Unijunction Transistor
(Volt-Ampere Characteristics)

Aim :- To draw the volt-ampere characteristics of the unijunction transistor and to find the UJT pameters.

Apparatus :- UJT, two variable d.c. power supplies, d.c. voltmeter, d.c. milli-ammeter, multi-meter and connecting terminals.

Formulae :- 1. Peak point voltage = V_P (V) (From the graph)

2. Valley point voltage = V_v (V) (From the graph)

3. Intrinsic stand off ratio $\eta = \dfrac{V_P - V_B}{V_{BB}}$

Where V_B = Barrier potential of P-n junction of Silicon diode = 0.7V

V_{BB} = Voltage applied between two bases B_1 and B_2 (V)

4. $R_{B1} = \eta R_{BB}$ $\because \eta = \dfrac{R_{B1}}{R_{BB}} = \dfrac{R_{B1}}{R_{B1} + R_{B2}}$

R_{BB} = Inter base resistance (Ω)

5. $R_{B2} = R_{BB} - R_{B1}$

6. Negative resistance = Slope of V-I curve in the negative resistance region.

OR $\dfrac{dV_E}{dI_E} = \dfrac{AB}{BC}$

7. Switching efficiency = $V_P - V_V$

Description :- In UJT a Silicon bar is taken and it is lightly doped with V- group material. So the silicon bar acts as lightly doped n – material and on one side of the bar above center a small region is heavily doped with III – group element Which then acts as P – material. Some times instead of doping with 3^{rd} group element a Aluminum wire is made contact at that region and that region acts as P- material. At the two ends of n – type material two wires are connected with ohmic contact, these two terminals are called " Bases" (B_1- lower and B_2 - upper) and another wire for the P – region is connected and is called " Emitter" (E). The UJT is as shown in Fig. 1

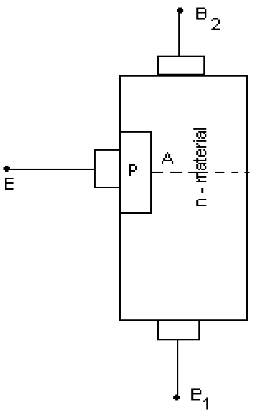

Fig. 1

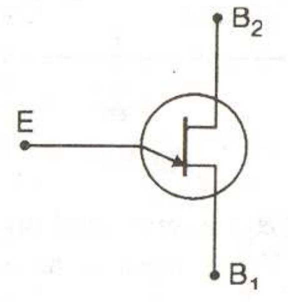

Fig. 2

Since the Silicon bar is lightly doped, the resistance between the bases B_2 and B_1 is high and its value ranges from 5 KΩ to 10 KΩ at room temperature. This is called '<u>double base diode</u>'. If some potential is applied between the bases B_2 and B_1, a uniform potential gradient is developed between them. Because of its resistance this will also acts as a potential divider and this divides the potential at E. In this UJT it has only one P-n junction, so it is called unijunction transistor. (Since it has three terminals it acts as transistor.)

The <u>circuit symbol of UJT</u> is as shown in the fig. 2. The arrowed terminal is the emitter and it gives the conventional current direction. The emitter arrow is inclined towards the base B_1 terminal because in the '<u>conducting state</u>' the current will flow from emitter to base B_1.

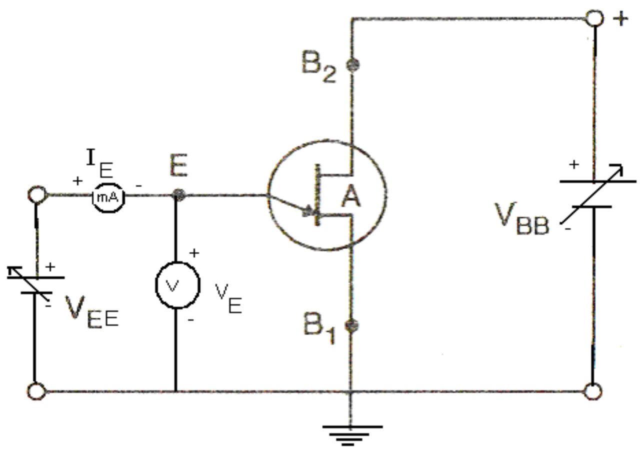

Fig. 3

THEORY :- Case 1:- First the emitter (E) is open i.e. it is given zero potential and a fixed voltage 'V_{BB}' is applied between two bases B_1 and B_2, such that B_2 is given positive that is B_2 is at $+V_{BB}$ and B_1 is at zero potential. This V_{BB} produces a current from B_2 to B_1, which in turn produces a uniform potential gradient between B_2 and B_1, as the Silicon bar has a resistance of 5 KΩ to 10 KΩ.

The potential at the point 'A' in the Silicon bar, where the emitter region touches the n-type bar is 'ηV_{BB}', where η is the intrinsic stand off ratio or 'voltage division factor'. The emitter is open means it is given zero potential then the P-n junction is reverse biased, and the current through the junction is zero.

Case 2:- Now a variable voltage V_E from a source V_{EE} is applied between the emitter E and base B_1 When V_E is less than 'ηV_{BB}' then the P-n junction is reverse biased and the resistance between A and B_1 i.e. R_{B1} is high. In this stage a small reverse leakage current will flow B_2 to E.

When V_E exceeds ηV_{BB} then the junction is for ward biased, but when $V_E \geq \eta V_{BB} + V_B$, holes enter from emitter 'E' to the n-type bar and these are repelled by the base B_2 due to its positive potential and are attracted by B_1 which is at negative potential. (Actually these holes get neutralized by attracting electrons from B_1, here V_B is the potential barrier of P-n junction). So the conductivity of this part of bar (A to B_1) increases and the resistance R_{B1} decreases. i.e. The emitter current I_E causes a decrease in the resistance which is known as negative resistance characteristic. In this stage emitter voltage V_E also decreases to a low value corresponding to the decrease of resistance R_{B1}. This minimum voltage is called the 'valley point voltage' V_V and the corresponding current is called 'valley point current' I_V. The emitter voltage is maximum when $V_E = \eta V_{BB} + V_B$ and is called 'peak point' voltage (V_P) or 'firing potential'. The current corresponding to V_P is called 'peak point current' I_P. Above I_V the V_E increases gradually and this state is called 'on-state' and the corresponding region in the graph is called 'saturation region'.

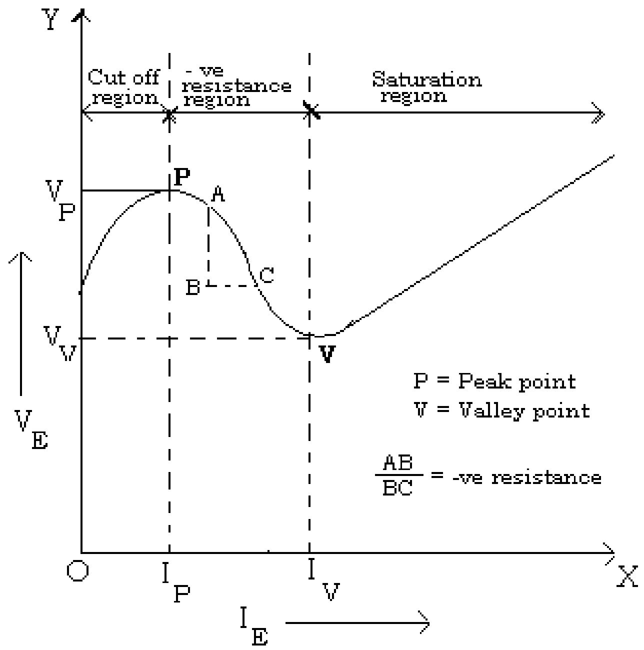

Fig. 4

<u>Procedure</u> :- First the emitter is open and the inter base resistance 'R_{BB}' is measured with a ohmmeter. Now the circuit is connected as shown in Fig.3. Apply a fixed voltage V_{BB} (5V to 10V) between the two bases B_1 and B_2. Increase the emitter voltage V_E in convenient steps starting from zero. Note the corresponding emitter current I_E. Draw a graph by taking I_E on X-axis and V_E on Y-axis. The shape of the graph is as shown in the Fig. 4. Note the peak point P and valley point V also note the corresponding voltages V_P & V_V and currents I_P & I_V. Find the value of intrinsic stand off ratio η, switching efficiency (V_P - V_V), $R_{B1}$and R_{B2} using the above formulae. Also find the value of the negative resistance of UJT from the slope drawn to the curve in the –ve resistance region.

The characteristic curves can be drawn with different values of V_{BB}. The V_P and V_V values increase with the increasing value of V_{BB}. The I_P and I_V values do not change with the change of V_{BB}.The switching efficiency also increases with increasing value of V_{BB}.

Graph-1 :- A graph is drawn by taking emitter current I_E on X-axis and emitter Voltage V_E on Y-axis. From the graph the V_P and V_V values and I_P and I_V values are noted as shown in the graph Fig. 4.

Precautions :- 1) The continuity of the connecting terminals should be checked before going to connect the circuit.

2) Identify the two bases and emitter of UJT and connect properly.

3) The power supply should be 'on' only when the observations are taken.

Table

S. No.	V_{BB} = Volt		V_{BB} = Volt	
	I_E (mA)	V_E (Volt)	I_E (mA)	V_E (Volt)

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