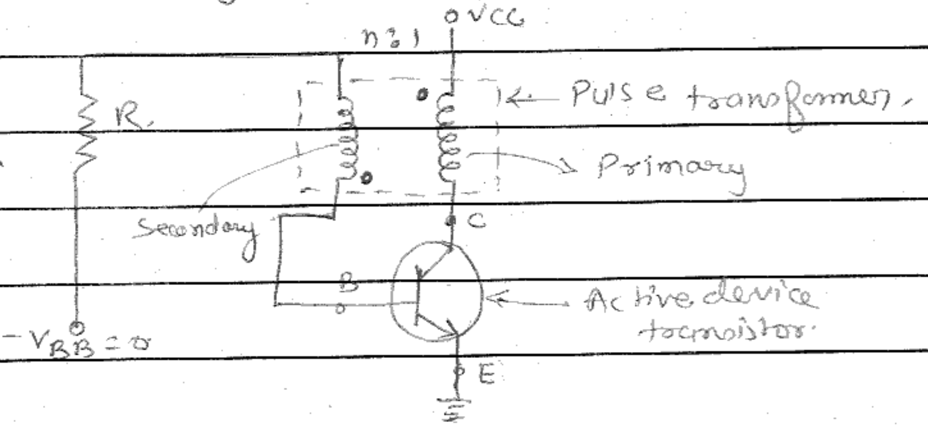
Unit-5

Q1. Explain with suitable diagram the performance of Monostable blocking Oscillator.

Soln

A monostable blocking Oscillator using base timing is also called a triggered transistor blocking Osillator.



One winding of the pulse transformer is in the collector circuit while the other is in the base circuit. The number of turns of transformer winding in ~~base~~ circuit is n-times the number of turns of transformer winding in the collector circuit.

A pulse transformer is basically a transformer which accepts the pulse at one winding and tries to produce a similar pulse at the other winding. It can produce inverted pulse of that applied to one winding, if winding polarities are properly designed.

A resistance R is used in series with the base of transistor, which controls the timing i.e pulse duration. Hence the circuit is called base timing blocking Oscillator. The pulse width can be varied in the range from nanosecon to microsecond. The pulse width depends on resistance R, other pulse transformer parameters and the circuit

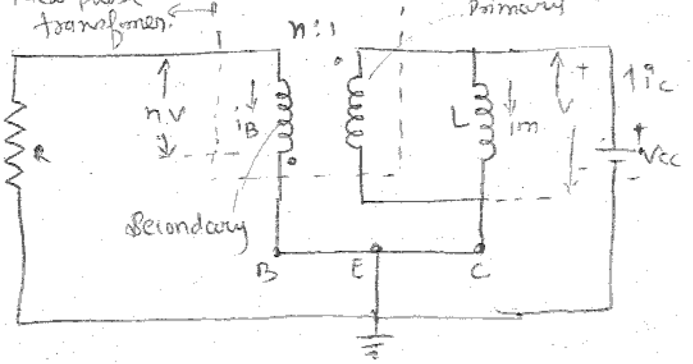
Parameters to operate the circuit, a triggering signal is required. to the collector momentarily (short time)

In the (inactive) quiescent state, the transistor is off. The cut in base-emitter voltage at room tempr for germanium, transistor is 0.1 v. while for a silicon transistor it is 0.5 V Thus if a small voltage pulse gets applied to the collector, then as the turns ratio of the pulse transform is n:1, it can produce a large signal which is enough to start the operation of circuit. such a small voltage pulse may be noise voltage or noise pulse. Thus unintentionally circuit may get triggered. In order to avoid such false triggering at increased tempr V_{BB} is applied to the base, keeping base-emitter junction reverse biased. But the magnitude of V_{BB} is of the order of few tenths of a volt and hence $|V_{BB}| < |V_{cc}|$.

x **Operation:** Let a triggering signal is applied momentarily to the collector of transistor Q_1 such that collector voltage level reduces suddenly. The pulse transformer winding polarities are designed such that the voltage applied at the primary (collector) produce inverted signal at the secondary. The phase dots on the transformer indicates such a voltage inversion.

When this voltage is more than the cut-in voltage of the transistor, it starts conducting drawing current from the supply. This increases the collector current. Due to this drop across transformer winding in collector increases. This further lowers collector potential and increases base potential. This draws more collector current resulting further decrease in collector potential.

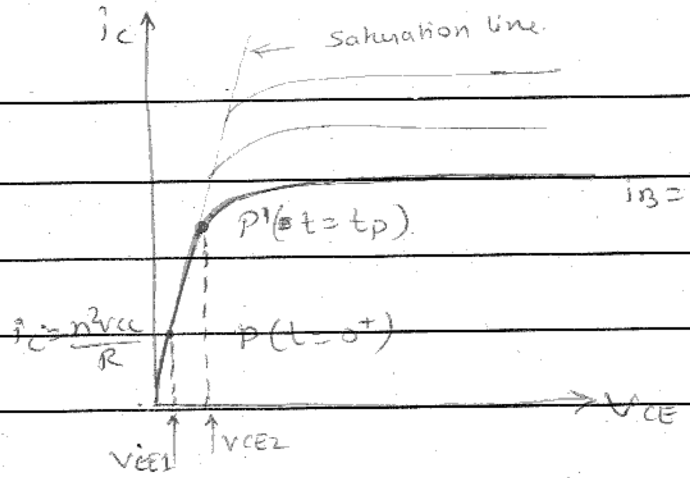
This cummulative action happens very quickly and time ~~period~~ required for the transistor to enter saturation from its off state. can be ignored.



Equivalent ckt.

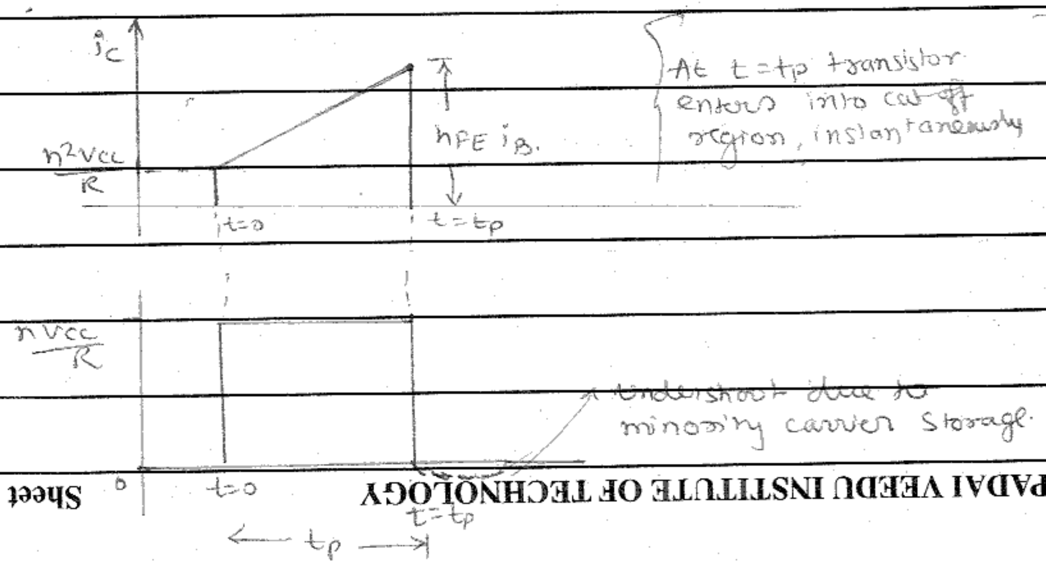
The Equivalent ckt of the pulse transformer neglecting resistance and shunt capacitance: The only important parameter is the shunt magnetising inductance L. The transformer is ideal. The leakage inductance of the winding also can be neglected. Similarly for the transistor the saturation voltage levels for $V_{BE}(sat)$ and $V_{CE}(sat)$ are very small

Compared to V_{CC} and hence can be neglected.



i_B remain constant but i_C increases as t increases.

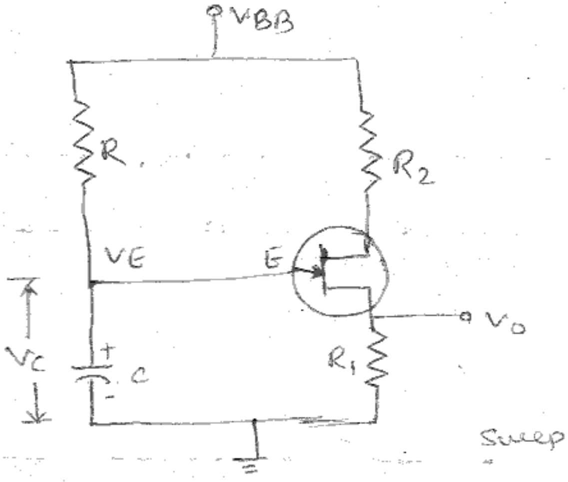
Thus on the Collector Characteristics, the point P moves along the constant i_B characteristics to P' as shown in the fig. So operating point moves up the curve from P to P'. It can be noted that the corresponding change in V_{CE} is from V_{CE1} to V_{CE2}. Due to increased V_{CE}, the transformer primary voltage drop reduces. Due to increased V_{CE}, the transformer primary voltage drop reduces. Due to transformer enters into active region from saturation region. This can be observed from the characteristics. As base current reduces the collector current reduces which further reduces transformer primary voltage level and gain base current further reduces. As the loop gain exceeds unity in the active region this action is regenerative.



At $t=t_p$ transistor enters into cut off region, instantaneously

Q2 a) Explain how sawtooth waveform are generated using UJT.

Sol^n



Sweep ckt using UJT

The exponential sweep ckt is used in which mechanical switch is used in parallel with the capacitor C. Many devices such as transistor UJT, FET can be used as a switch. In this section we will see how a UJT can be used as a switch to obtain the sweep voltage.

Operation.

Capacitor C gets charged through the resistance R towards supply voltage V_{BB}. As long as the capacitor voltage is less than peak voltage V_P the emitter appears as an open circuit.

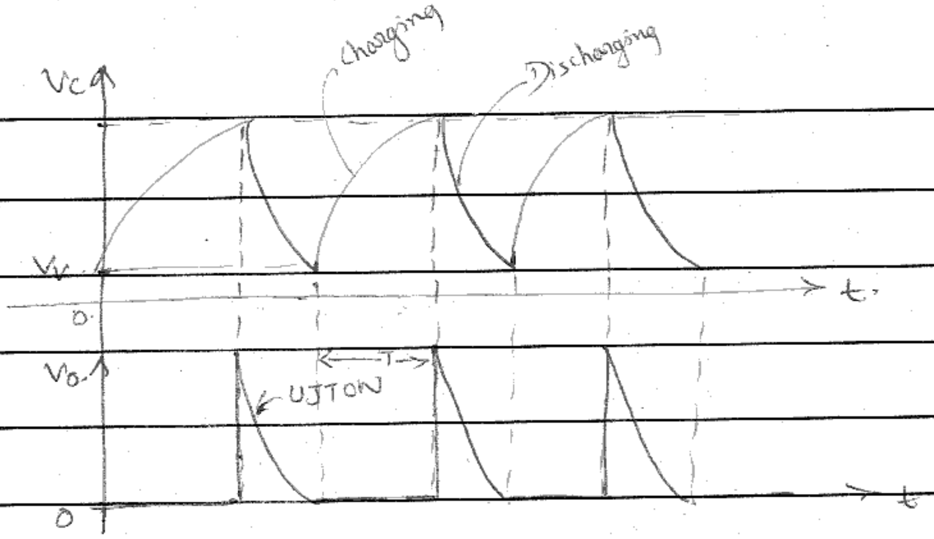
$$V_P = \eta V_{BB} + V_D \quad ①$$

where η = stand off ratio of UJT
V_D = cutin voltage of diode.

When the capacitor voltage V_C exceeds the voltage V_P the UJT fires (switche ON) The capacitor starts discharging through $R_1 + R_{B1}$ where R_{B1} internal base resistance. As R_{B1} is assumed negligible and hence capacitor discharge through R_1.

Due to the design of R_1, this discharge is very fast, and it produces a pulse across R_1 when the capacitor voltage falls below V_V i.e. $V_{CE} = V_E = V_V$ the UJT gets turned OFF. The capacitor starts charging again.

The discharge time of the pulse is controlled by time constant CR_1 while the charging time is controlled by time constant RC. The waveforms are shown in fig.



There is voltage drop across R2 and voltage rise across R1 when UJT fires. The charging eqn of the capacitor is given by,

$$V_C(t) = V_V + V_{BB}\left[1 - e^{-t/RC}\right] \quad — ②$$

But $V_C(t) = V_P$, at $t = T$

$$V_P = V_V + V_{BB}\left[1 - e^{-T/RC}\right] \quad — ③$$

Substituting value of V_P from eqn ③ in eqn ① we have

$$\eta V_{BB} + V_D = V_V + V_{BB}\left[1 - e^{-T/RC}\right] \quad — ④$$

Neglecting V_D and V_V to get approximate relation for T

$$\therefore \eta = 1 - e^{-T/RC}$$

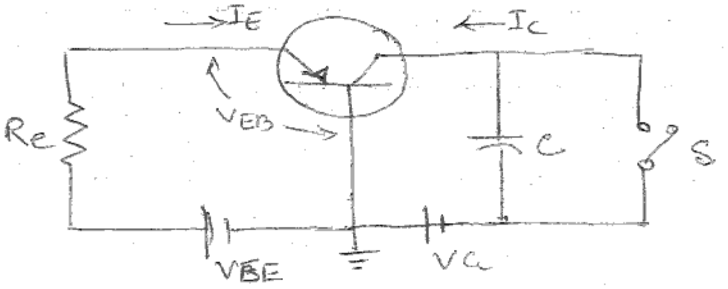
$$\therefore T = T_C = T_S = RC \ln\left[\frac{1}{1-\eta}\right] \quad — ⑤$$

$$\boxed{f_0 = \frac{1}{T} \quad \frac{1}{RC \ln\left[1/1-\eta\right]}} \quad — ⑥$$

Q.2b) Discuss about linearization using constant current source.

8.M

In a common base configuration, the collector current of the transistor is almost constant with fixed emitter current except for very small values of collector-to-Base voltage. This characteristics of common base configuration can be used to generate linear sweep by causing a constant current to flow into a Capacitor.

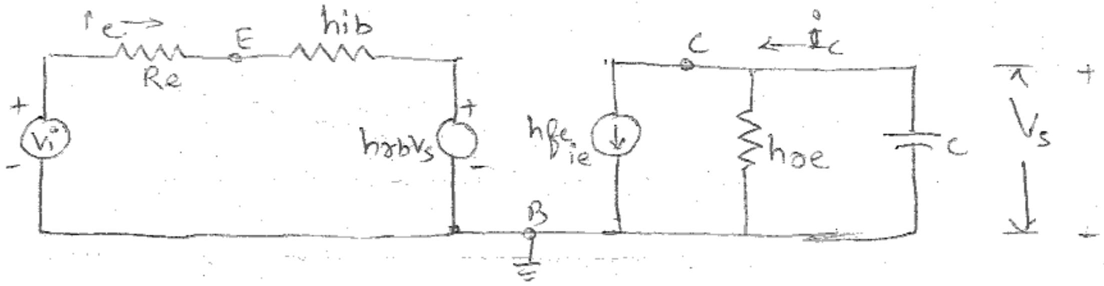


Looking at the fig: the emitter current I_E can be given as

$$I_E = \frac{V_{EE} - V_{EB}}{R_e} \quad ①$$

If we assume that V_{EB} remains constant with time after the switch S is opened, then the collector current will also be constant because $I_c = h_{fb} I_E \simeq -\alpha I_E$. As a result, the capacitor C will charge linearly with time.

Fig (b) show h-parameter equivalent ckt. Here the transistor is replaced by its CB hybrid parameters sweep Voltage is represented by V_s. and the effective input signal V_i is given as $V_i = V_{EE} - V_\gamma \equiv V_i$. The V_γ is the emitter threshold bias which brings the transistor just to the point of conduction.



By applying KVL to the i/p ckt and KCL to o/p node.

$$V_i = i_e (R_e + h_{ib}) + h_{rb} V_s = V_i \quad ②$$

$$i_c = i_e h_{fb} + h_{ob} V_s = -C \frac{dV_s}{dt} \quad ③$$

Considering initial conditions $V_s = 0$ at $t = 0$, the Eqn becomes

$$V_s = \frac{\alpha \tau V_i}{C(R_e + h_{ib})} \left(1 - e^{-t/\tau}\right)$$

where $\alpha = -h_{fb}$, $V_i = V_{EE} - V_\gamma$ and.

$$\frac{1}{\tau} = \frac{1}{C}\left(h_{ob} + \frac{\alpha h_{rb}}{R_e + h_{ib}}\right) \quad \text{④}$$

Expanding the exponential term into a power series in t/τ and retaining only the first term, we get.

$$V_s = \frac{\alpha V_i t}{C(R_e + h_{ib})} \quad \text{⑤}$$

$$= \frac{\alpha i_e t}{C} \qquad \therefore i_e = \frac{V_i}{(R_e + h_{ib})}$$

$$= \frac{i_c t}{C} \qquad \because i_c = \alpha i_e \quad \text{⑥}$$

The sweep ampl. V_s can be obtained by substituting $t = T_s$ in eqn ⑥ as.

$$V_s = \frac{\alpha V_i T_s}{C(R_e + h_{ib})} \quad \text{⑦}$$

$$\therefore \quad T_s = \frac{V_s C\,(R_e + h_{ib})}{\alpha V_i} \quad \text{⑧}$$

We know that, the slope error given by ~~eqn ③~~ [illegible]

$$e_s = T_s/\tau$$

$$e_s = \frac{V_s C\,(R_e + h_{ib})}{\alpha \tau V_i} \quad \text{⑨}$$

Substituting expression for τ from eqn ④ we have.

$$e_s = \frac{V_s \cdot C\,(R_e + h_{ib})}{\alpha V_i} \times \frac{1}{C}\left(h_{ob} + \frac{\alpha h_{rb}}{R_e + h_{ib}}\right)$$

$$\boxed{e_s = \frac{V_s}{V_i}\left[\frac{h_{ob}(R_e + h_{ib})}{\alpha} + h_{rb}\right]} \quad \text{⑩}$$

* **Slope error!** The first term in eqn ⑩ represents the slope error introduced due to the fact that the collector current is not precisely constant due to shunting effect of h_{ob} even for constant emitter current.

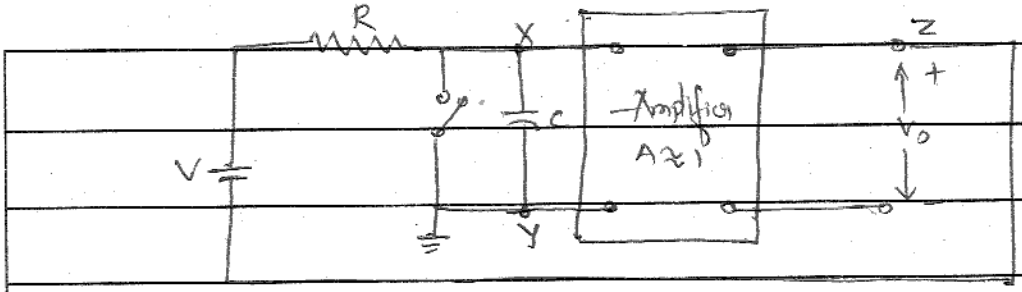
* **Change in the Emitter current!** In the h-parameter equivalent ckt shown in fig. (b) the generator $h_{rb} V_s$ represents the reaction of the collector voltage on the I/p circuit and it causes the change in emitter current as the sweep forms. The second term in the eqn results from this change in emitter current.

* **Effect of loading!** : If a load R_L is placed across C, then this resistance appears in parallel with $1/h_{ob}$ in fig (6.b). Hence the Eqn ⑩ h_{ob} must be replaced by $h_{ob} + 1/R_L$. This Replacement gives serious in the slope error. Therefore the ckt should not be loaded appreciably to deteriorate linearity.

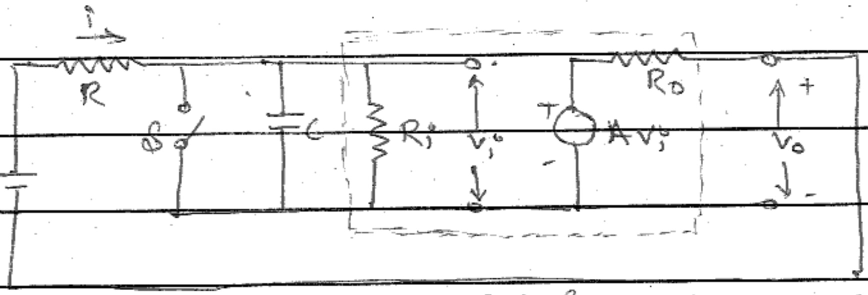
* **Deterioration of linearity!** To avoid this deterioration of linearity the sweep voltage must be applied to the load by means of an emitter follower.

* **Effect of Tempr!**:- we know that the transistor ckt are tempr dependent. The variation in transistor parameters does not affect the sweep ~~junction~~ linearly but does not make the sweep rate a fn of tempr. The emitter jn voltage V_{EB}, for a fixed current decreases about 2mV/°c. Hence from eqn ① the sweep speed $|I_c|/C = \alpha I_E / C$. increased with tempr.

Q3 With a neat Diagram explain the Operation of Bootstrap Circuit (5.71)



Basic bootstrap ckt



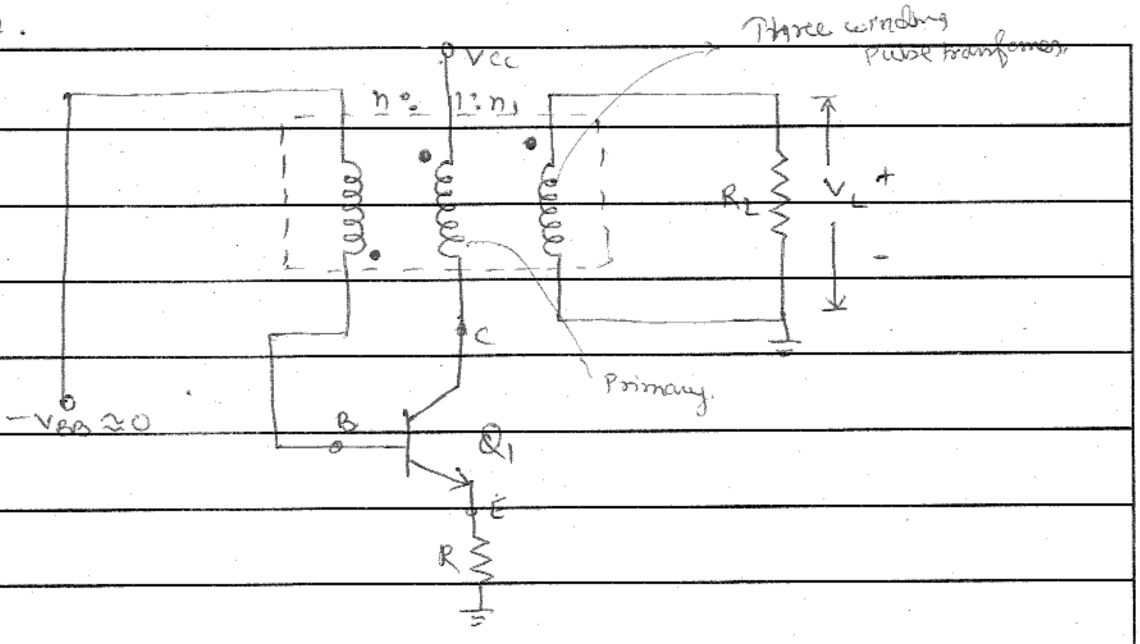
Basic ckt for bootstrap sweep generator.

looking.

$$V = iR + AV_i - iR_o = 0$$

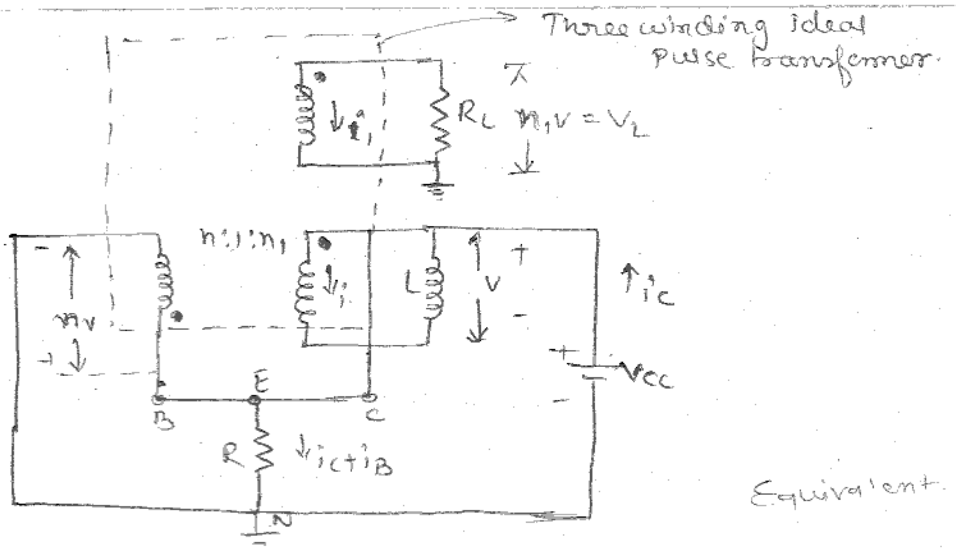
Q4 Draw the circuit diagram of monostable transistor blocking oscillator with emitter timing. Explain its operation with equivalent ckt during Pulse formation.

Sol^n



The circuit is also called triggered transistor blocking Oscillator using emitter timing. This uses a resistance in the emitter circuit which controls the pulse width. The pulse transformer used is a three winding transformer. One winding is in the collector circuit which is primary winding. The second winding is in the base circuit which has n times as many turns as the collector winding. A load resistance R_L is connected across third winding which has n_1 times as many turns as the collector winding. The resistance R_L acts as load and also helps in improving damping. The base and collector windings must produce polarity inversion indicated by dots, while relative direction of third winding can be arbitrary. The circuit diagram of emitter timing ckt as shown.

X Some basic operation of the ckt as that of base timing circuit.

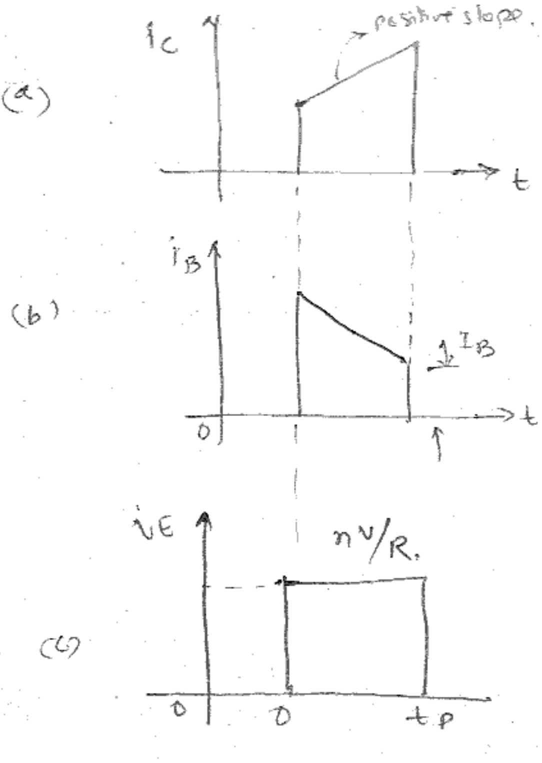


Equivalent ckt of ET MBOsc.

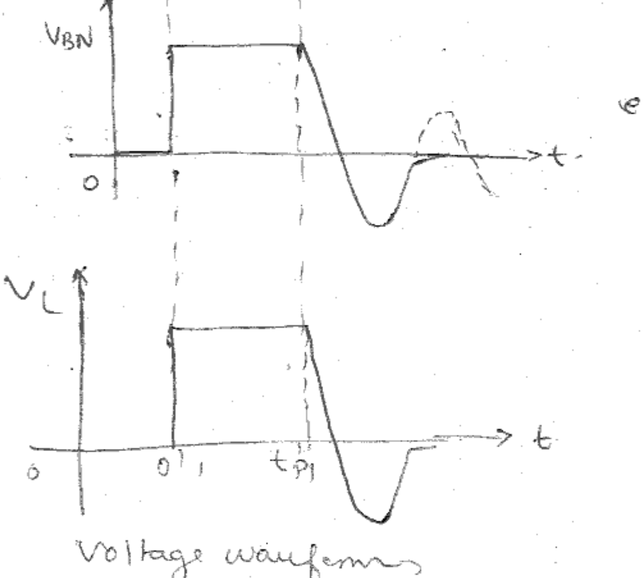
Assuming ideal transformer, neglecting leakage inductance, Capacitance and winding resistance and neglecting transistor saturation Voltages, the Equivalent ckt can be shown in the fig.

For simplicity of analysis assume no. of turns of primary of transformer which is in collector circuit be 1. proportionally the numbers of turns of winding in base ckt. is n and that of winding used to connect R_L is n_1.

Now V be the voltage across the primary collector winding, when transistor is in saturation. The corresponding voltage across secondary winding in base circuit is nV. And due to phase inversion polarities of V and nV are opposite. The voltage across the resistance R_L is $n_1 V$ and the polarity is same as that of V.



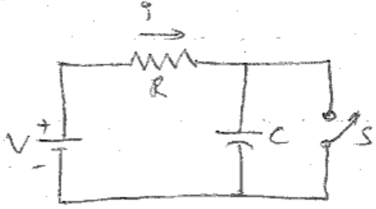
Current waveform



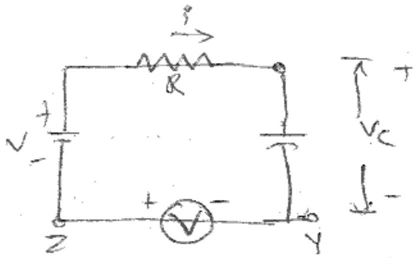
Voltage waveforms

Q5. Explain the basic principles of miller sawtooth generator circuit with the help of neat diagram.

Soln



→ Exponential Charging of capacitor



(b) Contant current charging of capacitor

The basic sweep circuit in which S opens to form the sweep. If we introduced an auxillary variable generator V and if V is always kept equal to the voltage drop across C, the charging current will be kept constant at $i = V/R$ and perfect linearity can be achieved.

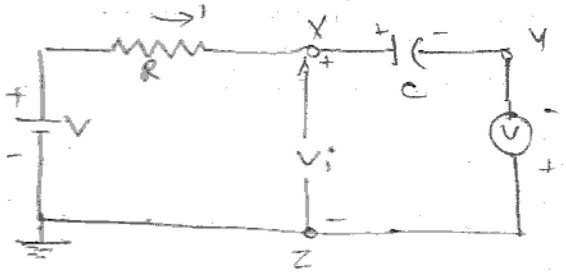
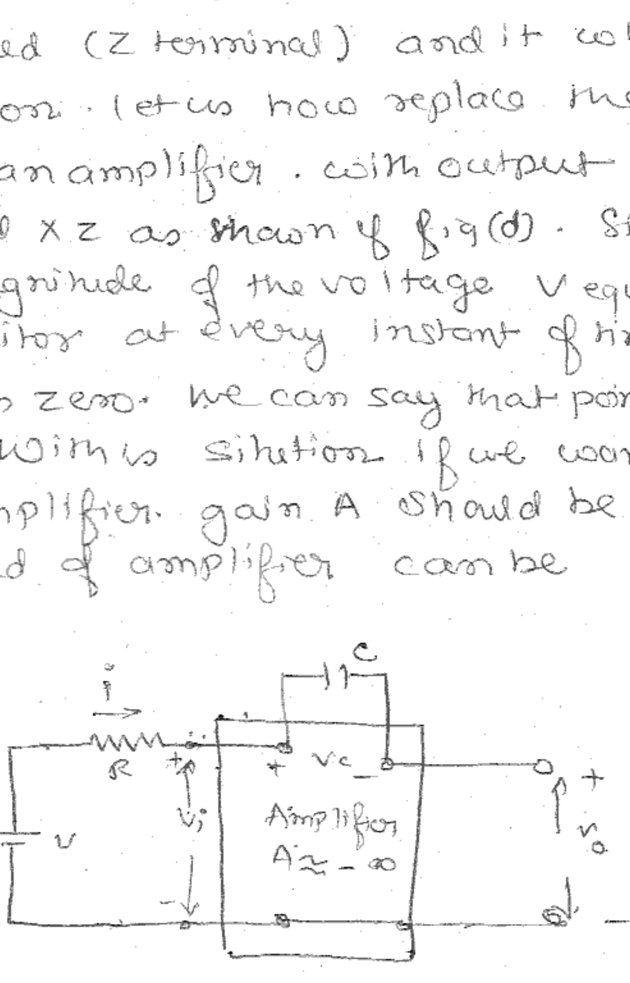


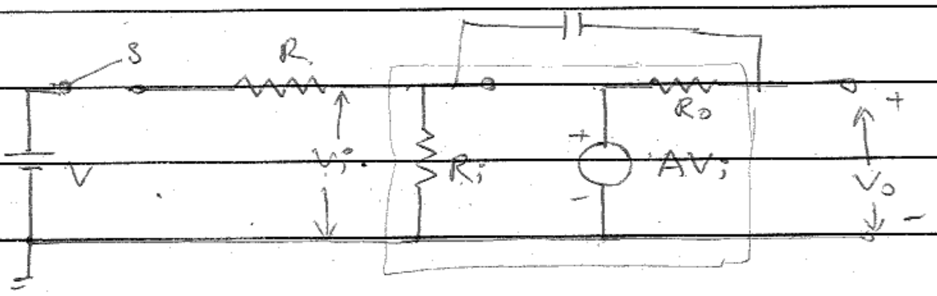
Fig (c)

Point Z is grounded.

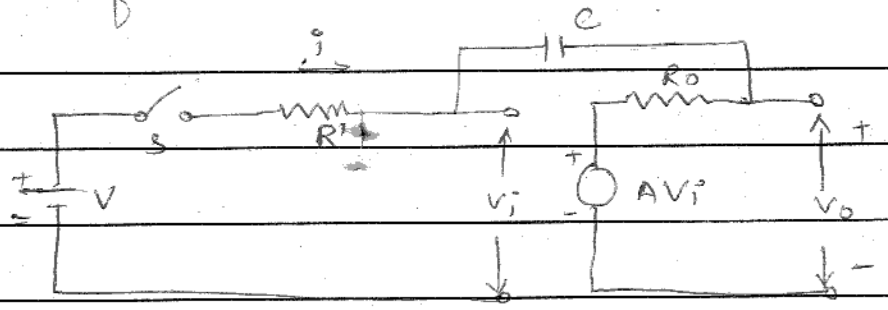
Let us consider the circuit in Fig (b) with its Z-terminal grounded as in Fig (c). With this ckt, linear sweep will appear between terminals Y and grounded (Z terminal) and it will increases in the negative direction. Let us now replace the auxilary variable generator by an amplifier with output terminal YZ and input terminal XZ as shown of fig (d). Since we have assumed that the magnitude of the voltage V equals the voltage Vc across the capacitor at every instant of time, then the i/p V_i to the amplifier is zero. We can say that point X behaves as a virtual ground. With is situation if we want to obtain finite output, the amplifier gain A should be ideally be infinite. Such a need of amplifier can be satisfied by using operational amplifier and ckt is recognized as the operational integrator amplifier. It is customarily reffered to as a Miller integrator or Miller sweep.



Fig(e) Shows the Miller Circuit with its Equivalent ckt R_i represents input impedance of the amplifier, A represents open circuit voltage gain and R_o is the o/p resistance, Here, Switch is added at the closing of which the time-base waveform will start.



Fig(f) Shows the Miller circuit with i/p circuit replaced by Thevenin's Equivalent the i/p circuit components V, R and R_i are replaced by V and R' as follows



$$V' = \frac{VR_i}{R_i+R} = \frac{V}{1+R/R_i} \quad \text{and} \text{ ——— } ①$$

$$R' = \frac{R_iR}{R_i+R} \text{ ——— } ②$$

let us assume that at $t = 0^+$ voltage across capacitor is Zero. Then neglecting R_o we can write.

$$V_i - AV_i = V_i(1-A) = 0$$

$$V_i = AV_i = 0$$

Since R_o is neglected $AV_i = V_o$

$$V_i = AV_i = V_o = 0$$