C}$)	T (K)	$\alpha_{\%}$ ($\% \text{K}^{-1}$)	R (Ω)
0			
25			
50			
75			

Figure 2: Resistance and temperature coefficient (%) of the thermistor at selected temperatures

PRECAUTIONS:

1. Connections must be tight and these experiments require utmost care.

VIVA QUESTIONS:

1. What are the applications of thermistor?
2. What are the advantages of thermistor?

13. CHARACTERISTICS OF SOURCE FOLLOWER CIRCUIT

AIM: To draw the input and output characteristics of JFET connected in CD (Common Drain) or source follower configuration.

APPARATUS:

JFET (BFW10)

R.P.S (0-30V) 2Nos

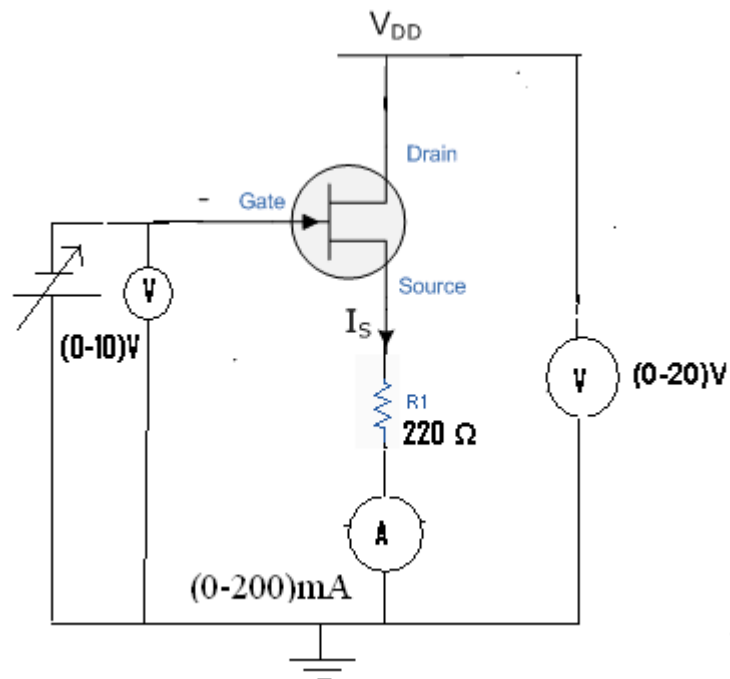
Voltmeters (0-20V) 2Nos

Ammeters (0-200mA)

Resistor 220 ohm

Bread board and connecting wires

CIRCUIT DIAGRAM:



PROCEDURE:

V-I CHARECTERSTICS:

1. Connect the circuit as per the circuit diagram.
2. Keeping gate voltage V_G as 0V, vary V_{DD} in steps of 0.1V from 0 to 1 V and in steps of 2V from 1 to 15V.
3. Note down the source current I_s for each step.
4. Now set V_G to -1V, -2V and -3V and repeat the above steps for each V_G value, record the readings in the table.
5. Keep V_{DD} at 4V and vary V_{GS} in steps of -5V till the drain current I_s is 0. Note I_s value for each value of V_G .
6. With V_{DD} at 8V repeat the above step and record the readings in the table.
7. Plot the characteristics from tabulated readings.

OBSERVATIONS:

Input Characteristics:

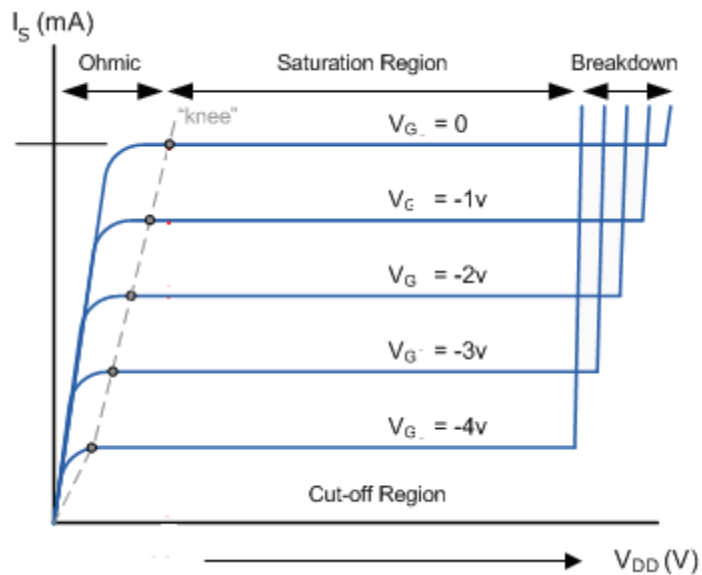
V_{DD}	$I_s (V_G=0V)$	$I_s (V_G=-1V)$	$I_s (V_G=-2V)$

Transfer Characteristics:

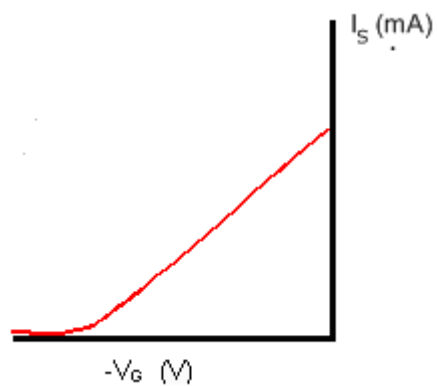
V_G	$I_s (V_{DD}=4V)$	$I_s (V_{DD}=8V)$

MODEL GRAPHS:

Drain Characteristics:



Transfer Characteristics:



PRECAUTIONS:

1. The supply voltage should not exceed the rating of the FET.
2. Connections must be tight.

VIVA QUESTIONS:

1. What are the advantages of CD configuration?
2. What are the applications?
3. Why is it called source follower?
4. Can you name the analogous configuration in transistors?

14. DESIGN AND VERIFICATION OF FIXED BIAS AND COLLECTOR TO BASE BIAS CIRCUITS

- AIM:** 1. To design a fixed bias circuit and observe stability by changing β of the given transistor in CE configuration.
2. To design a collector to base bias circuit and observe stability by changing β of the given transistor in CE configuration.

APPARATUS:

Transistors (BC 107) with different β values

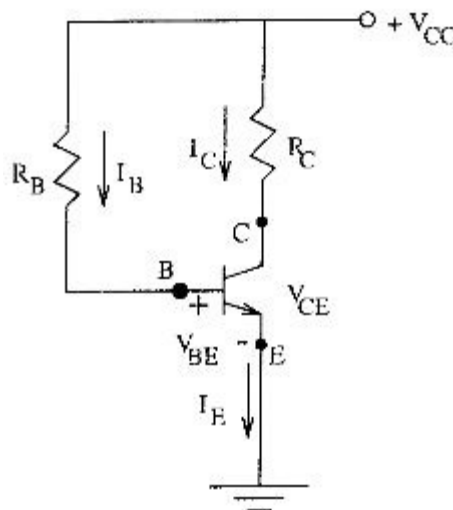
R.P.S (0-30V) 2 No.s

Resistors (from design values)

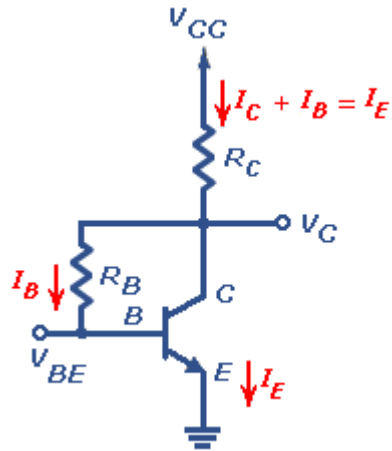
Bread board and connecting wires

CIRCUIT DIAGRAM:

Fixed Bias Circuit



Collector-to-base bias circuit



CALCULATIONS:

Fixed Bias Circuit

Given $V_{CC}=10V$, $I_C=4mA$, $V_{CE}=6V$, $V_{BE}=0.6V$

$$I_C = I_B / \beta$$

$$R_B = (V_{CC} - V_{BE}) / I_B$$

$$R_C = (V_{CC} - V_{CE}) / I_C$$

Collector-to-base bias circuit

Given $V_{CC}=10V$, $I_C=4mA$, $V_{CE}=6V$, $V_{BE}=0.6V$

$$I_C = I_B / \beta$$

$$R_C = (V_{CC} - V_{CE}) / (I_B + I_C)$$

$$R_B = \{(V_{CC} - V_{BE} - I_C R_C) / \beta\} / I_C - R_C$$

PROCEDURE:

1. Assemble the circuit on breadboard with design values of R_C , R_B and β .
2. Apply V_{CC} and measure V_{CE} and V_{BE} and record the readings in the table.
3. Without changing bias resistors, change the transistors with other β values and repeat the above step.
4. Repeat the above steps using the collector to base bias circuit and tabulate all the readings.

OBSERVATIONS:**Fixed Bias**

β value	V_{CE}	V_{BE}	$I_C = (V_{CC} - V_{CE}) / R_C$

Collector to base bias

β value	V_{CE}	V_{BE}	$I_C = (V_{CC} - V_{CE}) / R_C - I_B$

PRECAUTIONS:

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

VIVA QUESTIONS:

1. What are the applications of fixed bias configuration?
2. What are the applications of collector to base bias configuration?
3. What are the disadvantages of fixed bias configuration?
4. How to overcome the disadvantages of fixed bias configuration.

15. Characteristics of Phototransistor

AIM: To obtain the V-I characteristics of the given photo transistor.

APPARATUS:

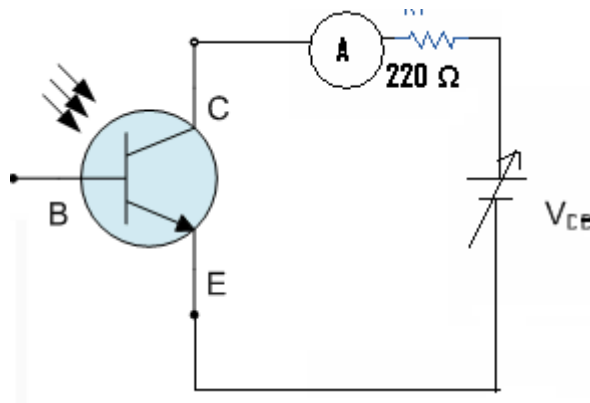
Photo transistor IR 3MM 935NM

R.P.S (0-30V) 2Nos

Resistors 220 ohm

Bread board and connecting wires

CIRCUIT DIAGRAM:



THEORY:

The photo transistor is a 3 terminal device which gives an electrical current as output if an input light excitation is provided. It works in reverse bias. When reverse biased along with the reverse bias current I_{CO} , the light current I_L is also added to the total output current. The amount of current flow depends on the input light intensity given as excitation. Phototransistor is basically a photodiode with amplification and operates by exposing its base region to the light source. Phototransistor light sensors operate the same as photodiodes except that they can provide current gain and are much more sensitive than the photodiode with currents are 50 - 100 times greater than that of the standard photodiode. Phototransistors consist mainly of a bipolar NPN transistor with the collector-base PN-junction reverse-biased. The

phototransistor's large base region is left electrically unconnected and uses photons of light to generate a base current which in turn causes a collector to emitter current to flow.

PROCEDURE:

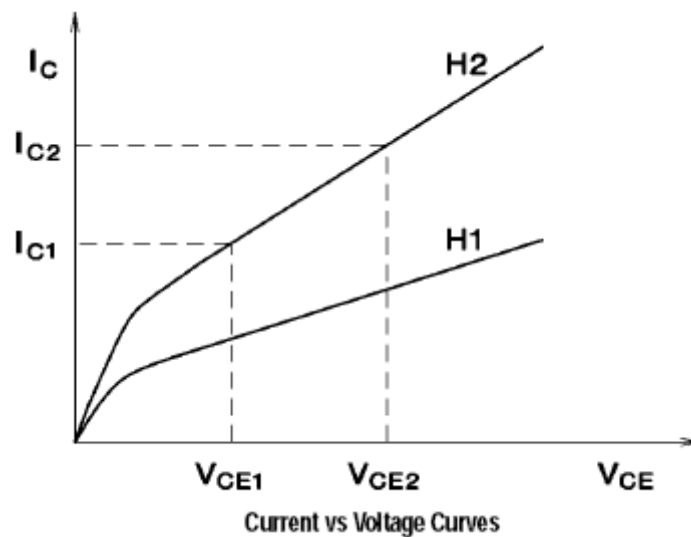
1. Connect the circuit as per the circuit diagram.
2. Keep the input light excitation fixed. Then vary the V_{ce} in steps of 1V till the maximum voltage rating of the transistor is reached and then note down the corresponding values of I_c .
3. Tabulate the readings. For various values of input excitation record the values of V_{ce} and I_c and plot the characteristics of the photo transistor.

OBSERVATIONS:

V-I Characteristics:

V_{ce} (V)	I_c (mA)

MODEL GRAPH:



PRECAUTIONS:

1. The photo transistor must be given a proper excitation for a reasonable current flow.
2. Connections must be tight.

VIVA QUESTIONS:

1. What are the applications of phototransistor?
2. When does the photo transistor conduct?
3. What is the input excitation in a photo transistor?

