Chapter Outline: -

3.1 Unijunction transistor

3.2 UJT Simple Equivalent

3.3 Input forward characteristic curve of UJT

3.4 UJT Relaxation Oscillator

3.5 Summary

3.6 Exercises and Problems

3.1 Unijunction transistor

The **Unijunction Transistor** or **UJT** for short, is another solid state three terminal device that can be used in gate pulse, timing circuits and trigger generator applications to switch and control either thyristors and triac's for AC power control type applications.

Like diodes, unijunction transistors are constructed from separate P-type and N-type semiconductor materials forming a single (hence its name Uni-Junction) PN-junction within the main conducting N-type channel of the device.

Like N-channel FET's, the UJT consists of a single solid piece of N-type semiconductor material forming the main current carrying channel with its two outer connections marked as *Base 2* (B_2) and *Base 1* (B_1). The third connection, confusingly marked as the *Emitter* (E) is located along the channel. The emitter terminal is represented by an arrow pointing from the P-type emitter to the N-type base.

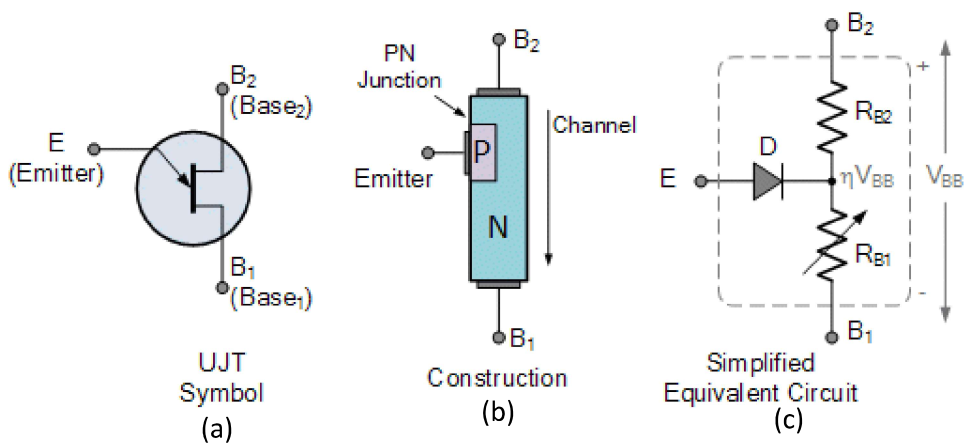

Fig. (3.1) The UJT

3.2 UJT Simple Equivalent

V_D = *the small contact potentiol* 0.6*v to* 0.7 *v*

V_E = *the emitter voltage*

V_{BB} = *Positive supply voltage applied at B2*

$$\eta = \frac{R_{B1}}{R_{B1} + R_{B2}} \ \textit{intrinstic standoff ratio}$$

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

$V_E \geq \eta V_{BB} + V_D$ condition of operation

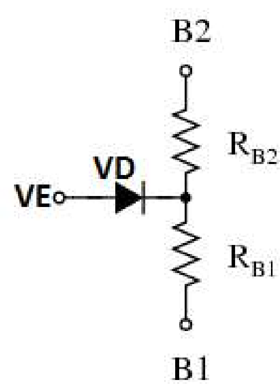

Fig. (3.2) The UJT Equivalent Circuit

3.3 Input forward characteristic curve of UJT

The input characteristic can be studied using the circuit shown in fig.3.3-b

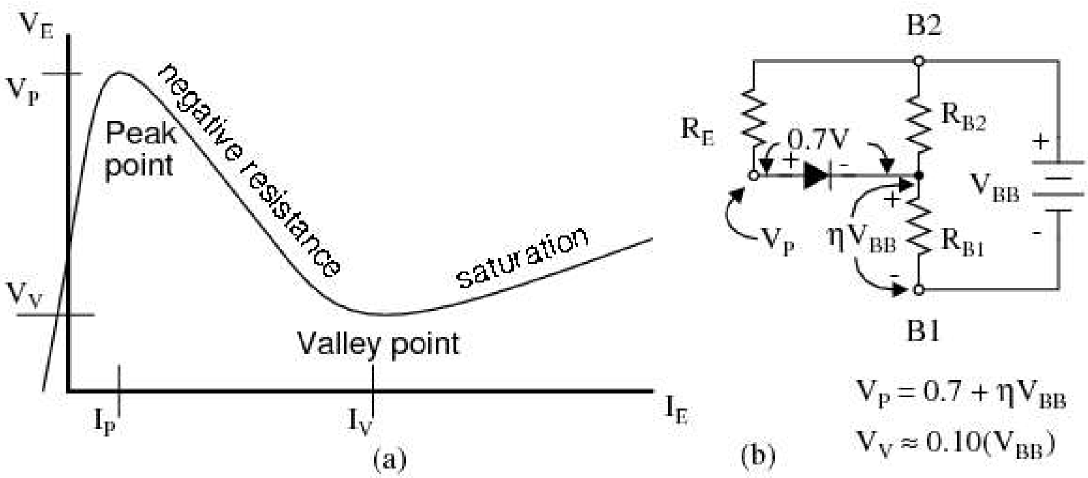

Fig. (3.3) Unijunction transistor: (a) emitter characteristic curve, (b) model for V_P

The Unijunction emitter current vs voltage characteristic curve (Figure 3.3 (a)) shows that as V_E increases, current I_E increases up I_P at the peak point. Beyond the peak point, current increases as voltage decreases in the negative resistance region. The voltage reaches a minimum at the valley point. The resistance of R_{B1}, the saturation resistance is lowest at the valley point.

Region of operation

1) Cut off region: - $\mathbf{0 \le I_E < I_P}$ **and** $\mathbf{0 \le V_E < V_P}$
2) Negative resistance region: - $\mathbf{I_P \le I_E \le I_V}$ **and** $\mathbf{V_P \le V_E \le V_V}$

The UJT at this region works as a relaxation oscillator if a capacitor is connected across the emitter, the charging time of the capacitor is much longer the discharging time when the following condition is existing: -

The oscillation condition :-

$$R_{1Min} \le R_E \le R_{1Max}$$

$$\frac{V_{BB} - V_V}{I_V} \le R_E \le \frac{V_{BB} - V_P}{I_P}$$

3.4 UJT Relaxation Oscillator

When a voltage (Vs) is firstly applied, the unijunction transistor is "OFF" and the capacitor C1 is fully discharged but begins to charge up exponentially through resistor R3. As the Emitter of the UJT is connected to the capacitor, when the charging voltage Vc across the capacitor becomes greater than the diode volt drop value, the p-n junction behaves as a normal diode and becomes forward biased triggering the UJT into conduction. The unijunction transistor is "ON". At this point the Emitter to B1 impedance collapses as the Emitter goes into a low impedance saturated state with the flow of Emitter current through R1 taking place.

As the ohmic value of resistor R1 is very low, the capacitor discharges rapidly through the UJT and a fast rising voltage pulse appears across R1. Also, because the capacitor discharges more quickly through the UJT than it does charging up through resistor R3, the discharging time is a lot less than the charging time as the capacitor discharges through the low resistance UJT.

When the voltage across the capacitor decreases below the holding point of the p-n junction (V_{OFF}), the UJT turns "OFF" and no current flows into the Emitter junction so once again the capacitor charges up through resistor R3 and this charging and discharging process between V_{ON} and V_{OFF} is constantly repeated while there is a supply voltage, Vsapplied.

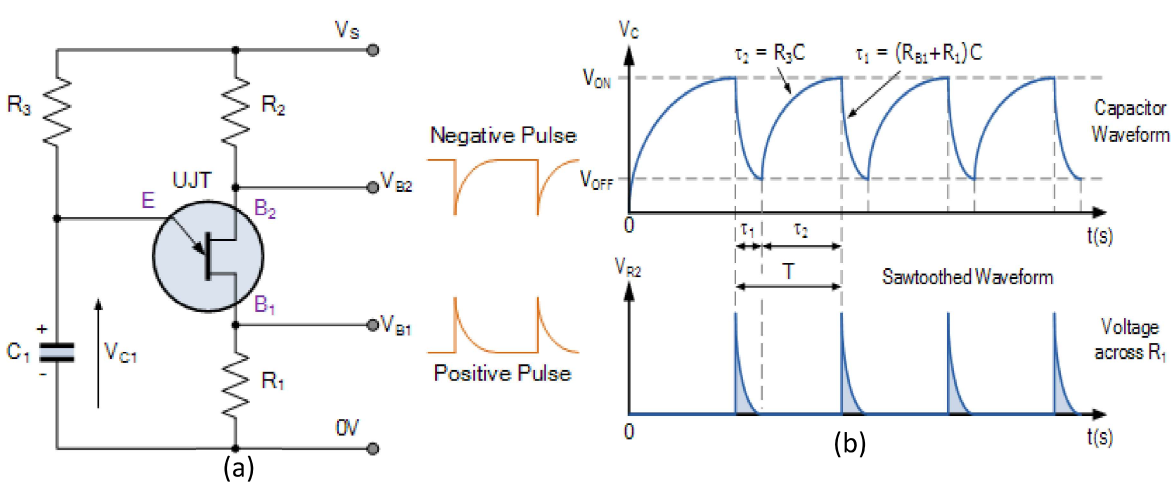

Fig. (3.4): (a) The UJT Oscillator, (b) input output waveforms

$$V_C = V_{BB}\left[1 - e^{-\frac{t}{R_1C_1}}\right]$$

$$V_P = \eta V_{BB} = V_C$$

$$\eta V_{BB} = V_{BB}[1 - e^{-\frac{t}{R_1C_1}}]$$

$$\eta = [1 - e^{-\frac{t}{R_1C_1}}]$$

$$e^{\frac{t}{R_1C_1}} = \frac{1}{1-\eta}$$

$$\frac{T}{R_1C_1} = Ln\frac{1}{1-\eta}$$

$$T = R_1C_1Ln\frac{1}{1-\eta}$$

$$F = \frac{1}{T}$$

3.5 Summary

القوانين التي نستخدمها في حل المسائل

$$T = R_1C_1Ln\frac{1}{1-\eta} \qquad (1)$$

$$F = \frac{1}{T} \qquad (2)$$

$$\frac{V_{BB} - V_V}{I_V} \le R_E \le \frac{V_{BB} - V_P}{I_P} \qquad (3)$$