16.02.2022

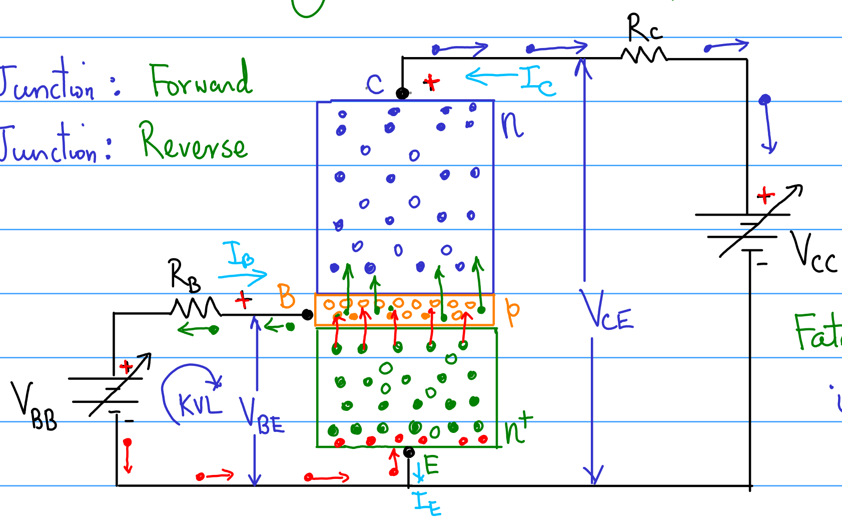
Reference: Chapter 6
Malvino & Bates

Current-Voltage Characteristics of the Biased BJTs

Emitter-Base Junction : Forward
Collector-Base Junction : Reverse

$$V_{BB} = V_{R_B} + V_{BE}$$

$$V_{BB} = I_B R_B + V_{BE}$$



$$I_E = I_B + I_C$$

$I_B \sim \mu A$

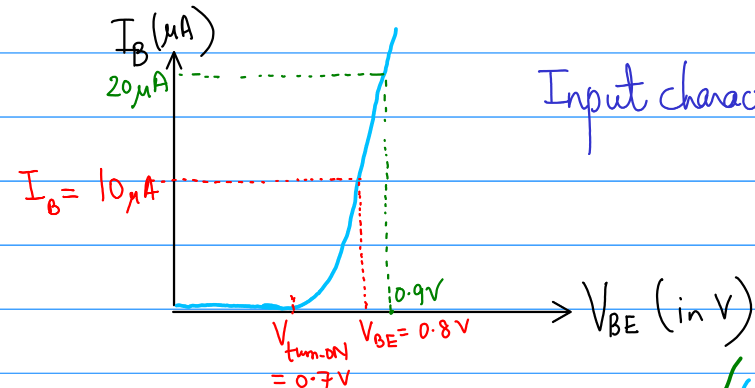
$I_E, I_C \sim mA$

Fate of the electrons entering into the Base region from emitter

i) The electrons have chances to recombine with holes in the base

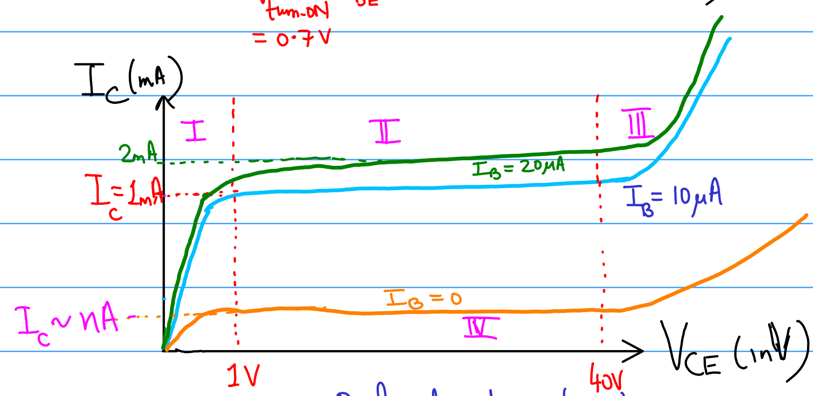
ii) The electrons may come out from the base terminal & constitute a base current I_B.

iii) Since the collector-base junction is reverse, the electrons can be collected by the collector.



Input characteristics

$\beta_{dc} = 100$



Output characteristics

I : Saturation Region
II : Active Region (Normal)
III : Break down Region
IV : Cut-off Region

$$I_C = \beta_{DC} I_B$$

Region II is the most useful region of operation. It is also called linear region of operation of the BJTs. If the BJT is biased in this region, then the collector current follows the base-current. That is, any change happening in the base ckt, will directly appear across the collector ckt.

Region I & IV are the saturation & Cut-off regions of operation of the BJTs, respectively.

In region I : The BJT is in 'ON' state.

In region IV : The BJT is in "OFF" state

Electronic Switch

Whenever, you switch from region-I to IV or vice-versa, the BJT is switching from ON-state to OFF-state.

⇒ BJT is Operating as an "Electronic - Switch".

Note : In region-III (Breakdown region) ; the BJT burns out. ie, it never return back to normal operation.

Input Terminal :

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

Also, if current gain of the BJT is given, ie, β_{DC}

- $I_C = \beta_{DC} \cdot I_B$

Output Terminal :

$$V_{CC} = I_C R_C + V_{CE}$$

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

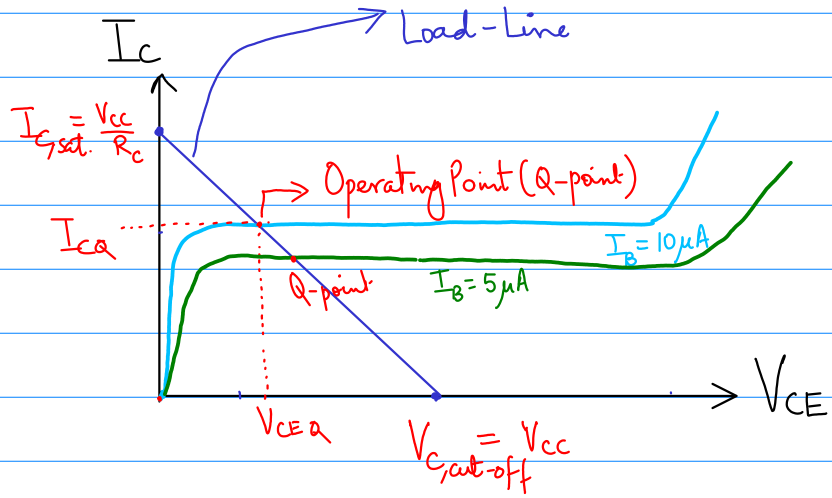
Also,

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

$$\boxed{I_C = \left(-\frac{1}{R_C}\right) V_{CE} + \frac{V_{CC}}{R_C}}$$

$Y = (m) X + C$

$\Rightarrow$ st. line eq^n



for $V_{CE} = 0$; $I_C = \frac{V_{CC}}{R_C}$

for $I_C = 0$