Experiment No. - 09

Characteristics of Uni-Junction Transistor (UJT)

Object :-

To Study and plot the characteristics of UJT.

Apparatus required :-

UJT 2N2646, Resistors (1 Kohm), Bread board, Regulated Power Supply (0-2V) and (0-12V), Ammeters (0-20 mA), Voltmeter (0-2V), Voltmeter (0-10V), Connecting wires.

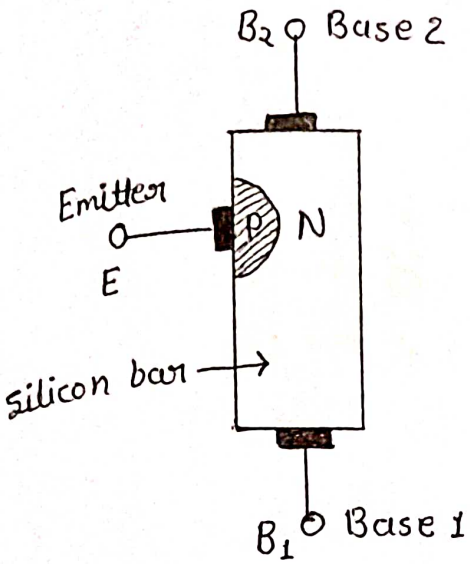
Theory :-

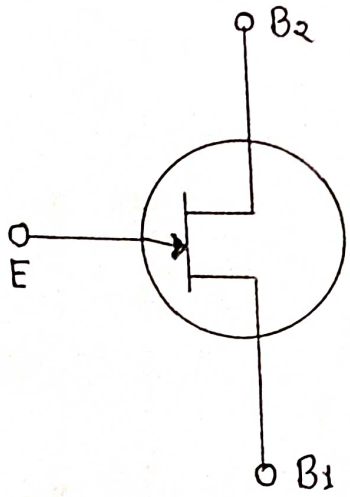
Construction :-

A unijunction transistor is a three terminal semiconductor switching device. It is used in switching circuits requiring rapid discharge of a capacitor.

Figure shows the structure of UJT while fig.(a) shows the symbolic representation. It consists of a lightly - doped N- type silicon bar with a heavily-doped P - type material alloyed to its one side for producing single P-N junction. At the ends of silicon bar electrical connections are made.

The leads at these connections are called as base 1 (B_1) and base 2 (B_2). The terminal brought out from P- type material is called emitter points in the direction





(a) Symbol of UJT

of forward current through the junction and inclined towards B_1 terminal.

Operation of UJT :-

Figure (b) shows the basic circuit operation of UJT. Here we shall consider the following two cases :

1) When no voltage is applied between B_1 and B_2 with emitter open, the inter base resistance is given by.

$$R_{BB} = R_{B1} + R_{B2}$$

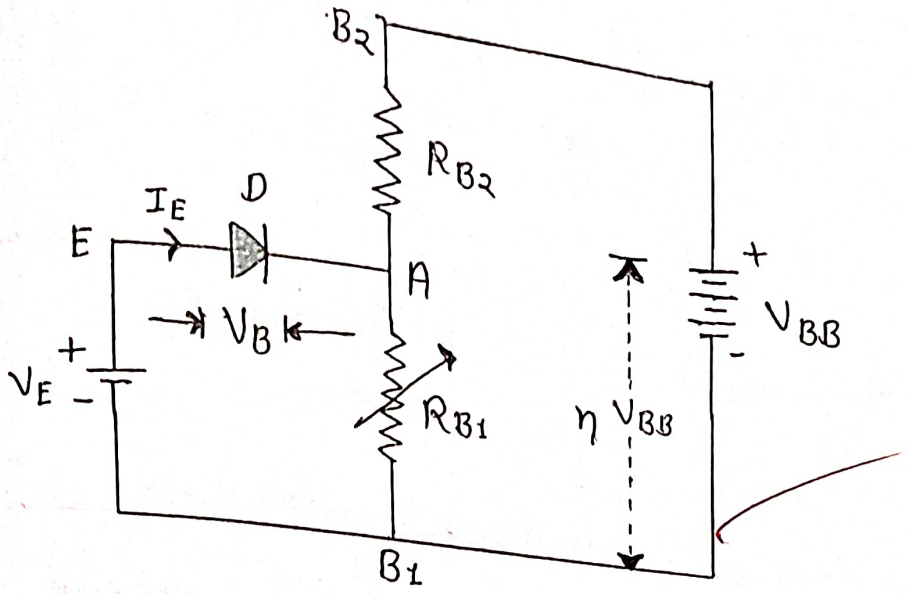


Fig :- (b) Equivalent circuit of UJT

2) When a voltage V_{BB} is applied between B_1 and B_2 with emitter open, voltage will divide up across R_{B1} and R_{B2}.

$$V_{R_{B1}} = \frac{R_{B1}}{R_{B1} + R_{B2}} \times V_{BB}$$

$$\frac{V_{R_{B1}}}{V_{BB}} = \frac{R_{B1}}{R_{B1} + R_{B2}}$$

Where the intrinsic stand-off ratio

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$V_{RB1} = \eta V_{BB}$.

$$\eta = \frac{R_{B_1}}{R_{B_1} + R_{B_2}}$$

The typical value of η ranges from 0.56 to 0.75.

The potential drop ηV_{BB} across R_{B_1} reverse biases the diode thereby dropping the emitter current to zero. Here, up to the peak point, the diode is reverse biased and hence, the region to the left of the peak point is called cut-off region.

When emitter voltage V_E equals the peak voltage $V_p = \eta V_{BB} + V_D$, the diode starts conducting and holes are injected into n-layer.

Hence, resistance decreases thereby decreasing V_E for the increase in I_E. So there is a negative resistance region from peak point P

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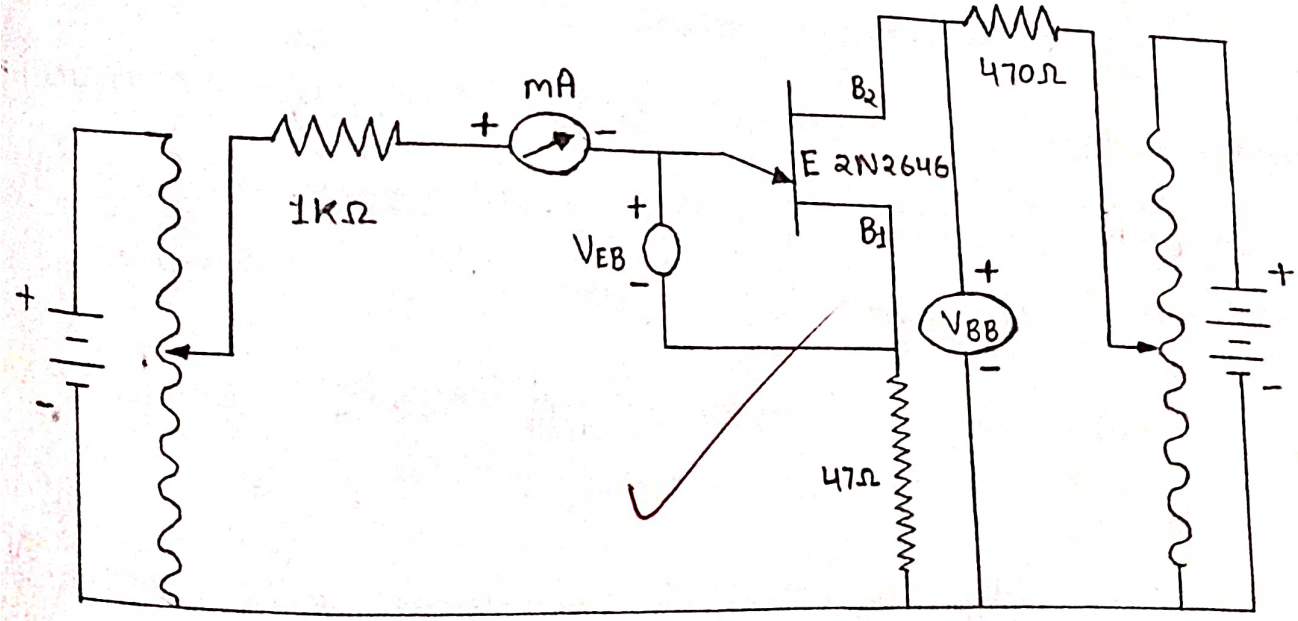
to valley point V. After the valley point, the device is driven into saturation and behaves like a conventional forward biased PN-junction diode.

The region to the right of the valley point is called saturation region. In the valley point, the resistance changes from negative to positive. The resistance remains positive in the saturation region.

Circuit Diagram :-



Procedure :-

1) Connect the circuit as shown in the circuit diagram.

2) Set output voltage V_{BB} = 8V by varying V_{BB}.

3) Varying V_{EE} gradually, note down bath emitter current I_E and emitter voltage V_E.

4) Step size is not fixed because of non linear curve. Initially vary V_{EE} in steps of 1V. Current I_E remains zero. As voltage is varied further, current starts increasing while voltage V_E drops. Note down the readings V_E and I_E.

5) Repeat above procedure for V_{BB} = 10V.

6) Plot the tabulated readings on a graph sheet with I_E on X-axis and V_E on Y-axis.

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Characteristics of UJT :-

The static characteristics of a typical UJT at different voltages between bases are shown in graph. Initially when $V_E < \eta V_{BB} + V_B$, the emitter junction is reverse-biased resulting in a small reverse emitter current.

However, if $V_E > \eta V_{BB} + V_B$, the emitter junction gets forward biased and emitter current flows. The current increases until the peak voltage V_p and current I_p are reached at point P.

Now holes are injected into N-region which are repelled by base 2 (B_2) while they are attracted by base 1 (B_1). These holes increases the conductivity of the region between emitter and base B_1.

Thus voltage V_E drops. This drop in voltage between

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the junction point and B_1 further more heavily forward-biased the junction thereby further increasing the current. This process continues until valley point is reached.

At valley point, the current is increased to such an extent that no further increase in conductivity can take place. Beyond valley point, the device behaves as a conventional forward-biased P-N junction diode.

Between the peak point and valley point on the characteristics, the UJT exhibits a dynamic negative resistance. Curves for different V_{BB} are shown in graph.

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Observation Table :-

Static characteristics of UJT

S.No.	V_{BB}	Peak Voltage (V_P) in V	Valley point (V_E) in V	current I_E in mA
1.	1.2	1.5	1.1	3
2.	2.4	2.5	1.2	5
3.	3.6	3.3	1.3	6.4
4.	4.8	4	1.4	6.6
5.	6.0	4.8	1.5	8.6

Precautions :-

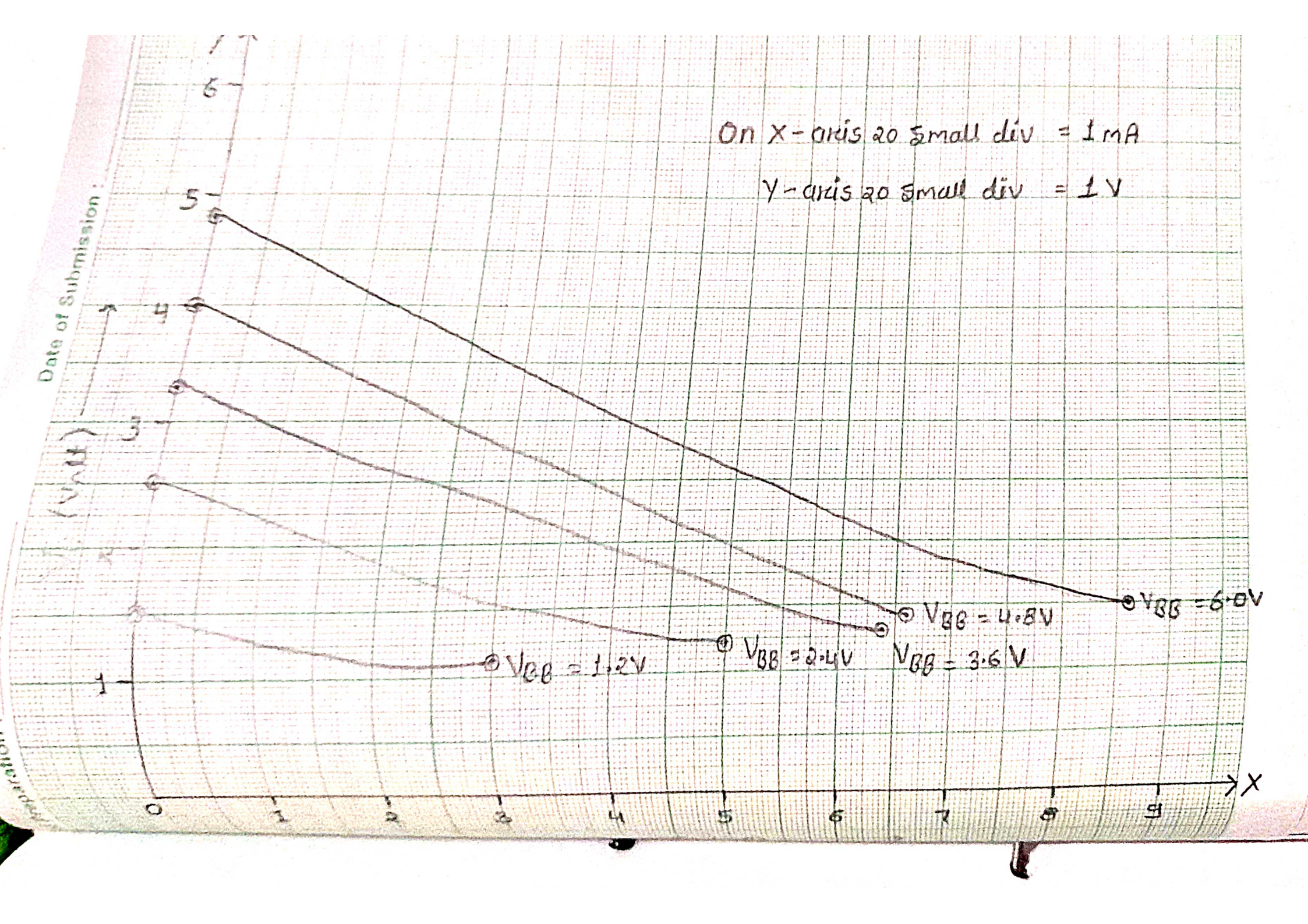
1) While doing the experiment do not exceed the ratings of the UJT. This may lead to damage the UJT.

2) Connect Voltmeter and Ammeter in correct Polarities as shown in the circuit diagram.

Date of Submission :

On X-axis 20 Small div = 1 mA

Y-axis 20 Small div = 1 V



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-1 and base-2 terminals of the UJT.

Seen/checked by
27/11/2023