Transistor Biasing

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Ground Rules

⟨1⟩ Emitter Diode must be forward biased, whereas collector Diode must be reverse biased

⟨2⟩

NPN

Collector – Maxm. Potential
Base – Intermediate "
Emitter – Minm "

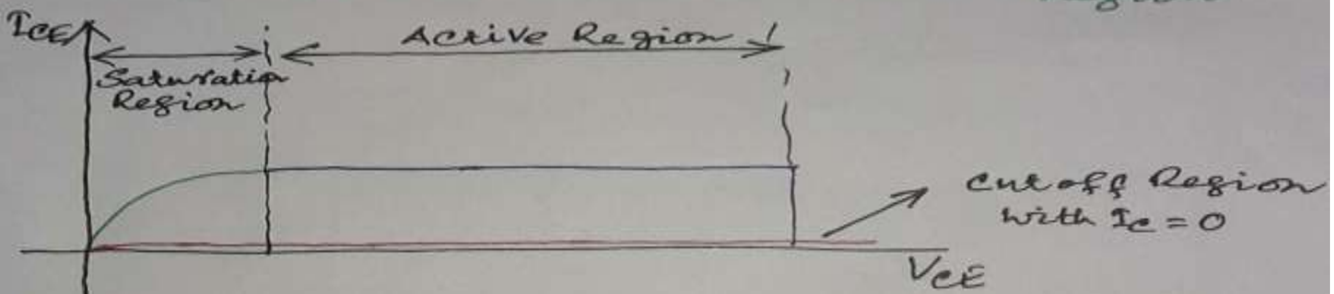
PNP

Collector – Minm Potential
Base – Intermediate "
Emitter – Maxm. "

Biasing ??

Biasing circuit should be re-designed to use BJT as ① SWITCH or ② CURRENT SOURCE or ③ AMPIFIER

SWITCH — ON State or OFF State without having any intermediate state.
[Saturated Transistor] - Saturation Region



CURRENT SOURCE OR AMPLIFIER

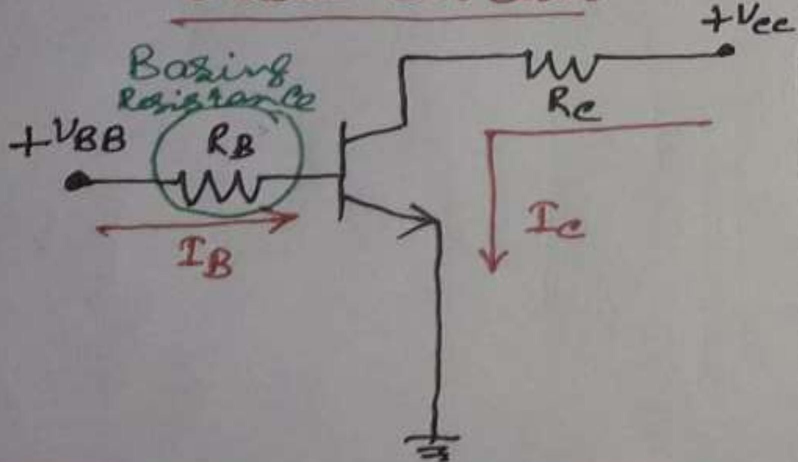
Q point should kept fixed.

Evolution of Transistor Biasing

$$I_C = \beta I_B$$

As due to temperature change, β changes therefore I_C changes. So this equation cannot give a constant Q point.

Basic circuit

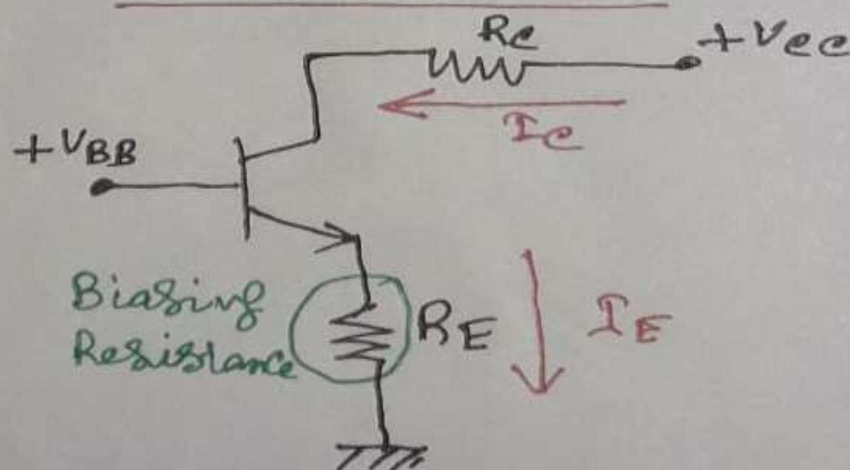


Basic Base Bias ckt.

$$I_C = \alpha I_E \approx \frac{\beta}{\beta+1} I_E \approx I_E$$

Here change of β due to temperature hardly affects I_C. Possible to keep I_C constant.

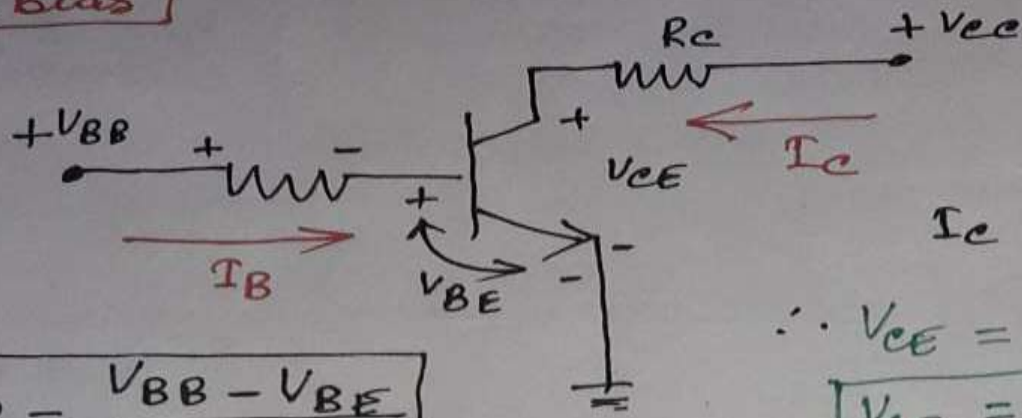
Basic circuit.



Basic Emitter Bias ckt.

Base Bias

Base Bias



$$I_C = \frac{V_{CC} - V_{CE}}{R_C}$$

$$\therefore V_{CE} = V_{CC} - I_C \cdot R_C$$

$$\boxed{I_B = \frac{V_{BB} - V_{BE}}{R_B}}$$

$$\boxed{V_{CE} = V_{CC} - \beta (V_{BB} - V_{BE}) \left(\frac{R_C}{R_B}\right)}$$

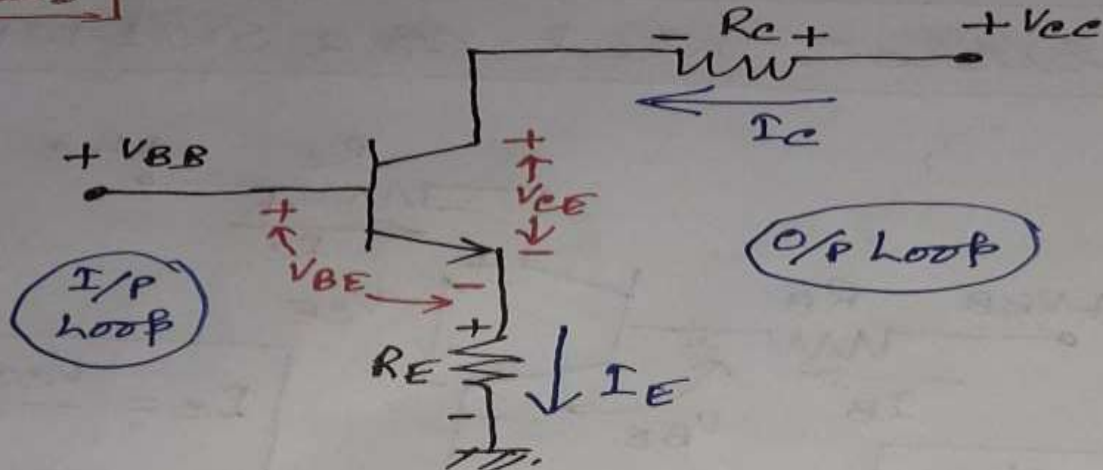
$$\boxed{I_C = \beta I_B = \beta \cdot \frac{V_{BB} - V_{BE}}{R_B}}$$

$\beta \nearrow \quad I_C \nearrow \quad V_{CE} \nearrow$

May be used in saturation Region

Emitter Bias

Emitter Bias



For I/P loop

$$V_{BB} - V_{BE} - I_E R_E = 0$$

$$\therefore \quad I_E = \frac{V_{BB} - V_{BE}}{R_E} = \overset{\approx 1}{\frac{\beta+1}{\beta}} I_C .$$

$$\boxed{I_E \approx I_C} = \frac{V_{BB} - V_{BE}}{R_E} \longrightarrow \text{Independent of } \beta$$

Emitter Bias

<u>For O/P Loop</u>

$$V_{CC} - V_{CE} - I_C R_C - I_E R_E = 0$$

$$\therefore V_{CC} - V_{CE} - I_C (R_C + R_E) = 0$$

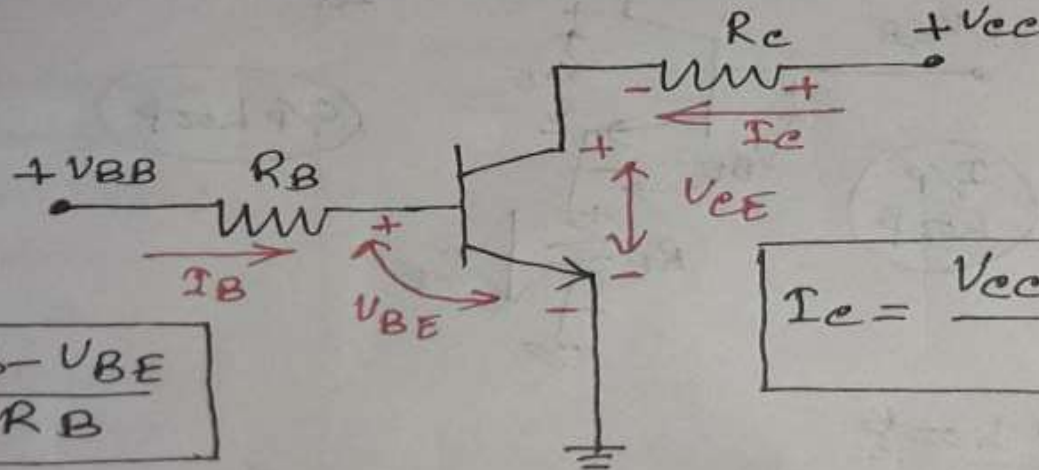
$$\therefore V_{CE} = V_{CC} - I_C (R_C + R_E)$$

$$= V_{CC} - \frac{V_{BB} - V_{BE}}{R_E} (R_C + R_E)$$

$$\boxed{V_{CE} = V_{CC} - (V_{BB} - V_{BE}) \left(1 + \frac{R_C}{R_E}\right)} \rightarrow \text{Independent of } \beta.$$

If β changes due to temperature, it hardly affects I_C & V_{CE}. So it is possible to use it in the active region where Q pt. needs to be identified.

Transistor used as a SWITCH



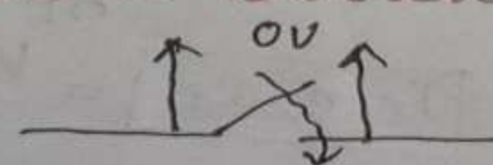
$$\boxed{I_B = \frac{V_{BB} - V_{BE}}{R_B}}$$

$$\boxed{I_C = \frac{V_{CC} - V_{CE}}{R_C}}$$

$$\boxed{I_B \approx \frac{V_{BB}}{R_B}}$$

Let the Transistor acts as a switch & in on condition.

$$V_{CE} = 0$$



$$I_C = \frac{V_{CC}}{R_C} = \beta I_B = \beta \cdot \frac{V_{BB}}{R_B}.$$

So

$$\boxed{\frac{V_{CC}}{R_C} = \frac{V_{BB}}{R_B/\beta}}$$

Transistor Switch

Since, Transistor is now on saturation region, so β value cannot be fixed.

Use 10:1 Rule & consider $\beta = 10$

So $$\boxed{\frac{V_{CC}}{R_C} = \frac{V_{BB}}{R_B/10}}$$

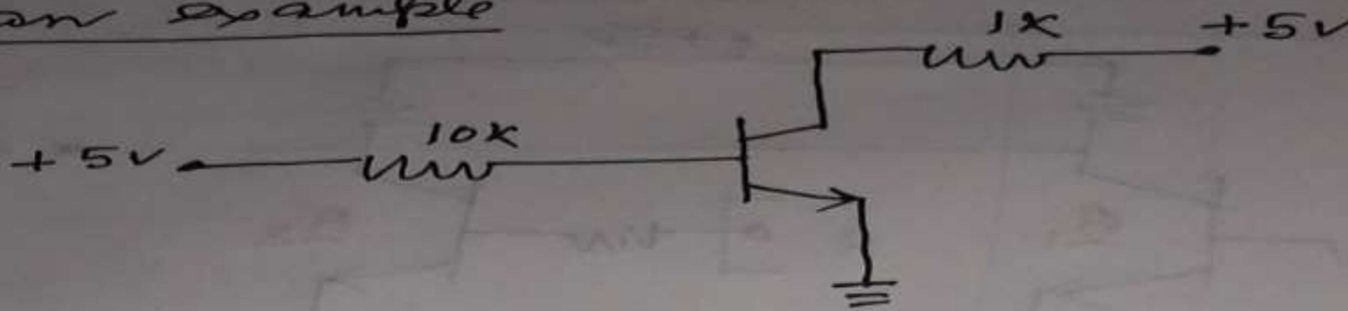
$$V_{CC} = V_{BB}$$

$$R_C = \frac{R_B}{10}$$

condn for hard saturation

Switch (contd)

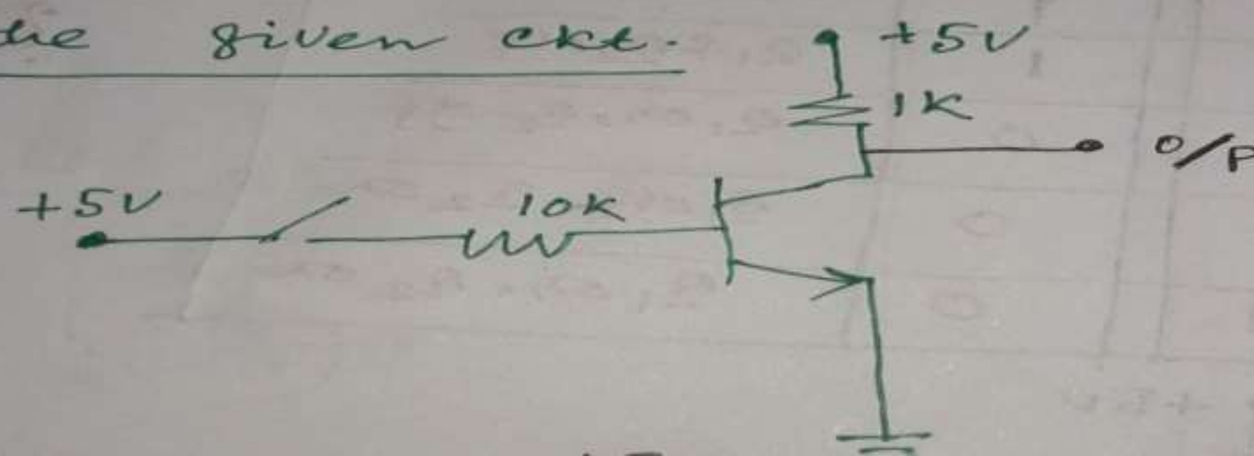
As an example



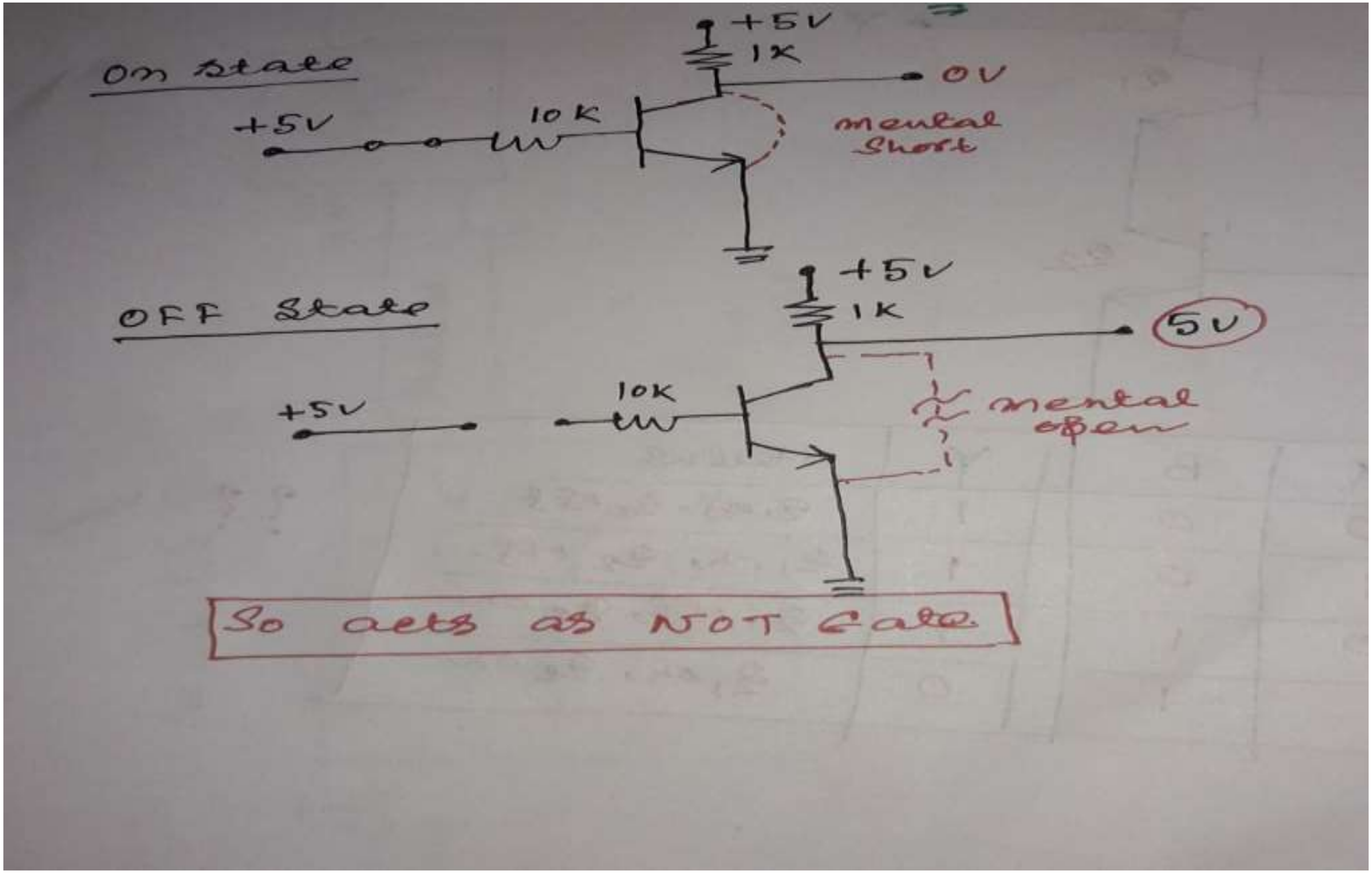
OFF State

$I_C = 0$, $V_{CC} = V_{CE} = +5V$

For the given ckt.



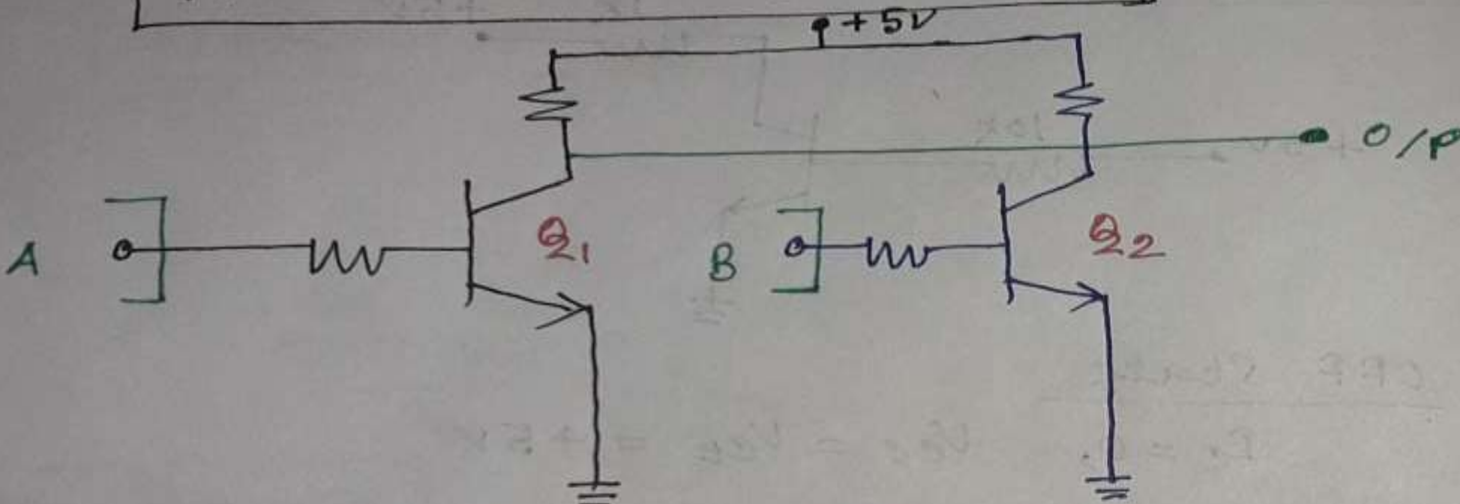
Switch ???



On state
+5V
1K
0V
10K
+5V
mental Short
OFF State
+5V
1K
5V
10K
+5V
mental open
So acts as NOT Gate

Applications

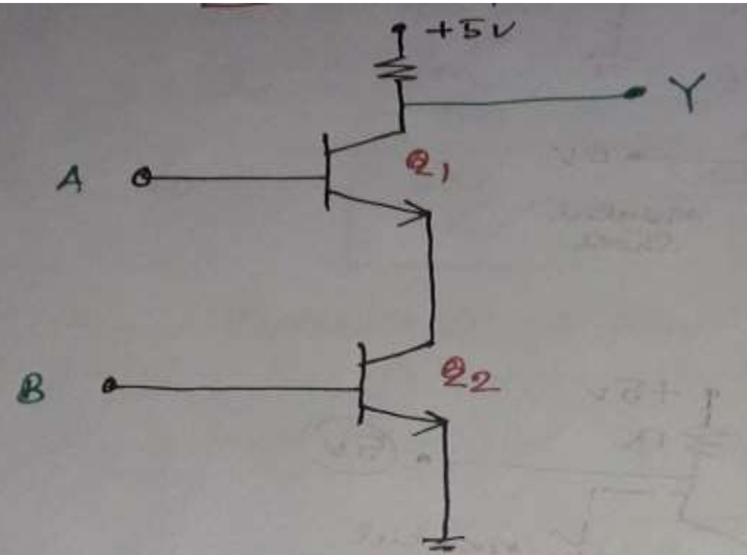
Applications in logic circuit.



A	B	Y	Status
0	0	1	Q_1 & Q_2 off
1	0	0	Q_1 on, Q_2 - off
0	1	0	Q_1 off, Q_2 on
1	1	0	Q_1 on, Q_2 on

??

Applications



A	B	Y	Status
0	0	1	Q_1 off, Q_2 off
1	0	1	Q_1 on, Q_2 off
0	1	1	Q_1 off, Q_2 on
1	1	0	Q_1 on, Q_2 on

??

Applications = Temperature Control