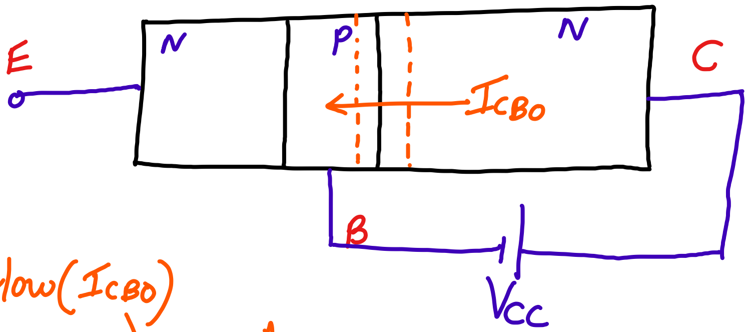
AEC lec 5 28/7/23

* Leakage currents in BJT:

- If we set $I_E = 0$ (emitter open)
- Transistor → cut-off mode
- B-C J^n is still R.B

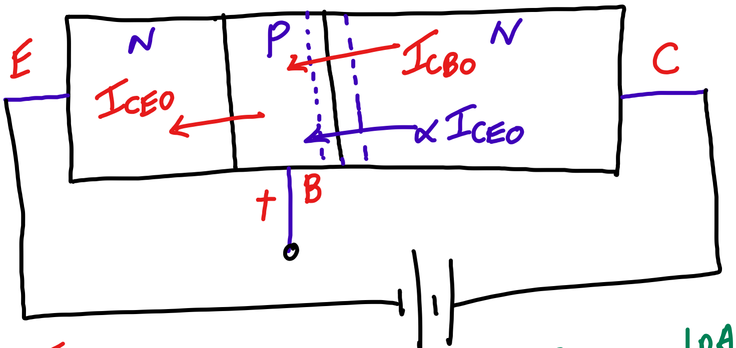


→ R.B leakage current will flow (I_{CBO}) nA

→ I_{CBO} : Collector leakage current in CB configuration
↳ when emitter is open

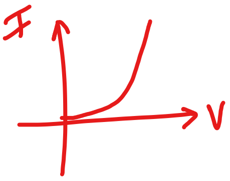
$I_{CEO} = 10nA$ $\quad \alpha I_{CEO} = 9nA$ $\quad \alpha = 0.9$

$\boxed{I_C = \alpha I_E}$



- I_{CEO} → leakage current betn E & C with Base open ($I_B = 0$)

I_{CBO} → R.B BC pn J^n
↓
cause base potential to rise
↓
F.B B-E J^n & induces B-E current 'I_{CEO}'



$$\overset{10nA}{I_{CEO}} = \overset{9nA}{\alpha I_{CEO}} + \overset{1nA}{I_{CBO}}$$

$$I_{CEO}(1-\alpha) = I_{CBO}$$

$$* \quad \boxed{\underbrace{I_{CEO}}_{nA} = \frac{I_{CBO}}{1-\alpha}} \quad \Big| \; I_B = 0\mu A$$

αI_{CEO} — collector current resulting from emitter current I_{CEO}

→ $I_C = \alpha I_E + I_{CBO}$ $\qquad I_E = I_C + I_B$

$$I_C = \alpha(I_C + I_B) + I_{CBO}$$

$$I_C(1-\alpha) = \alpha I_B + I_{CBO}$$

$$I_C = \left(\frac{\alpha}{1-\alpha}\right) I_B + \left(\frac{1}{1-\alpha}\right) I_{CBO}$$

i.e. $\boxed{I_C = \beta I_B + (1+\beta) I_{CBO}}$

$$\beta = \frac{\alpha}{1-\alpha}$$

$$1+\beta = 1 + \frac{\alpha}{1-\alpha} = \frac{1-\alpha+\alpha}{1-\alpha}$$

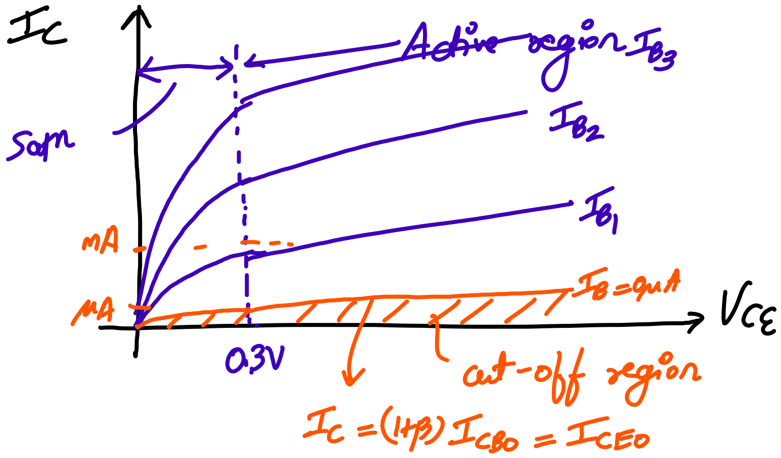
$$1+\beta = \frac{1}{1-\alpha}$$

if $I_B = 0$, $I_C = \underbrace{(1+\beta)}_{99} \overset{1\mu A}{I_{CBO}}$

$I_C = 100\mu A$

$$I_{CEO} = \frac{I_{CBO}}{1-\alpha} = 1+\beta(I_{CBO})$$

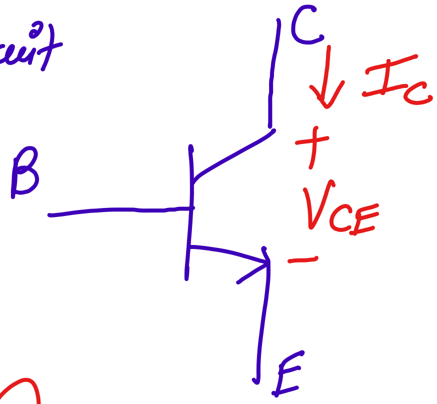
$$\boxed{I_C = \beta I_B + I_{CEO}}$$



* Transistor Biasing (BJT):

→ establishing & maintaining proper Collector to emitter voltage 'V_{CE}' and collector current 'I_C' in the circuit

"Transistor biasing"



I_C and V_{CE} can change due to
1. Variatn in temperature
2. — " — gain
3. — " — leakage current
4. — " — supply voltage

✗ I_C & V_{CE} should not change

Need of Biasing:

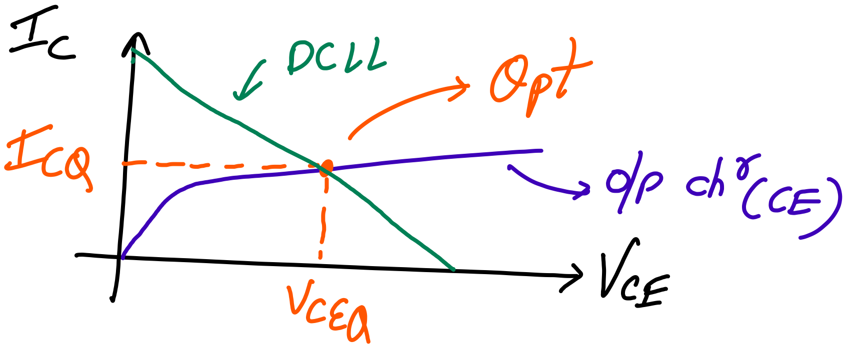
(1) I_C (2) V_{BE} (3) V_{CE} (4) Eliminates addition dc supply

→ Value of I_C & V_{CE} is expressed in terms of Operation Point (Q pt)

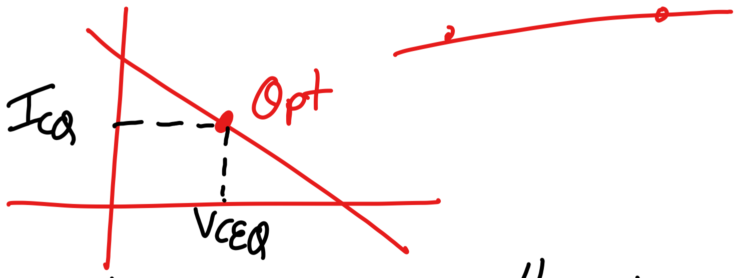
$$Q\,pt \equiv (V_{CEQ}, I_{CQ})$$

→ For faithful amplificatn: Q pt must be selected properly

"DC load line"
(DC LL)



* Need of Stabilization:



The rate of change of collector current w.r.t collector leakage current "I_{CO}" at constant β & V_{BE} is called "Stability factor" (S)

$$\boxed{S_{I_{CO}} = \frac{\partial I_C}{\partial I_{CO}} \Bigg|_{\beta,\, V_{BE}\ \text{constant}}}$$

3 methods to bias the BJT "Three Biasing ckts"

1. Fixed bias
2. Collector to base bias
3. Voltage divider bias

$$I_C = \beta I_B + I_{CO}(1+\beta) \quad \text{—} \ (1)$$

Differentiate eq^n (1) w.r.t I_C,

$$\frac{\partial I_C}{\partial I_C} = \beta \frac{\partial I_B}{\partial I_C} + (1+\beta)\frac{\partial I_{CO}}{\partial I_C}$$

$$S = \frac{\partial I_C}{\partial I_{CO}}$$

$$1 - \beta \cdot \frac{\partial I_B}{\partial I_C} = (1+\beta)\frac{1}{S}$$

$$\boxed{S_{I_{CO}} = \frac{(1+\beta)}{1-\beta\left(\frac{\partial I_B}{\partial I_C}\right)}} \text{ or } S' \rightarrow \text{Stability factor}$$

$\boxed{\text{30, 40, 72, 78, 67, 16, 6, 58}}$

→ Attendance AEC lec 5 (28/7/23)