8. CE Configuration

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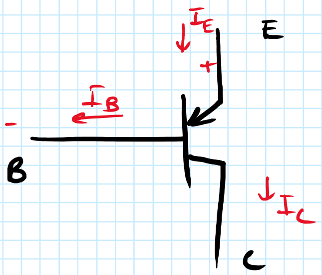
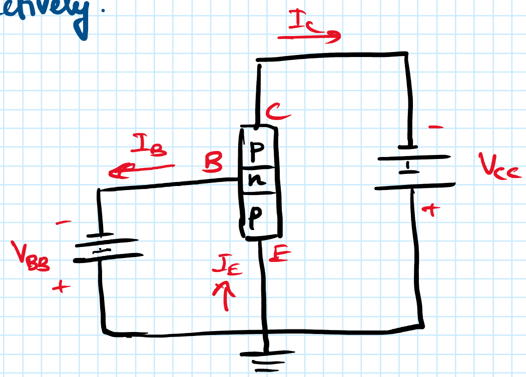
Common Emitter Configuration

- Arrow indicates direction of I_E
- The NPN BJT requires two voltage sources V_{BE} or V_{BB}, and V_{CE} or V_{cc} to bias the two junctions respectively.

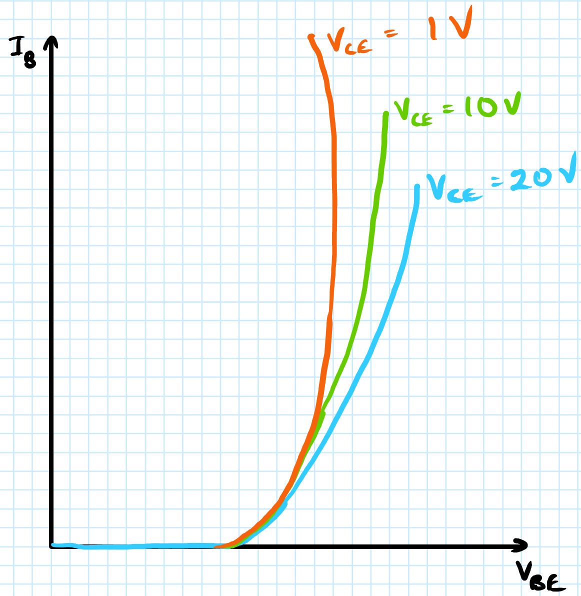




check diagrams

- For device to operate in active region:
  - one diode ⟶ forward bias
  - other ⟶ reverse

CE Configuration - Input Characteristics



As output voltage V_{CE} increases, current I_B decreases.

Hence graph shifts to the right.

BWM

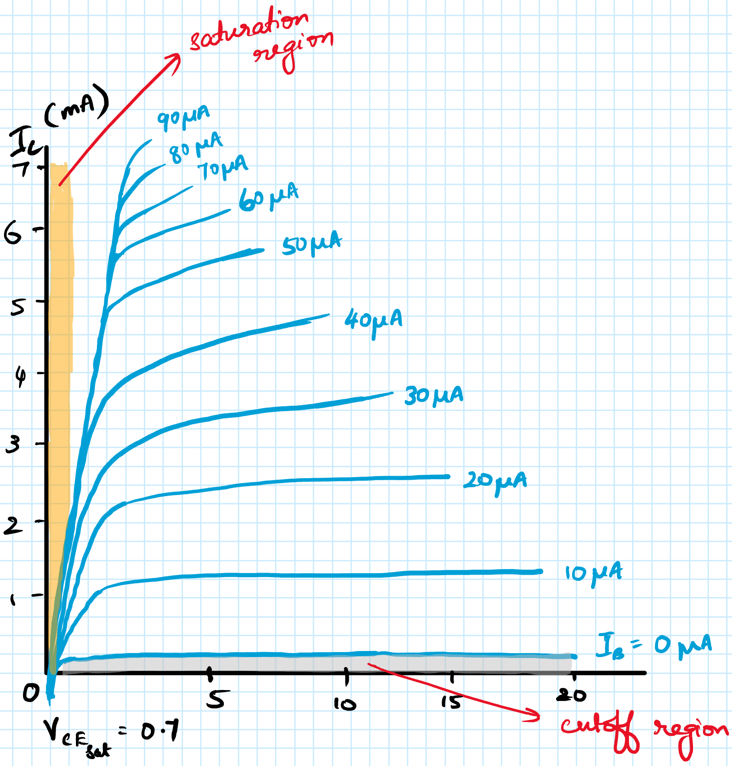
narrower base width

(less chance of recombination)

$V_{CE} > V_{BE}$

- In CB config,
  - $I_B \rightarrow$ input current (μA)
  - $V_{BE} \rightarrow$ input voltage
- Plot of I_B v/s V_{BE} ⟶ input characteristics
- When the output voltage V_{CE} is increased, this high voltage initiates a decrease in the current I_B through the device. Thus graph shifts to the right.

CE Configuration – Output Characteristics



$\beta \in (50, 500)$

$$\boxed{I_C = \beta I_B}$$

Output impedance? $= \dfrac{V_{CE}}{I_C} = \dfrac{10-5}{(3.4-3.1)\,m}$

$= 16.66\,k\Omega$

This is less compared to infinity?

Common Emitter – Active Region

$$I_C = \alpha I_E + I_{CBO}$$

$$= \alpha(I_C + I_B) + I_{CBO} \qquad [\because I_E = I_C + I_B]$$

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

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

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

Let $\beta = \dfrac{\alpha}{1-\alpha}$; $\Rightarrow \dfrac{1}{1-\alpha} = 1+\beta$

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

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

$[\because I_{CEO} = (1+\beta) I_{CBO}$

$I_{CEO} \approx \beta I_{CBO}$

or

$I_{CEO} = \left.\dfrac{I_{CBO}}{1-\alpha}\right|_{I_B = 0\mu A}$

$\boxed{I_C = \beta I_B}$ Neglecting leakage current I_{CEO}

$\boxed{50 \leq \beta \leq 500}$

Q. $I_{CBO} = 50\mu A$ and $\beta = 99$, find α and I_{CEO}

Soln $\beta = \dfrac{\alpha}{1-\alpha}$ | $I_{CEO} = \dfrac{I_{CBO}}{1-\alpha}$

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

$$99 - 99\alpha = \alpha$$

$$100\alpha = 99$$

$$\alpha = 0.99$$

$$I_{CEO} = \frac{I_{CBO}}{1-\alpha}$$

$$= \frac{50 \times 10^{-6}}{10^{-2}}$$

$$= 50 \times 10^{-4}\ A$$

Q. Find β if

(i) $\alpha = 0.9$ (iii) $\alpha = 0.99$

(ii) $\alpha = 0.98$

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

(i) $\beta = \frac{0.9}{0.1} = 9$

9 is outside the range $\Longrightarrow$ distorted output
DO NOT change the value you get

(ii) $\beta = \frac{0.98}{0.02} = 49$

(iii) $\beta = \frac{0.99}{0.01} = 99$