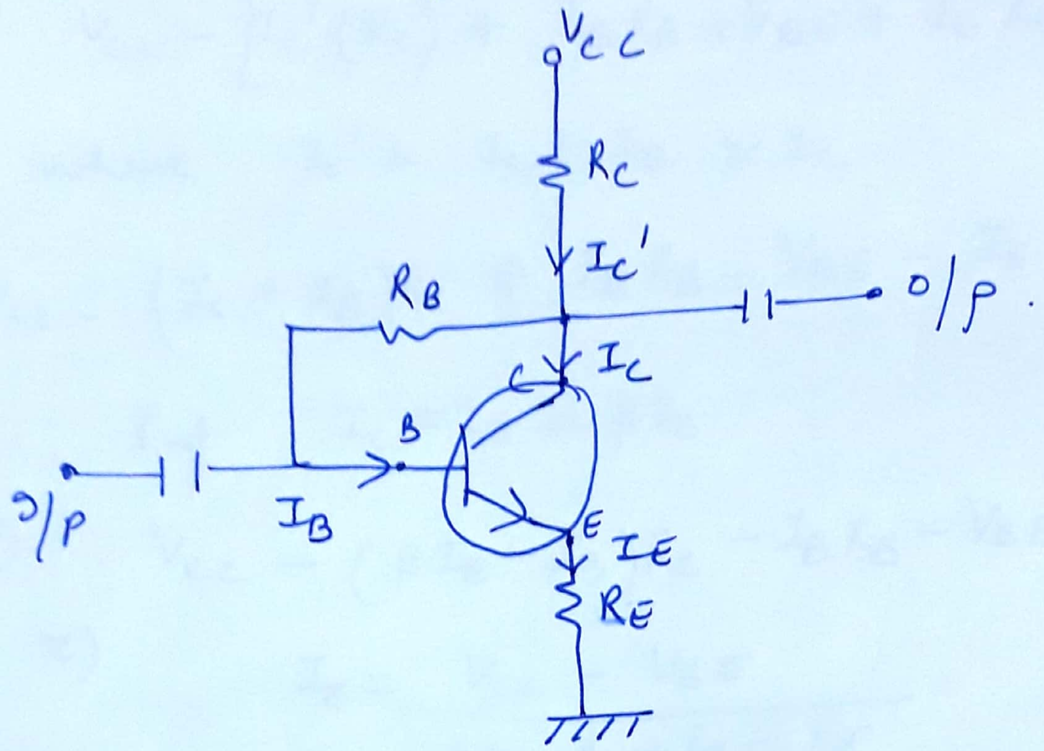
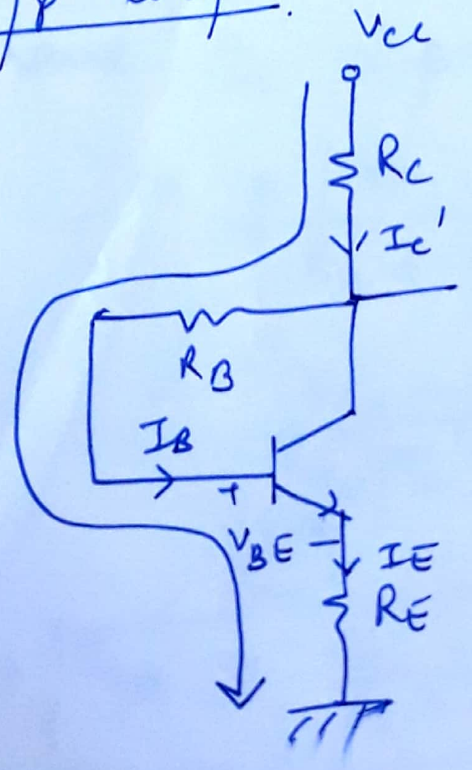
Collector feedback Configuration



To find operating points

① i/p loop.



Applying KVL.

$$V_{CC} - \left[I_C'(R_C) + I_B R_B + V_{BE} + I_E R_E\right] = 0.$$

where $I_C' = I_C + I_B \approx I_C$.

$$V_{CC} - (I_C + I_B)R_C \ \underline{\oplus}\ I_B R_B - V_{BE} - I_E R_E = 0.$$

Put $I_C \simeq I_E = \beta I_B$.

$$\Rightarrow \quad V_{CC} - (\beta I_B + I_B)R_C - I_B R_B - V_{BE} - \beta I_B R_E = 0$$

$$\Rightarrow \quad I_B = \frac{V_{CC} - V_{BE}}{(\beta+1)R_C + R_B + \beta R_E}$$

take $\beta + 1 \approx \beta$.

$$\Rightarrow \quad I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta(R_C + R_E)}.$$

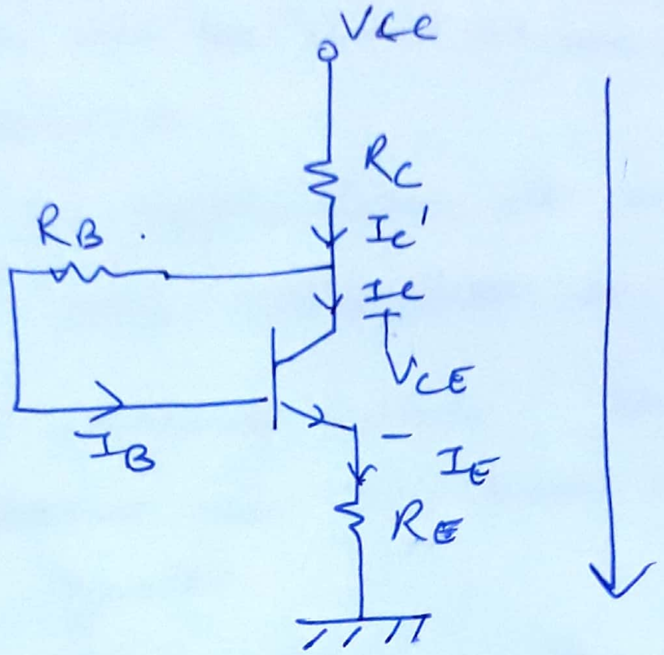
we have $I_C = \beta I_B$.

$$= \frac{\beta(V_{CC} - V_{BE})}{R_B + \beta(R_C + R_E)}.$$

$$= \frac{V_{CC} - V_{BE}}{\cancel{\frac{R_B}{\beta}}^{\to 0} + (R_C + R_E)}$$

$$\Rightarrow \quad \boxed{I_{CQ} \approx \frac{V_{CC} - V_{BE}}{R_C + R_E}}$$ (Independent of β).

(2) Output loop



Applying KVL.

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

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

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

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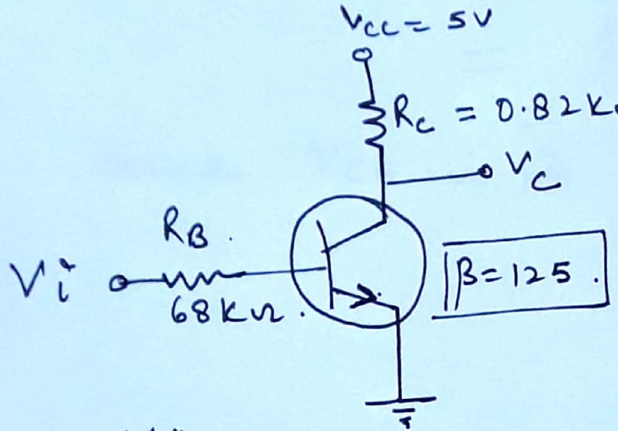
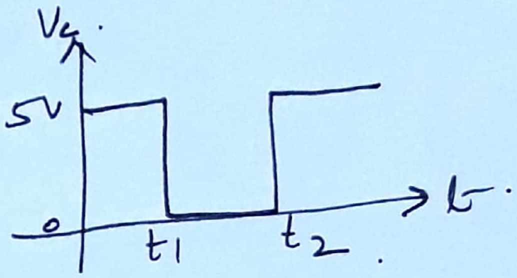
Transistor as a switch

Transistor can be used as an amplifier as well as a switch.

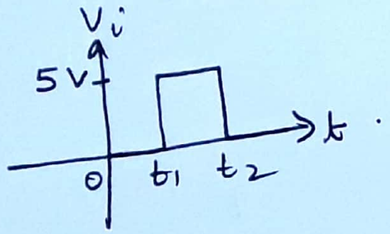
For switching application, it is biased to operate in the saturation or cutoff regions.

Note :- for making switch., the d.c. supply is absent from the base circuit.





where V_i is



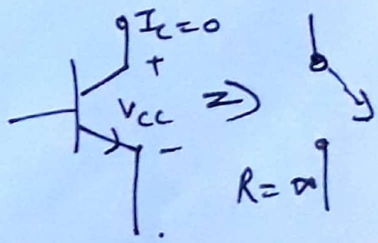
Working 1. (Transistor as an 'open' switch)

For $(0 \text{ to } t_1)$ $V_i \to 0 \Rightarrow I_B = 0$ and hence $I_C = 0$.

(BE junction is reverse bias)

(The transistor works in cutoff region as both junctions are reverse bias)

Q points $\rightarrow$ $\boxed{\begin{array}{l} I_C = 0 \\ V_{CE} = V_{CC} \end{array}}$

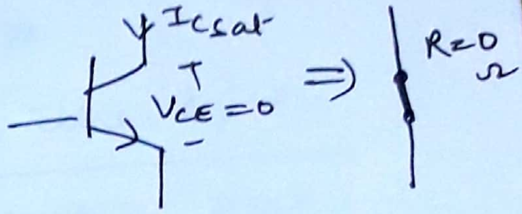


2) Transistor act as a closed switch.

when $V_{in} = 5V$ (from t_1 to t_2).

The transistor works in saturation region as both the junctions will be forward biased.

In saturation condition we take $V_{CE} \simeq 0V$.



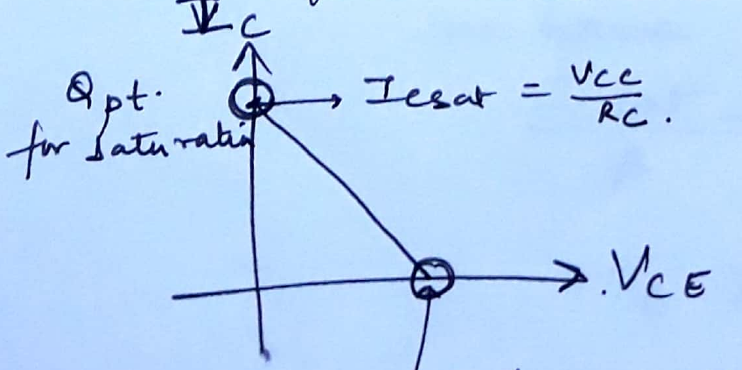
$$\Rightarrow \quad I_C = \frac{V_{CC}}{R_C}.$$

$\downarrow$

I_{Csat} so. $\boxed{I_{Csat} = \frac{V_{CC}}{R_C}}$

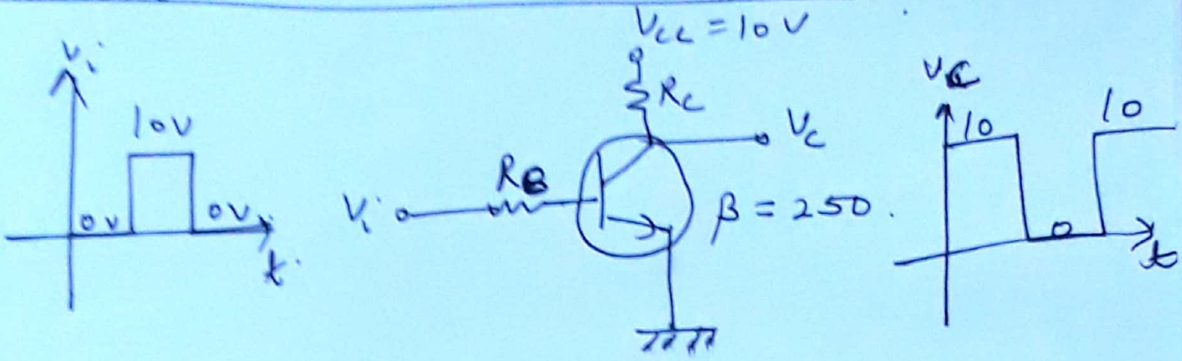
For successful implementation of the transistor in saturation, make sure that $\boxed{I_B > \frac{I_{Csat}}{\beta}.}$

or $\boxed{I_{B\,max} \simeq \frac{I_{Csat}}{\beta}.}$ (in active)



$$\boxed{V_{CE\,cutoff} = V_{CC}}$$

Numerical for Transistor as a switch.



determine R_B and R_C for the N/w.

if $\boxed{I_{csat} = 10\,mA}$

Sol^n^ we have $\boxed{I_{csat} = \frac{V_{CC}}{R_C}}$

$$\Rightarrow \quad 10 = \frac{10}{R_C}$$

$$\Rightarrow \quad \boxed{R_C = 1\,k\Omega}.$$

for saturation

$$\boxed{I_B > \frac{I_{csat}}{\beta}.}$$

we have

$$\frac{I_{csat}}{\beta} = \frac{10}{250} \quad .04\,mA.$$

$$\Rightarrow \quad I_B > .04\,mA$$

or. $$\frac{V_{in} - 0.7}{R_B} > 0.04\,mA$$

$$\Rightarrow \quad \boxed{R_B < \frac{10 - 0.7}{.04} = 232.5\,k\Omega}.$$