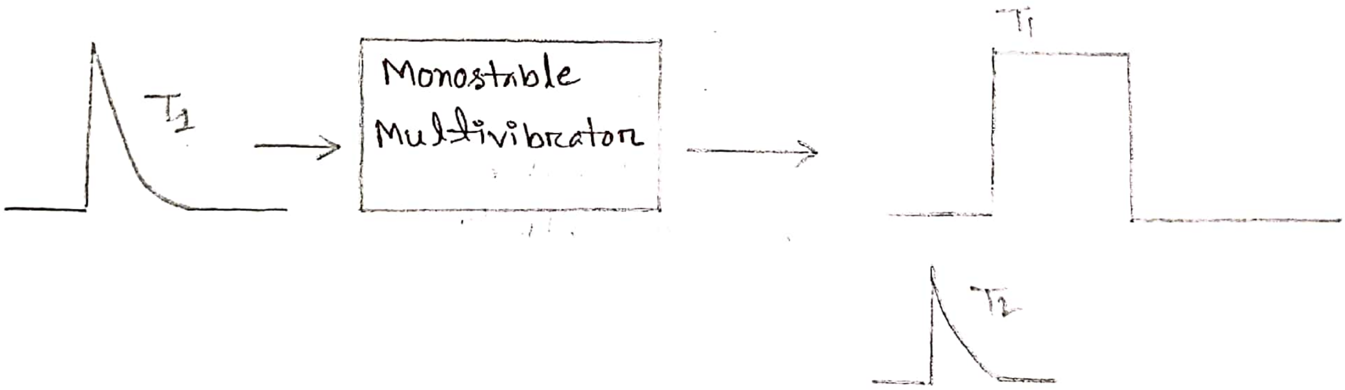
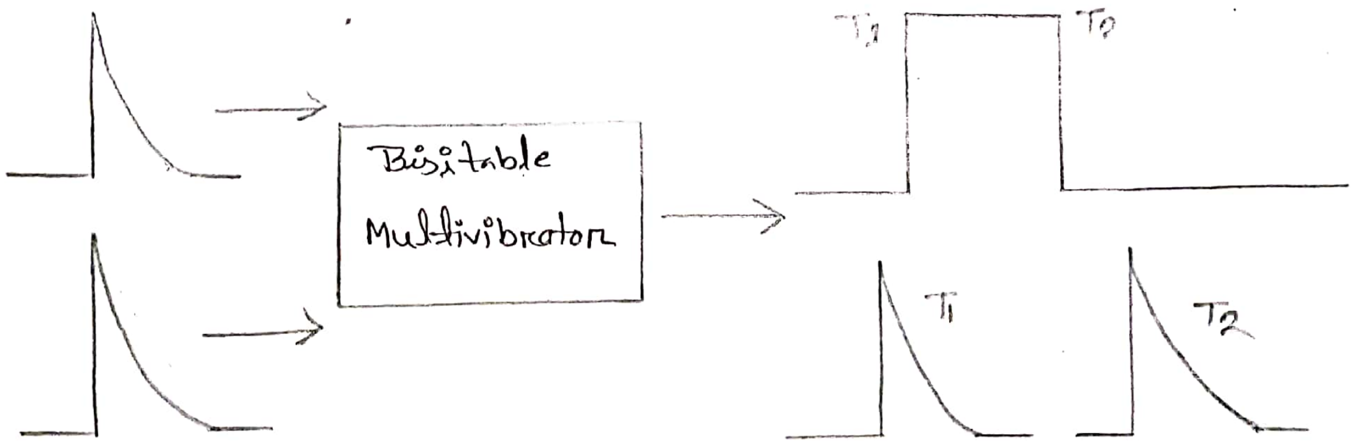
Multivibrator

Types:-

1. A-stable or Free running multivibrator
2. Mono-stable or one-shot multivibrator
3. Bi-stable or Flip-flop multivibrator

Input Output



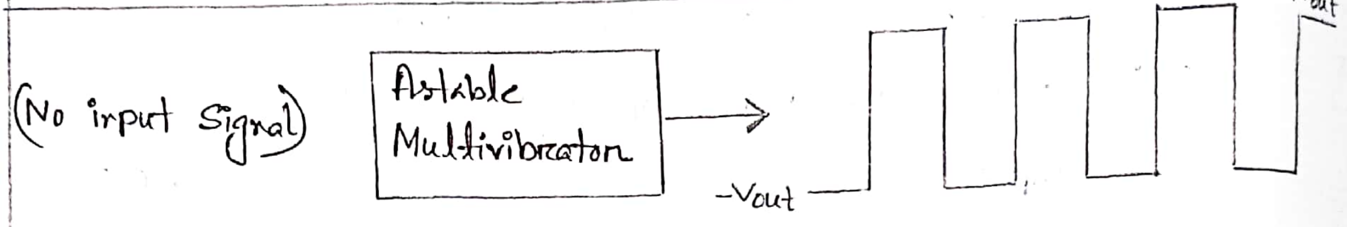


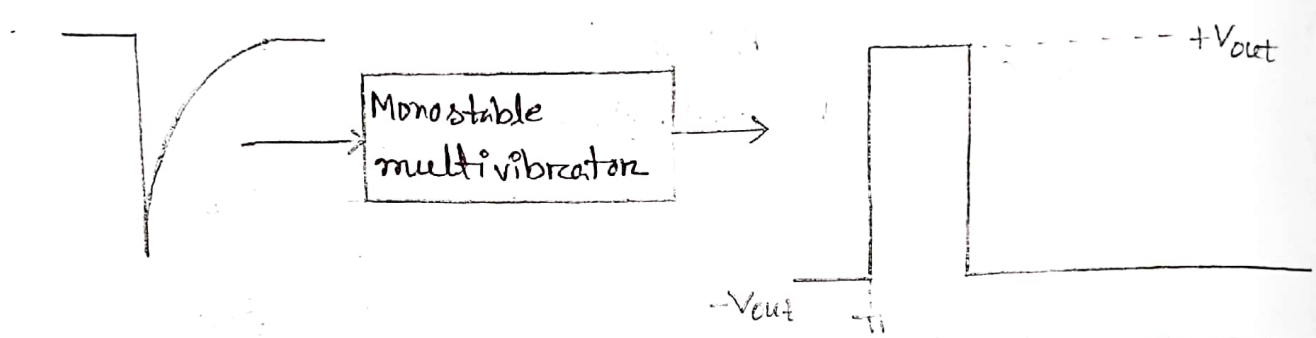
Multivibrator → transistor দিয়ে তৈরি।

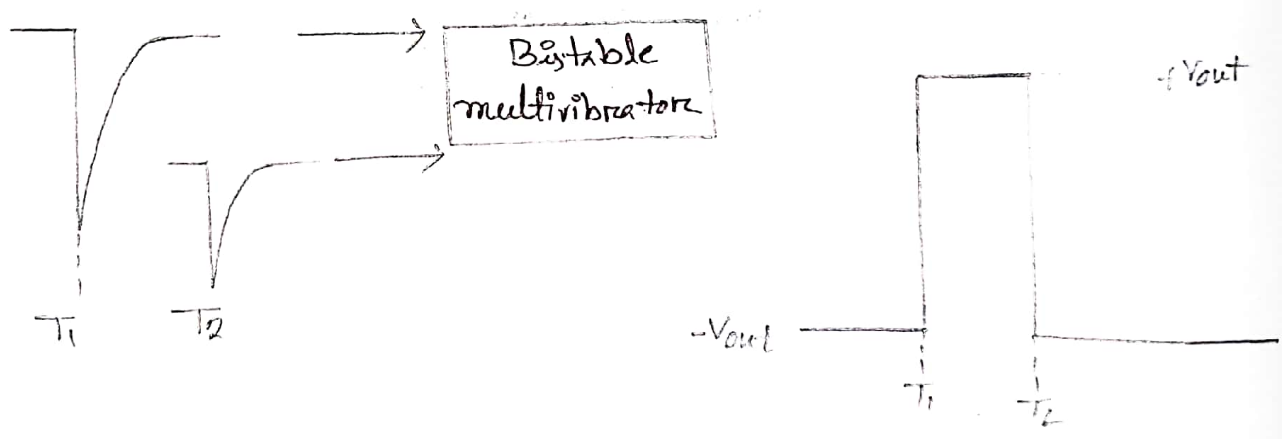
N_{GT} → Negative Going Transistor (Trigger).

P_{GT} → Positive Going Transistor (Trigger).

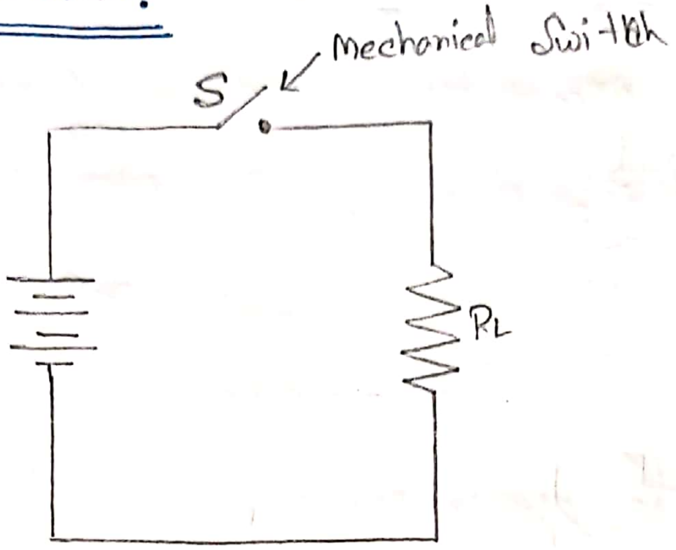
Input | Output





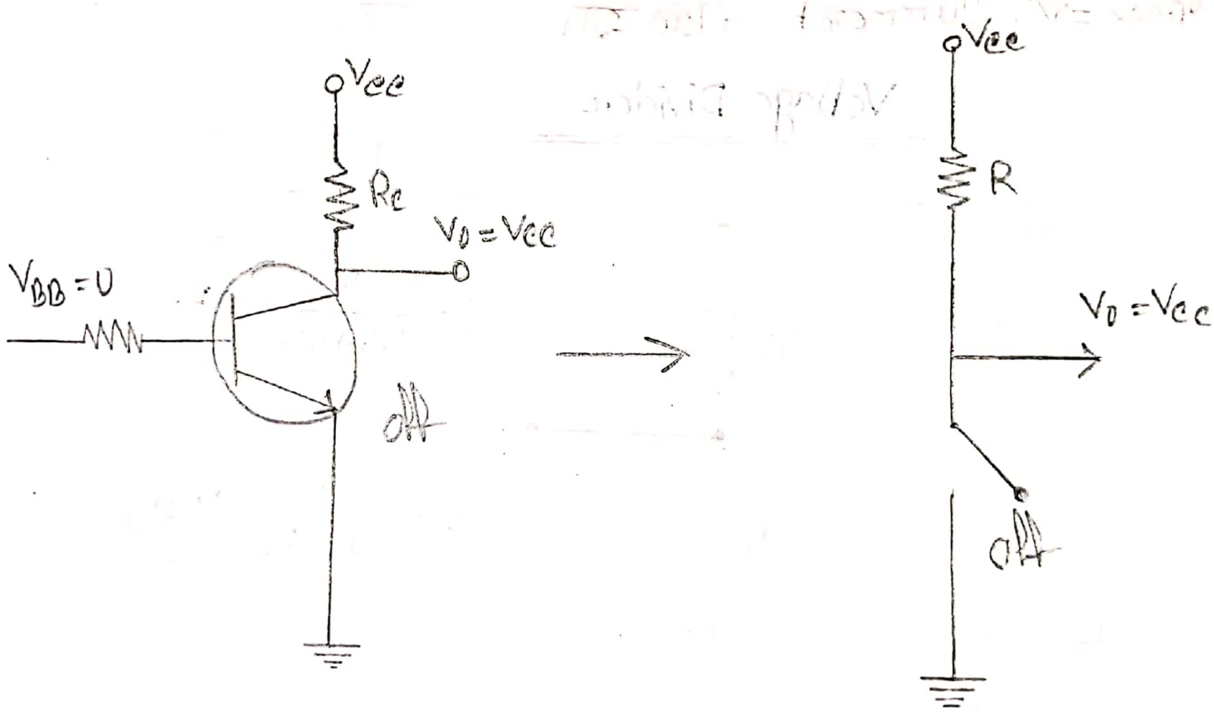


Switching of transistor:



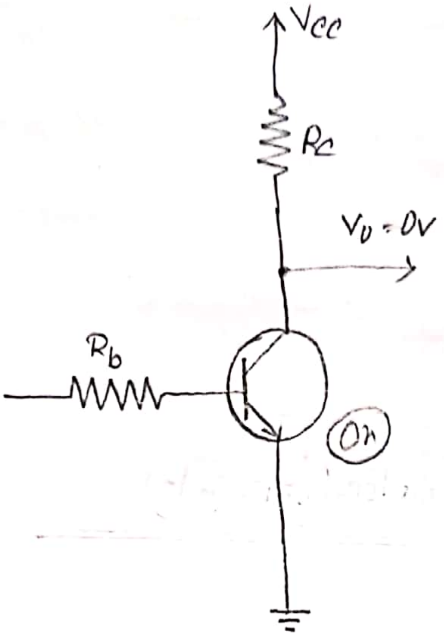
Switching action of Transistor (OFF State)

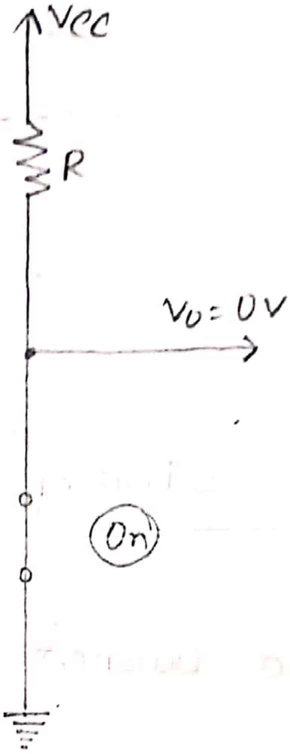
$V_{Base} = 0$ Current flow of করে।



- Current যায় না, high resistance এর মতো কাজ করে। তখন Voltage source voltage এর সমান হয়।

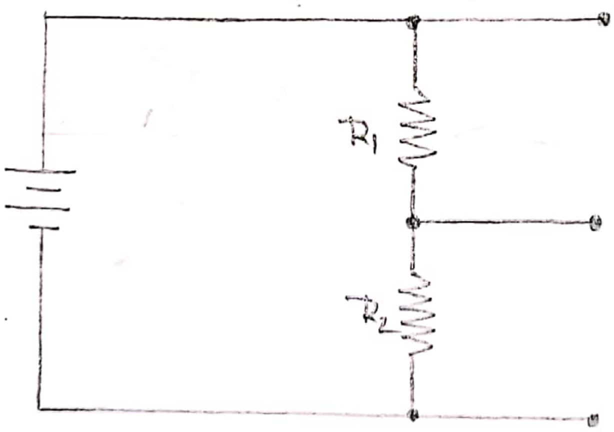
On State





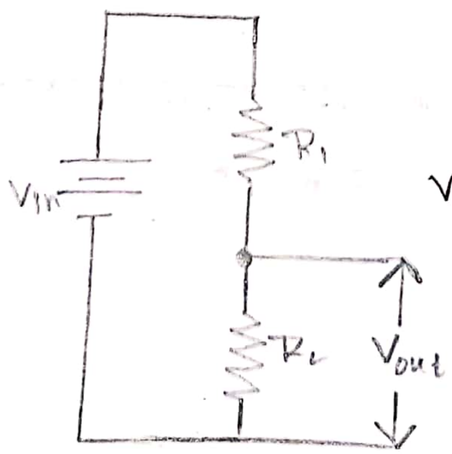
$V_{base} = V$, Current flow হয়।

Voltage Divider

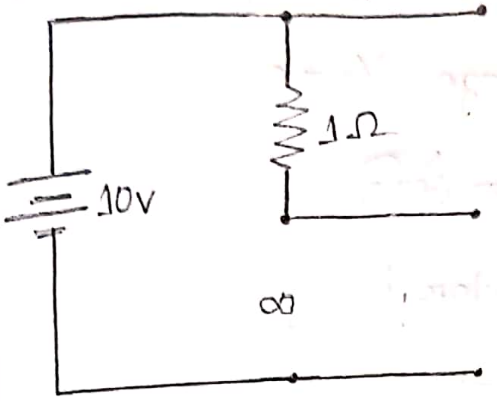


$$V_1 = \frac{V}{R_1 + R_2} \times R_1$$

$$V_2 = \frac{V}{R_1 + R_2} \times R_2$$



$$V_{out} = \frac{V}{R_1 + R_2} \times R_2$$



$$V_1 = \frac{V}{R_1 + R_2} \times R_1$$
$$= 0V$$

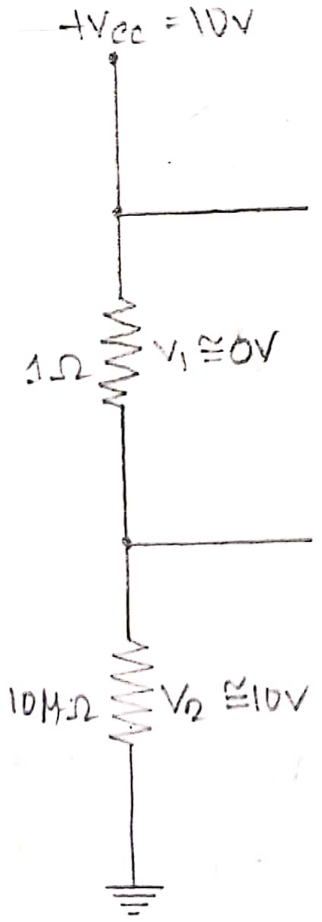
$$V_2 = \frac{V}{R_1 + R_2} \times R_2$$
$$= 10V$$

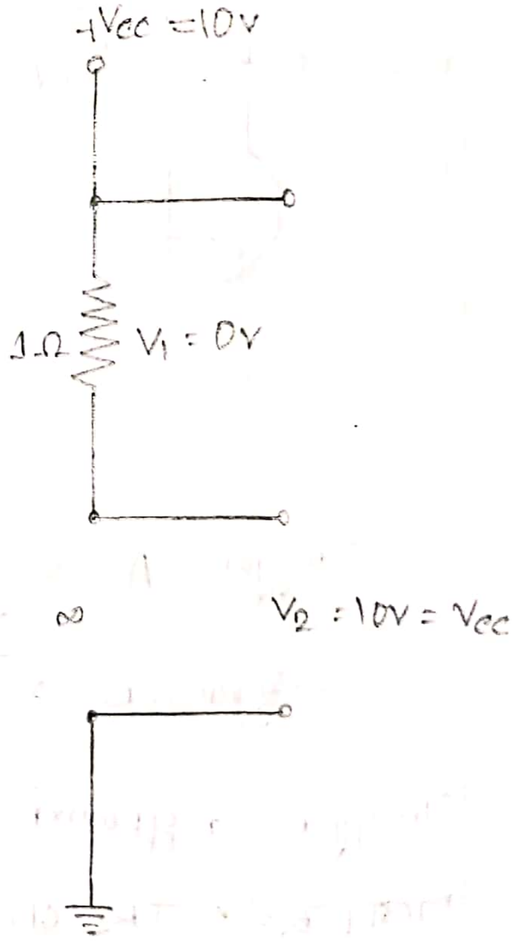
↓

Open circuit এর across এ Voltage

Source voltage এর সমান।

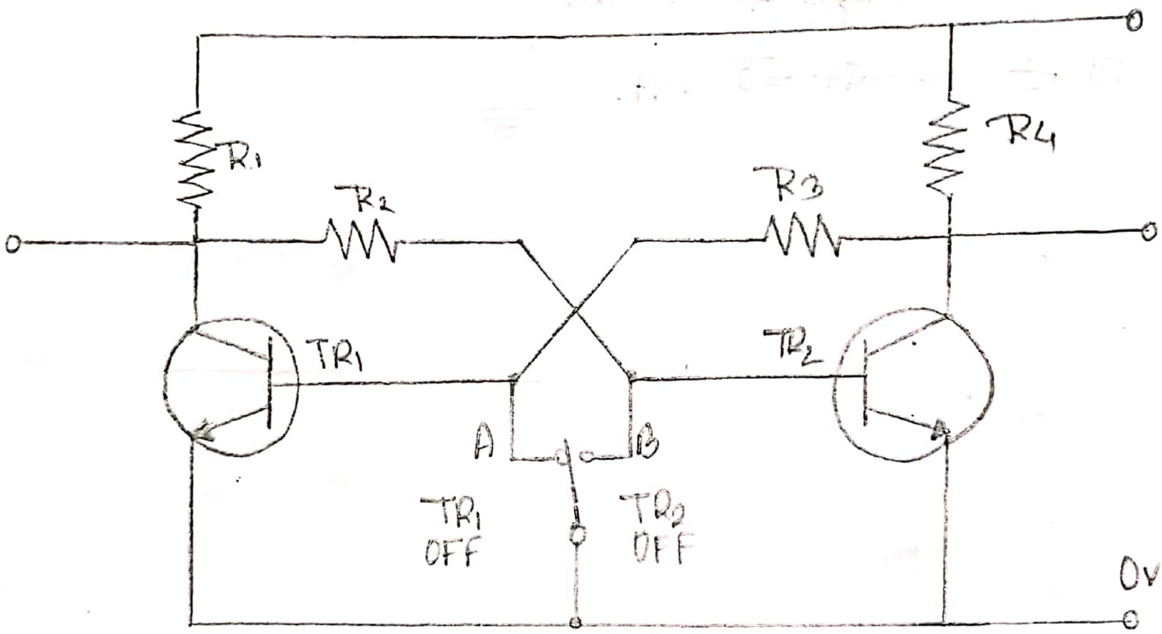
Short circuit = 0 volt.





- Transistor off → output Voltage $V_0 = V_{cc}$
- Transistor on → output Voltage $V_0 = 0$
- Multivibrator → transistor দিয়ে তৈরি।
- NGT → Negative Going transistor।
- PGT → Positive Going transistor।

Bi-stable Multivibrator



SPDT Switch

Trigger A →

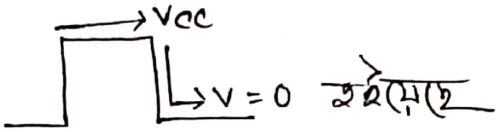
Trigger B →

Trigger A ground এ থাকলে TR_2 এর base এ current পাবে। অর্থাৎ TR_2 ON হবে, $V = 0$ হবে, এবং $TR_1 = off$ থাকবে তাই $V = V_{cc}$ হবে।

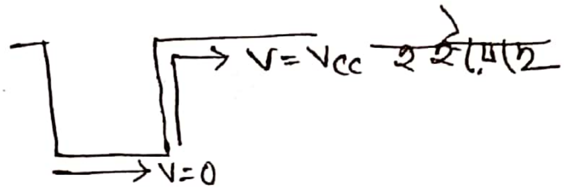
আবার, Trigger B ground -এ থাকলে TR_1 এর base এ current পাবে। অর্থাৎ, TR_1 ON হবে এবং $V = 0$ হবে।

∴ TR_2 off থাকবে তাই $V = V_{cc}$.

TR_1 =



TR_2 =



Monostable or one-shot multivibrator

২ টাই একজাতীয় (npn transistor)

Capacitor এর কারণে main ঘটনা ঘটে।

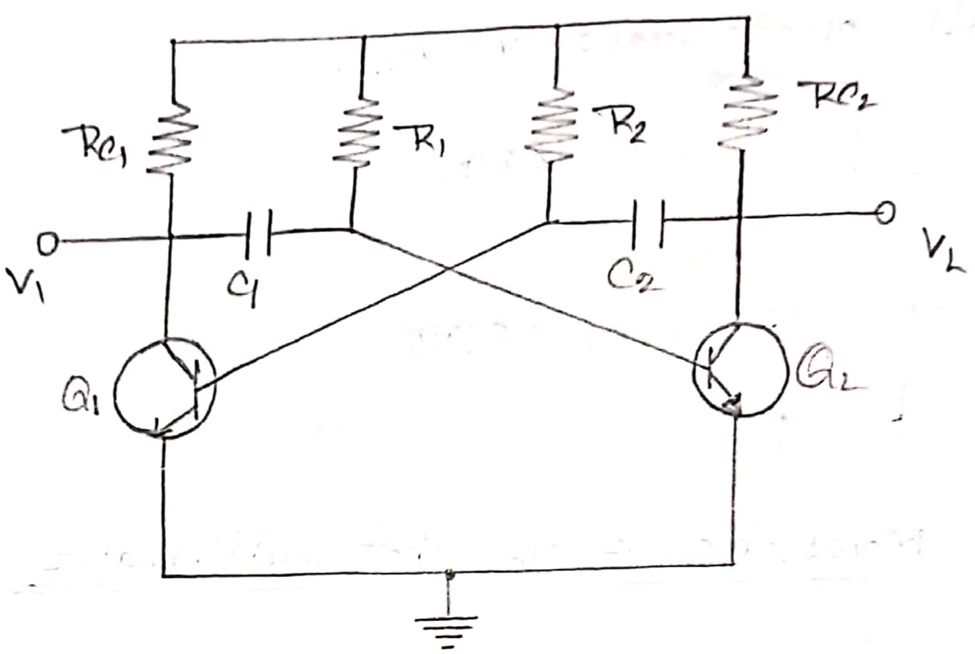
$C = 0.7$ হলে —

First এ base current পাবে। এজন্য Q_2 ~~off~~ on থাকবে।
Q_1 off থাকবে।

– V_{BB} তে current flow হয়েছে।

– Trigger from Q_1 on থাকবে।

Circuit Diagram of a Astable Multivibrator



Pnp → danger ⊗ not recommended.

<u>Astable Multivibrator:</u> শুরুতে Q_1 off Q_2 On হবে। Q_2 পথ দিয়ে গেলে C_2 চার্জিত হতে থাকে।

একসময় C_2 ফুল চার্জ হয়, এবং Q_2 off হয়ে যায়, Q_2 on হয়। Q_2 on হলে C_1 দিয়ে Current যেতে যেতে C_1 ফুল চার্জিত হয়। Q_1 off হয় Q_2 on হয়,

⇒ Astable frequency থাকে।

⇒ mono & bi " থাকেনা।

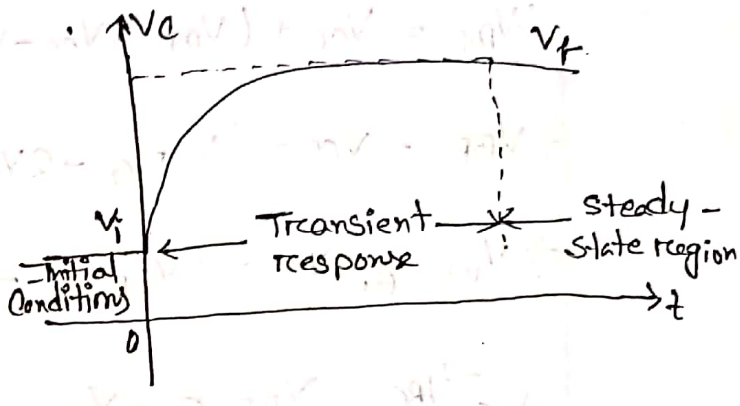
⇒ Same charge-এ Voltage কম বেশি করা যাবে. due to the volumn of capacitor.

Capacitor Voltage equation:-

$V_c = V_{max}(1-e^{1/\lambda})$

$= (V_f - V_i)(1-e^{1/\lambda})$

$V_c = \underbrace{V_i}_{\text{initial voltage}} + (V_f - V_i)(1-e^{-1/\lambda})$



$= V_i + V_f - V_f e^{-1/\lambda} - V_i + V_i e^{-1/\lambda}$

$$\boxed{= V_f + (V_i - V_f)e^{-1/\lambda}}$$

$\tau = \lambda = RC$

Voltage equation:

$V_c = V(1-e^{-1/\lambda})$

↳ equation এর RXC এর সমান

$V_c(t) = V_{BE-Q_1}$

$V_i = V_{BE-Q_1} - V_{cc}$

$V_f = V_{cc}$ [যদি Capacitor চার্জিত হতো, তাহলে $V_f = V_{cc}$ এর মান সমান হতো]

$V_c = V_f + (V_i - V_f)\, e^{-t/RC}$

$\Rightarrow V_{BE} = V_{CC} + (V_{BE} - V_{CC} - V_{CC}) \times e^{-t/RC}$

$\Rightarrow V_{BE} = V_{CC} + (V_{BE_{Q_1}} - 2V_{CC})\, e^{-t/RC}$

$\Rightarrow V_{BE-Q_1} - V_{CC} = (V_{BE-Q_1} - 2V_{CC})\, e^{-t/RC}$

$$\Rightarrow e^{-t/RC} = \frac{V_{BE\_Q_1} - V_{CC}}{V_{BE\_Q_1} - 2V_{CC}}$$

$$\Rightarrow -\frac{t}{RC} = \ln\left(\frac{V_{BE\_Q_1} - V_{CC}}{V_{BE\_Q_1} - 2V_{CC}}\right)$$

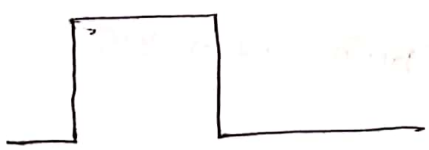
$$\Rightarrow t = -RC \ln\left(\frac{V_{BE\_Q_1} - V_{CC}}{V_{BE\_Q_1} - 2V_{CC}}\right) \quad [V_{CC} \gg V_{BE\_Q_1}]$$

$$\Rightarrow t = -RC \ln\left(\frac{-V_{CC}}{-2V_{CC}}\right)$$

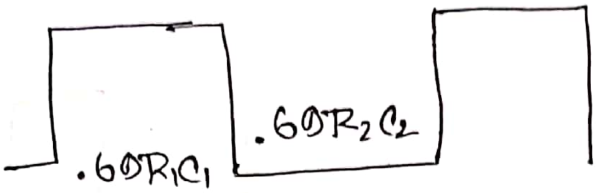
$\Rightarrow t = -RC \ln(1/2)$

$\Rightarrow t = RC \ln 2$

$\therefore t = 0.69RC$



$.69RC$



$$T = t_1 + t_2$$

$$= .69R_1C_1 + .69R_1C_1$$

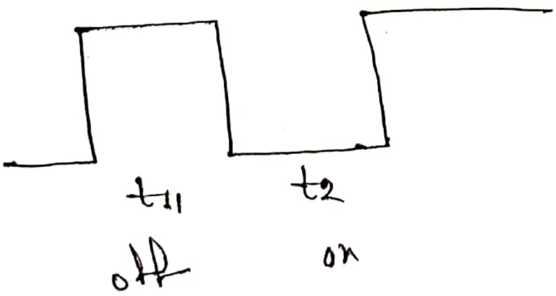
$$f = \frac{1}{T}$$

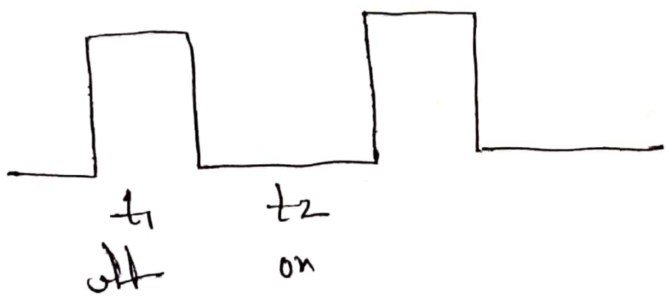
$$= \frac{.73}{RC} \left[\text{if } R_1 = R_2 = R \quad C_1 \sim C_2 = C\right]$$

Symetric & Asymmetric Wave

$t_1 = t_2 \rightarrow$ Symetric (off time = on time)

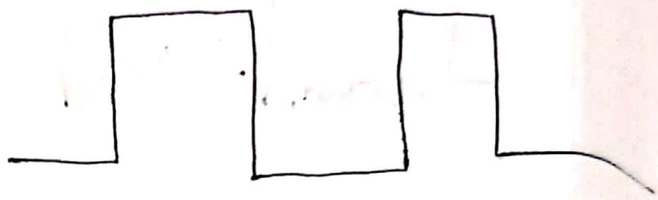
$t_1 \neq t_2 \rightarrow$ Asymmetric (off time $\neq$ on time)





$R_2 = R_3 = 47k\Omega$

$C_1 = C_2 = 0.01\mu F$

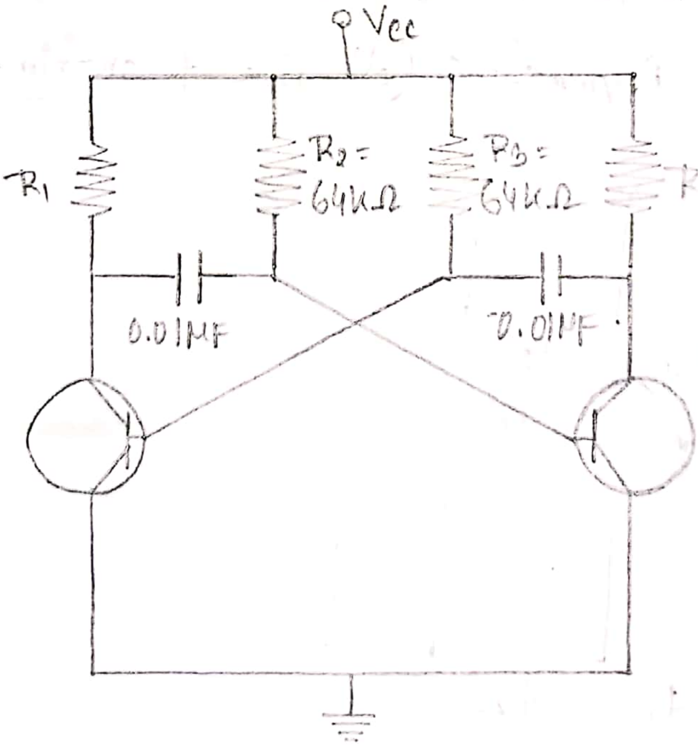


$t_1 = 0.69RC$

$= .69 \times 47 \times 10^3 \times 0.01 \times 10^{-6}$

$=$

• In an Astable multivibrator $R_2 = R_3 = XXk\Omega$ [last two digit of your ID] and $C_1 = C_2 = 0.01\mu F$, Determine the time period and frequency of the square wave.



$t = 0.60 \times 64 \times 10^3 \times 0.01 \times 10^{-6}$

$= 4.4 \times 10^{-4}$

$T = 0.693 R_2 C_1 + 0.693 R_3 C_2$

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

$= \frac{1}{RC}$

$= \frac{0.73}{64 \times 10^3 \times 0.01 \times 10^{-6}}$

$= \frac{0.73}{0.4 \times 10^{-4}}$

$= 1140.625.$

• In the following multivibrator $R_1 = 2K\Omega$, $R_2 = 20K\Omega$, $C_1 = 0.01\mu F$ and $C_2 = 0.05\mu F$. Calculate its time period and frequency of oscillation.

$T = t_1 + t_2$

$= .69 R_1 C_1 + .69 R_2 C_2$

$= .69 \times 2 \times 10^3 \times 0.01 \times (10^{-6}) + .69 \times 20 \times 10^3 \times 0.05 \times (10^{-6})$

$= 13.8 \times 10^{-6} + 690 \times 10^{-6}$

$= 703.8 \times 10^{-6}$ s

$f = \frac{1}{T} = \frac{1}{703.8 \times 10^{-6}} = 1420.85 Hz$