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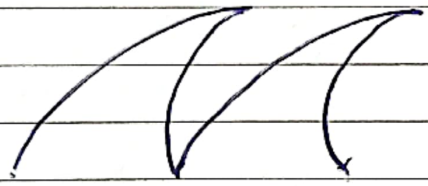
Part - II

UJT (Unijunction Transistor)

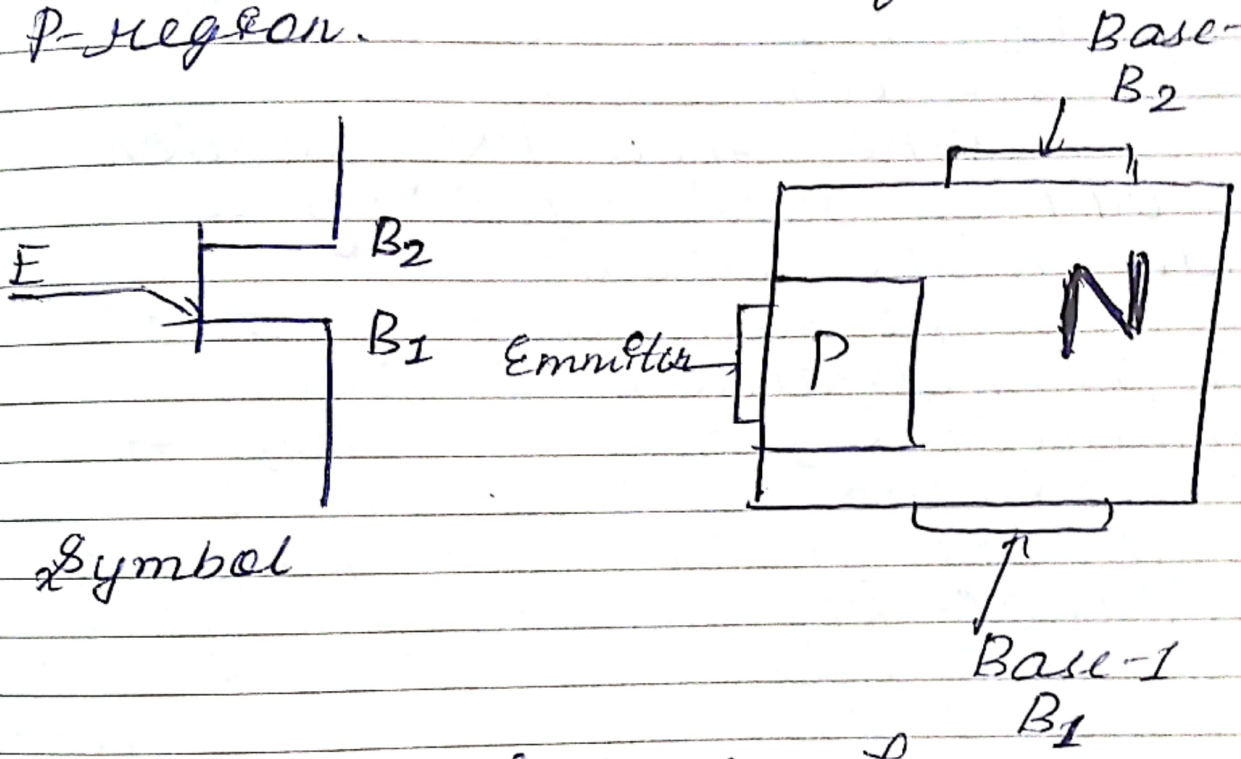
Unlike a BJT a UJT has a single PN junction. It is a semiconducting device which shows a negative resistance effect and hence it can be used to generate a sawtooth waveform



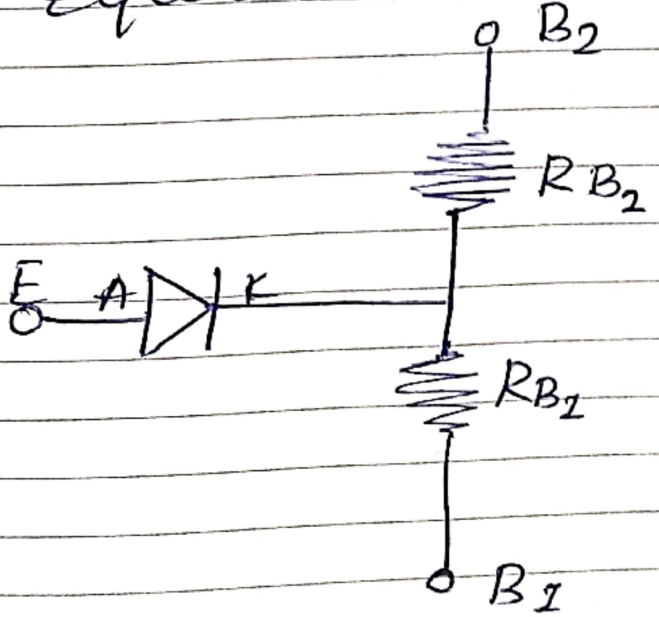
Construction:

It basically consists of a N-type silicon region with a P-type region diffused into it creating a single PN junction. The P region is a heavily doped region compared to the N regions, two terminals base-2 (B_2) and base-1 (B_1) are connections made to the N region while the third terminal

emmitter is taken out from the P-region.



Equivalent circuit



Nobody can answer success, it is just a matter of question.

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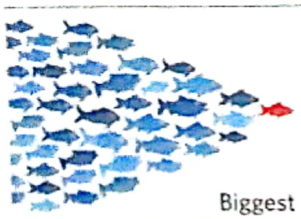
In order to understand the working of a UJT we study its equivalent circuit which is shown above.

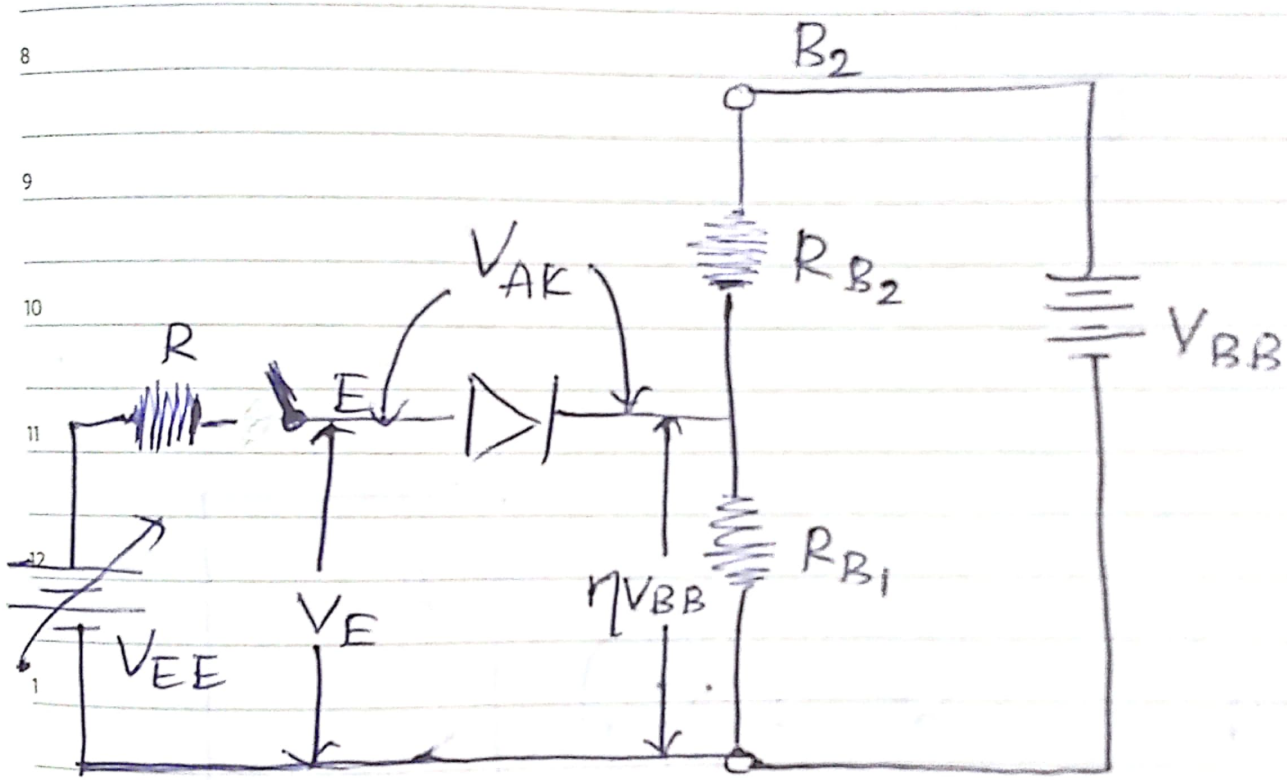
The single PN junction in a UJT is represented by a diode in the circuit.

The resistance of the UJT is indicated by 2 series resistances R_{B2} and R_{B1}. R_{B2} is the resistance of the base-2 portion of Emitter to base to resistance. R_{B1} indicates emmitter to B_1 resistance or resistance of base-1 portion, with no voltage applied to the UJT the inter-base resistance $R_{BB} = R_{B1} + R_{B2}$.

Working



Biggest responsibility of leader is to guide the followers to the right destination.



β η

(218-148) WK 32

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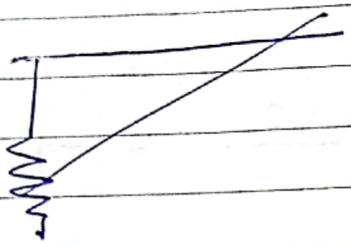
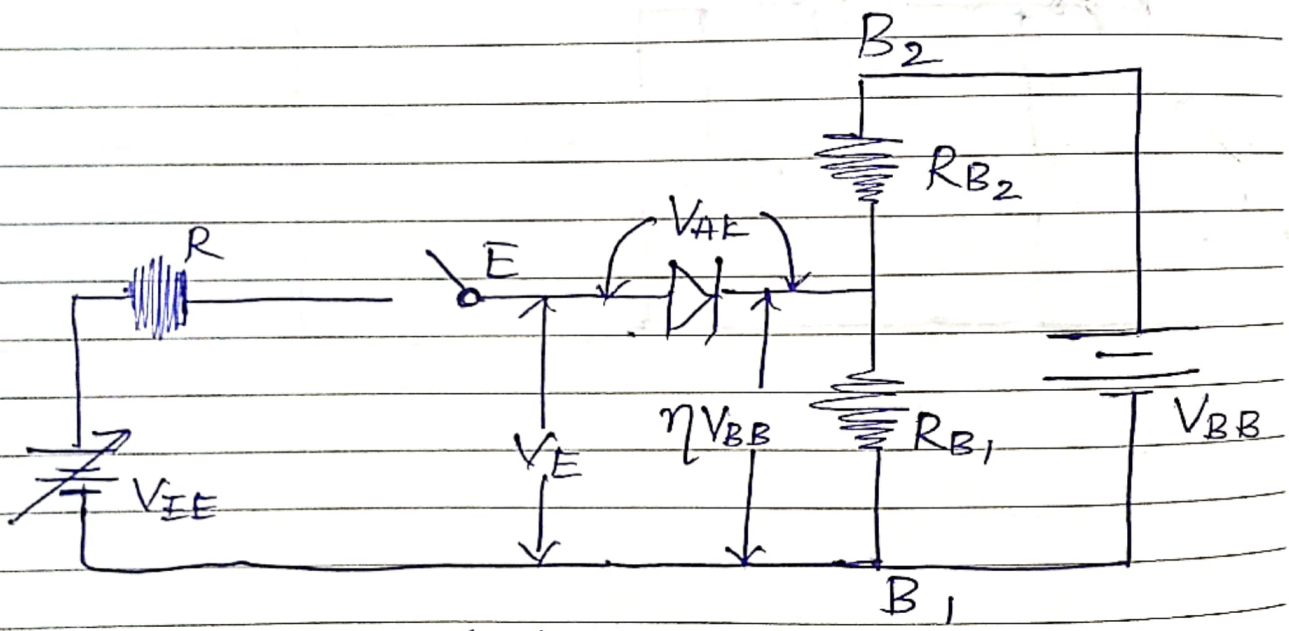




Suppose a voltage V_{BB} is applied between the two bases with no voltage given to the emmeter i.e. the switch is open, in this case the voltage V_{BB} divides up across R_{B_1} and R_{B_2} so that the voltage

across R_{B_1}, is $\frac{R_{B_1}}{R_{B_1}+R_{B_2}} \times V_{BB}$

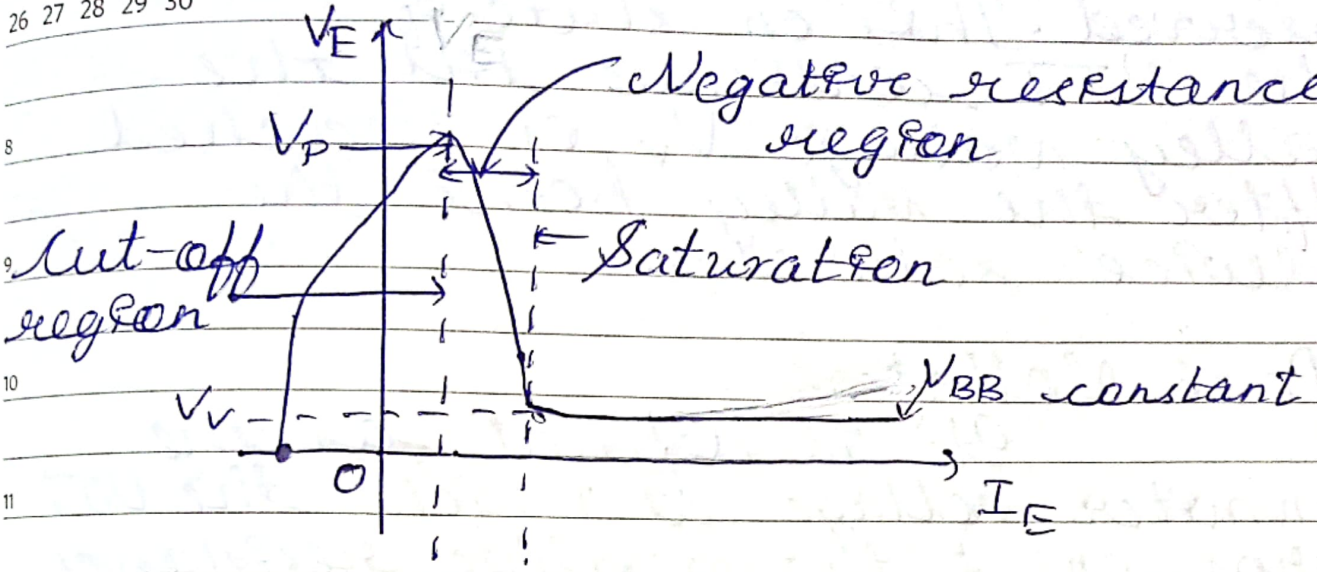
$= \frac{R_{B1}}{R_{BB}} \times V_{BB}$

i.e. ηV_{BB} $\because \eta = \frac{R_{B_1}}{R_{B_1}+R_{B_2}}$

(η is the intrinsic stand off ratio & its value lies between 0.51 and 0.82)

The voltage ηV_{BB} across R_{B_1} reverse biases the diode since cathode potential equal to ηV_{BB} is greater that anode potential. As a result negligible current flows through the diode and hence through the UJT of now a progressively rising positive voltage is applied to the emitter (switch closed) the diode will become forward biased when the emitter

or anode voltage exceeds ηV_{BB} for a voltage $\eta V_{BB} + 0.1$ the diode is ~~forw~~ forward biased with a voltage of 0.1 V across its terminals, hence a small forward current flows, this increases as the supply V_{EE} is increased but when the emitter voltage reaches the value $\eta V_{BB} + 0.7$ the diode becomes properly forward biased with 0.7 volts across it, for this condition a large current flows i.e. holes are injected from P-type to N-type region, these holes move towards the B_1 terminal & flooding of the lower portion of the N-region with holes indicates R_{B1} decrease by a large range. For such a large drop in R_{B1} V_E decreases, this is the negative resistance effect where can attempt to increase I_E decreases V_E.



The above curve shows the relation between emitter voltage V_E and emitter current I_E when a constant voltage V_{BB} is applied between the bases. When V_E equals zero the diode is reverse biased & a small reverse current flows which is shown in the characteristic. As long as $V_E < \eta V_{BB}$, diode is reverse biased and the reverse current flows. However when V_{EE} reaches the peak voltage $V_p = \eta V_{BB} + 0.7$, the diode becomes properly forward biased & negative resistance effect is

observed. In its on state of the UJT continue till the valley voltage V_v is reached after the valley point the device saturates.

Peak Voltage

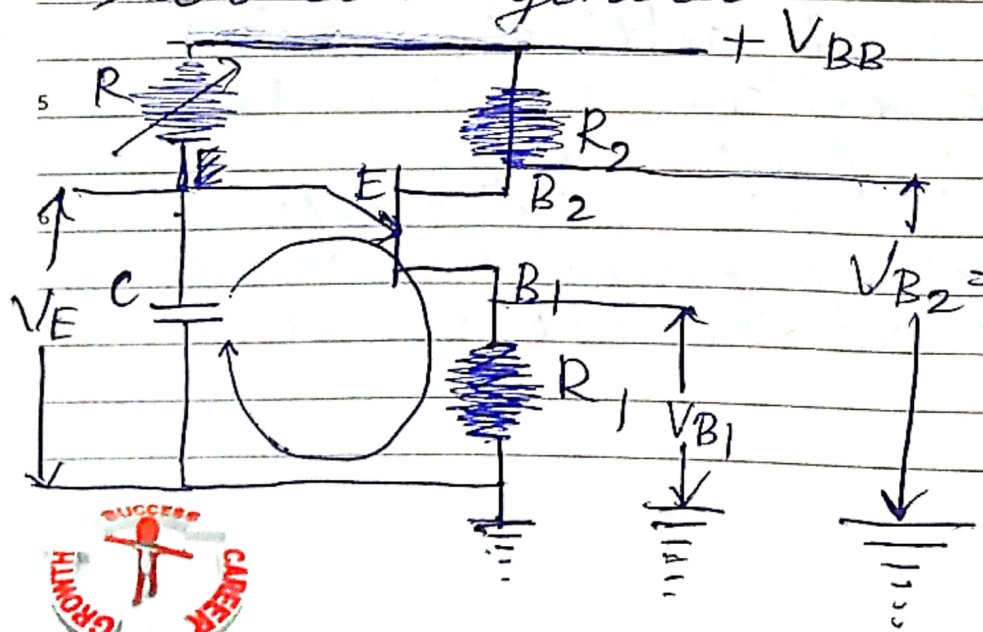
It is defined as the emitter voltage at which the UJT turns on & the negative resistance effect is observed.

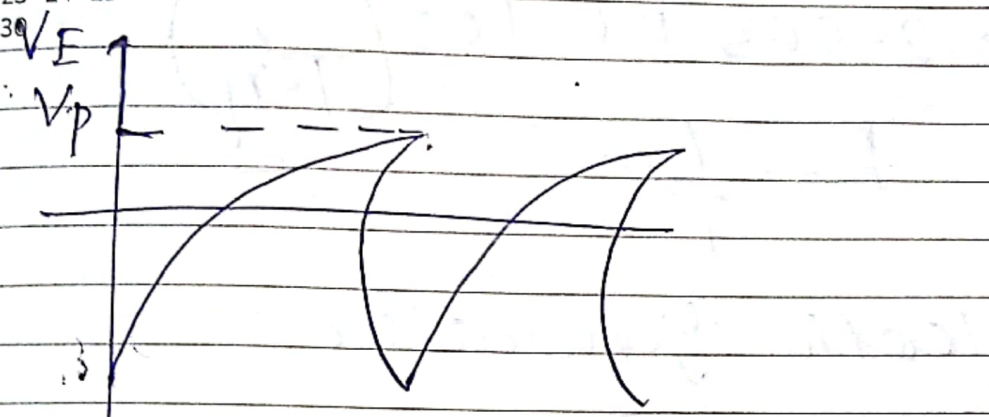
It is given by the expression

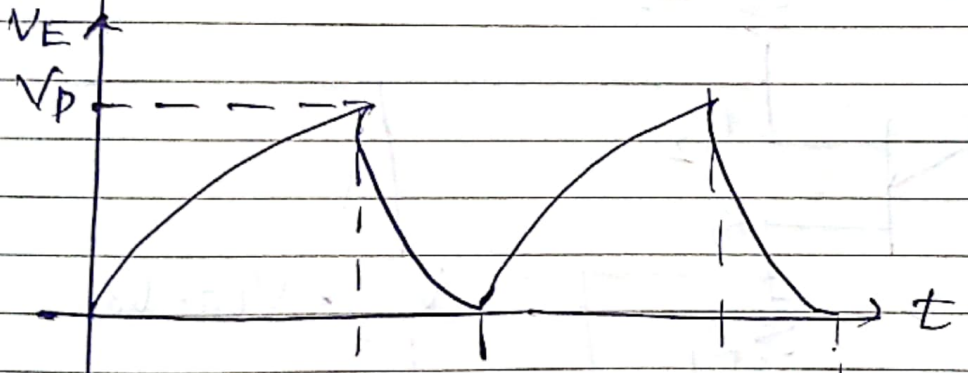
$$V_P = \eta V_{BB} + 0.7$$

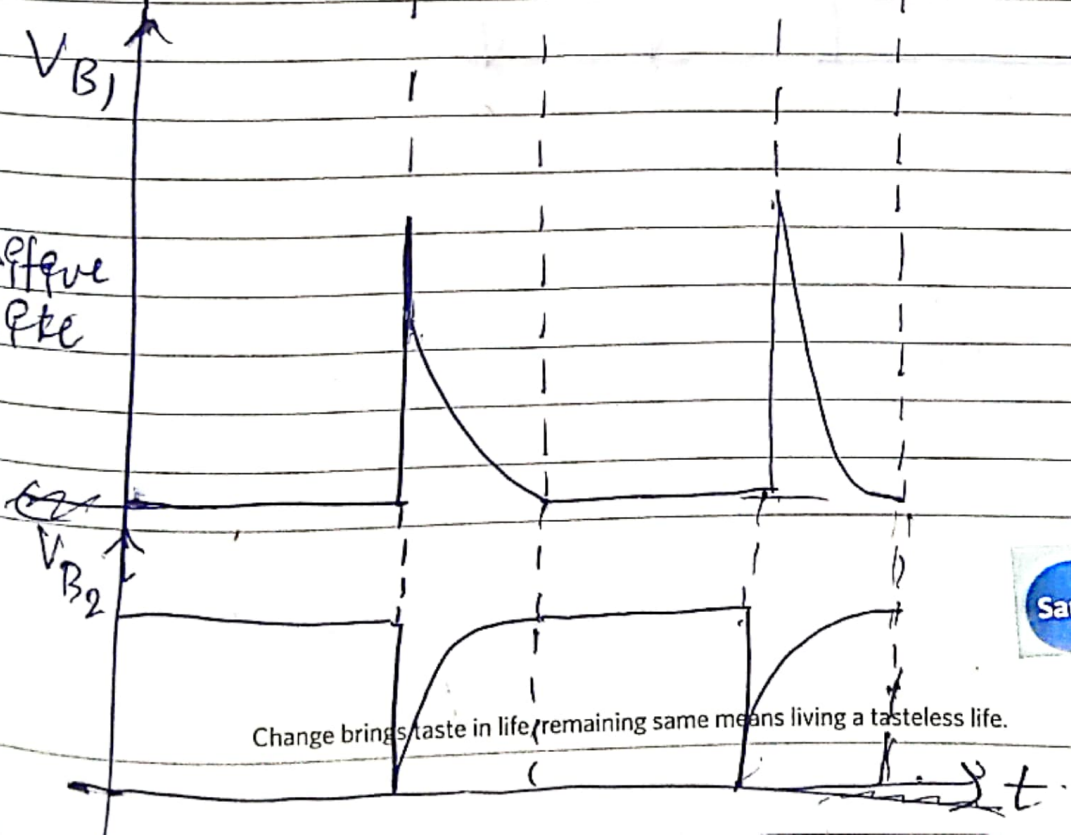
where ηV_{BB} is called the stand off voltage.

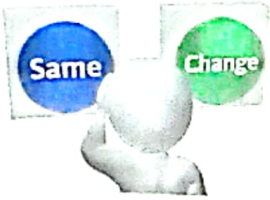
Sawtooth generator









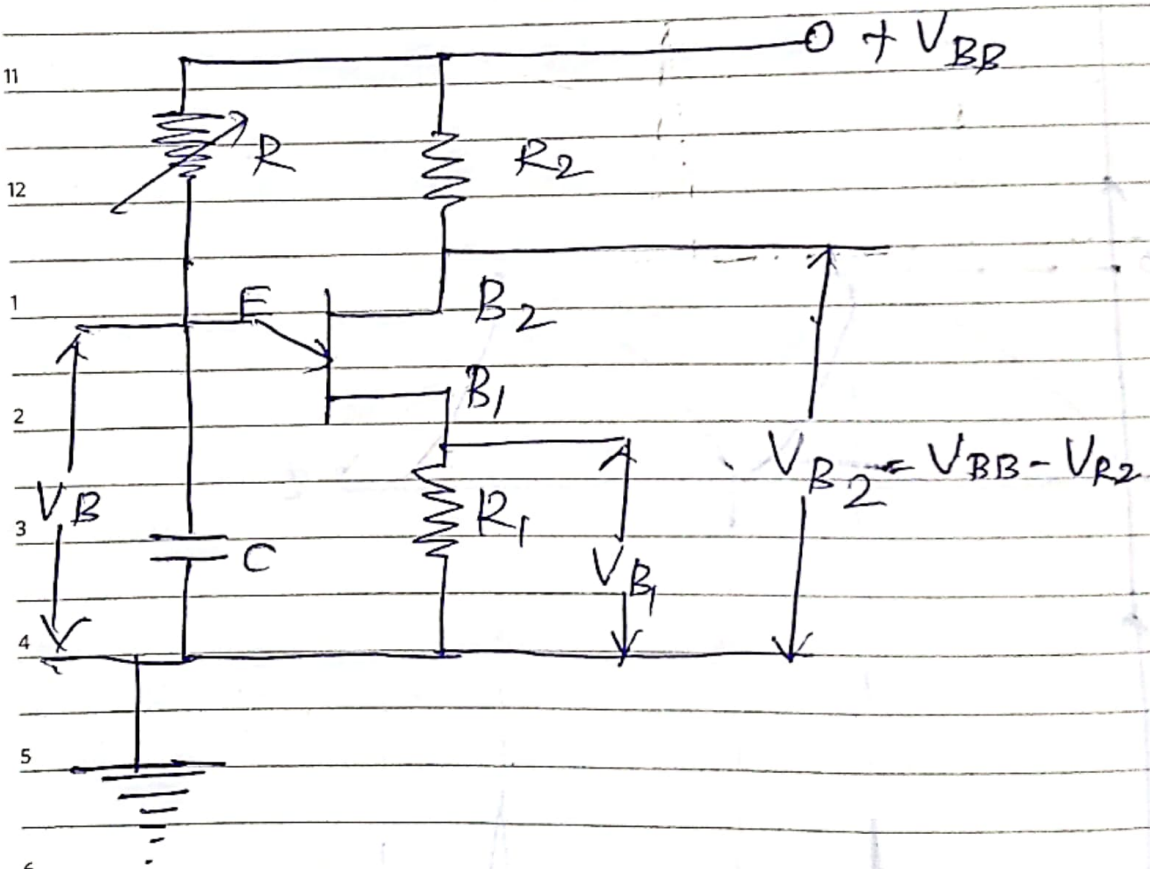


Change brings taste in life, remaining same means living a tasteless life.

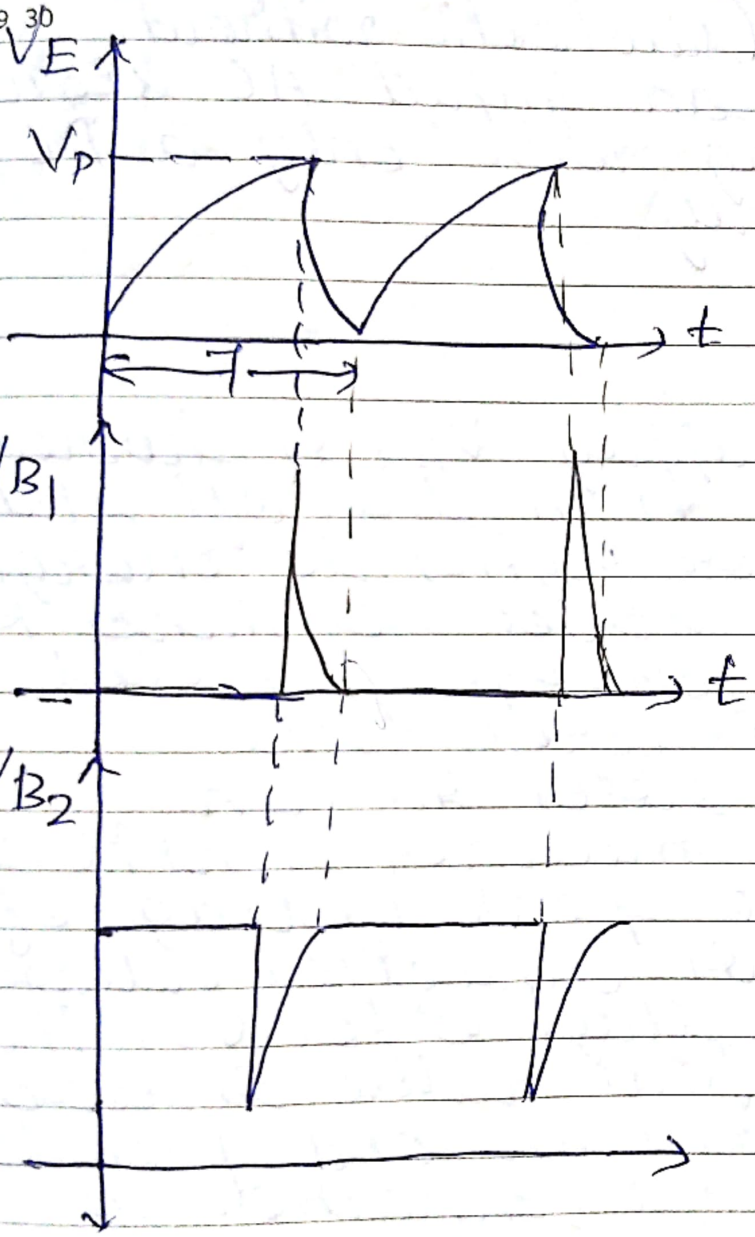
$$T = 2.303\, R \left(\log \left(\frac{1}{1-\eta} \right) \right.$$

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

Sawtooth generator



Build your confidence, give up your fear of being wrong.



A UJT sawtooth generator or oscillator circuit is a circuit that generates an

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AC output (sawtooth without the help of an input AC signal) and working with only a DC power supply

Working

When the supply V_{BB} is turned on the UJT is in the off state & the capacitor begins to charge through the series resistance R during the charging period. the voltage across the capacitor rises in an exponential manner until it reaches the peak voltage of the UJT. This capacitor voltage is emitter voltage of for UJT. Hence when the peak value is reached the UJT turns on and provides a path for the capacitor to discharge. The capacitor discharges through the UJT & R_1, when it discharges its voltage i.e. emit. voltage decreases & when it

Success comes to those who goes out and works for it.

reaches a certain low value the ~~rate~~ UJT turns on again & the capacitor begins to charge, this process continues over & over again & a sawtooth wave is generated at the emitter +ve going spike at V_1 & -ve going spike at V_2 the period of oscillation is given by.

$$T = 2.303\ RC \log\left(\frac{1}{1-\eta}\right)$$

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

Period & frequency of the sawtooth wave is independent of the supply V_{BB} & dependent on the values of R, C & η the amplitude of the sawtooth wave is dependent on the supply & η. It is independent of R & C values.

① The η value for a UJT is found to be 0.6 If inter base resistance is 10 kΩ, find R_{B_1} & R_{B_2}

$R_{BB} = 10\ k\Omega$

$\eta = 0.6$

$\eta = \frac{R_{B_1}}{R_{BB}}$

$R_{BB} = R_{B_1} + R_{B_2}$

$0.6 = \frac{R_{B_1}}{10k}$

$10k\Omega = 6k\Omega + R_{B_2}$

$R_{B_1} = 6k\Omega$

$R_{B_2} = 4k\Omega$

② A UJT has 10 V betⁿ its bases if $\eta = 0.65$, find stand-off voltage & peak voltage for UJT

$V_P = \eta V_{BB} + 0.7$

$= 0.65 \times 10 + 0.7$

$= 6.5 + 0.7$

$V_P = 7.2$

In a UJT $\eta = 0.8$, $V_P = 10V$ $R_{B_2} = 5k\Omega$ find supply voltage & R_{B_1}

Successful people use and give positive energy.

$V_p = \eta V_{BB} + 0.7$

$10.\cancel{88} = 0.8 \times V_{BB} + 0.7$

$\frac{9.6}{0.8} = V_{BB}$

$V_{BB} = 12\,V$

$\eta = \frac{R_{B1}}{R_{BB}}$

$0.8(R_{B1} + R_{B2}) = R_{B1}$

$0.8R_{B1} + 5 \times 0.8 = 5$

$0.8R_{B1} = 5 - 4$

$R_{B1} = \frac{1}{0.8}$

$= \frac{10}{8}$

$0.8R_{B1} + 5 \times 0.8 = R_{B1}$

$0.2R_{B1} = 4$

$R_{B1} = \frac{40}{2}$

$R_{B1} = 20k\,\Omega$

You can't lean a direct ladder to the final, you have to clear the previous terms.

(3) For a sawtooth generator find frequency of oscillation if $R = 50K\Omega$, $C = 0.1\mu F$ & $\eta = 0.6$

$$T = 2.303\, RC \log\left(\frac{1}{1-\eta}\right)$$

$$= 2.303 \times 50K \times 0.1\mu \log\left(\frac{1}{0.4}\right)$$

$$= 2.303 \times 50 \times 10^{3} \times 0.1 \times 10^{-6} \log\left(\frac{10}{4}\right)$$

$\log 10 = \log 4$

$= 1.0000 - 0.6021$

$= 0.3979$

$= 2.303 \times 50 \times 0.1 \times 10^{-3} \times 0.3979$ sec

$= 2.303 \times 50 \times 0.3979 \times 10^{-4}$ sec

$= 45.818185 \times 10^{-4}$ sec

$= 45.92 \times 10^{-4}$ sec

$= 4.582 \times 10^{-3}$ sec

$= 4.582$ ms

$$F = \frac{1}{T} = \frac{1}{4.582m} = 218Hz$$