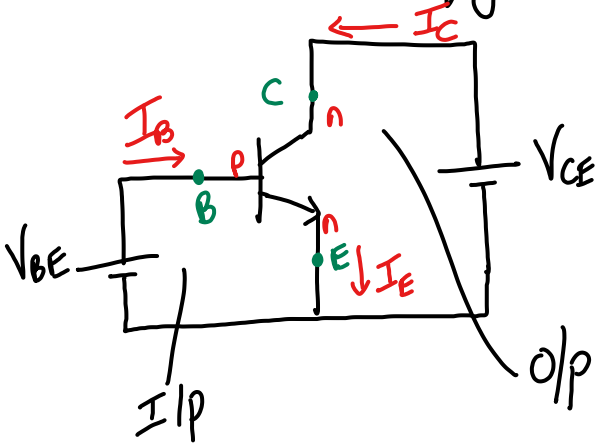
# EEEE BJT CE configuration

12/11/23

- most famous configuration for BJT as amplifier



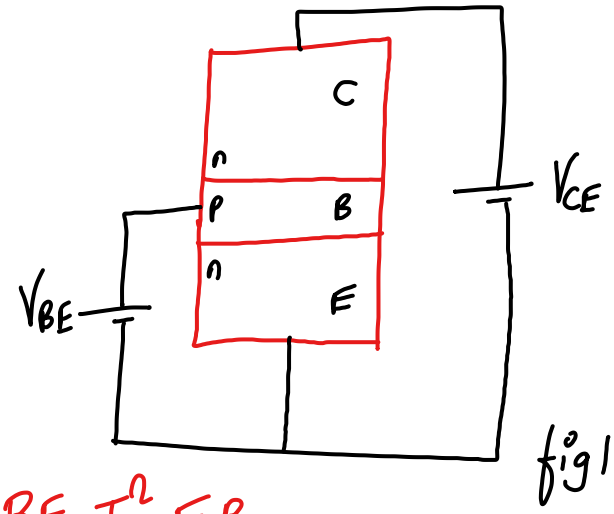
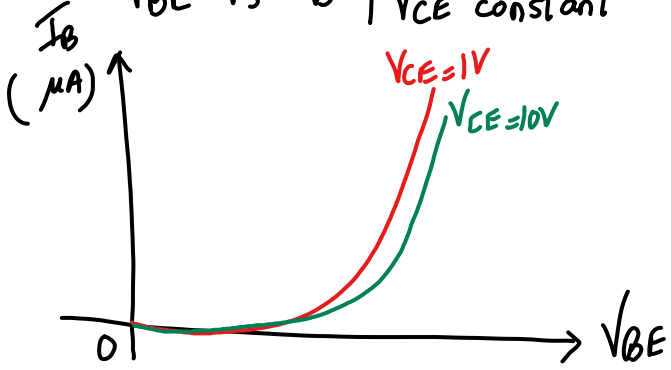




fig 1

npn BJT in active region → BE J^n F.B, BC J^n R.B

① Input characteristics:

$V_{BE}$ Vs $I_B$ | $V_{CE}$ constant




② I/p characteristics is similar to PN J^n characteristics since BE J^n is forward-biased

i.e As $V_{BE}$ ↑, $I_B$ ↑ exponentially for constant $V_{CE}$ value (i.e BC J^n is R.B)

③ As $V_{CE}$ ↑ → $I_B$ is reducing? why?

a) $V_{CE} = V_{CB} + V_{BE}$ ..... ($V_{CB} = V_{CE} - V_{BE}$)

∴ with $V_{BE}$ constant, if $V_{CE}$ ↑ → $V_{CB}$ ↑ (↳ emitter is common terminal)

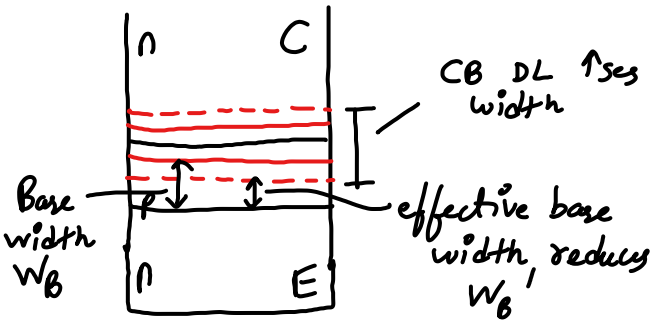
b) As $V_{CB}$ ↑, CB J^n is more R.B

↓

c) i.e CB depletion region width ↑ses

↓

i.e effective base width reduces from $W_B$ to $W_B'$




↓

d) i.e possibility of e⁻-holes recombination in base region will reduce

↓

e) i.e Most of e⁻s travelling from emitter to base gets collected at collector.

i.e $I_B$ reduces

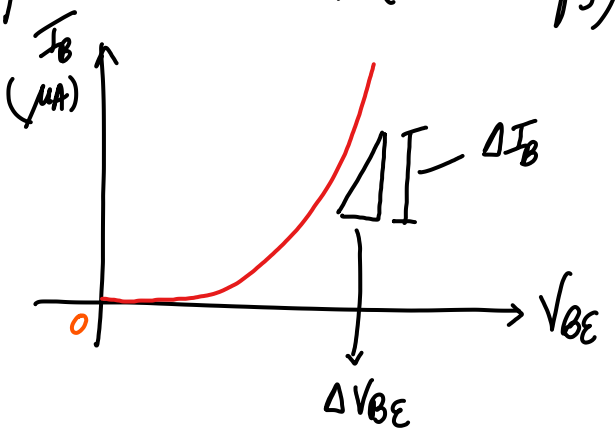
∴ As $V_{CE}$ ↑ses → $I_B$ ↓ses i.e curve shifts Left hand side

④ Input resistance from input characteristics (CE config)

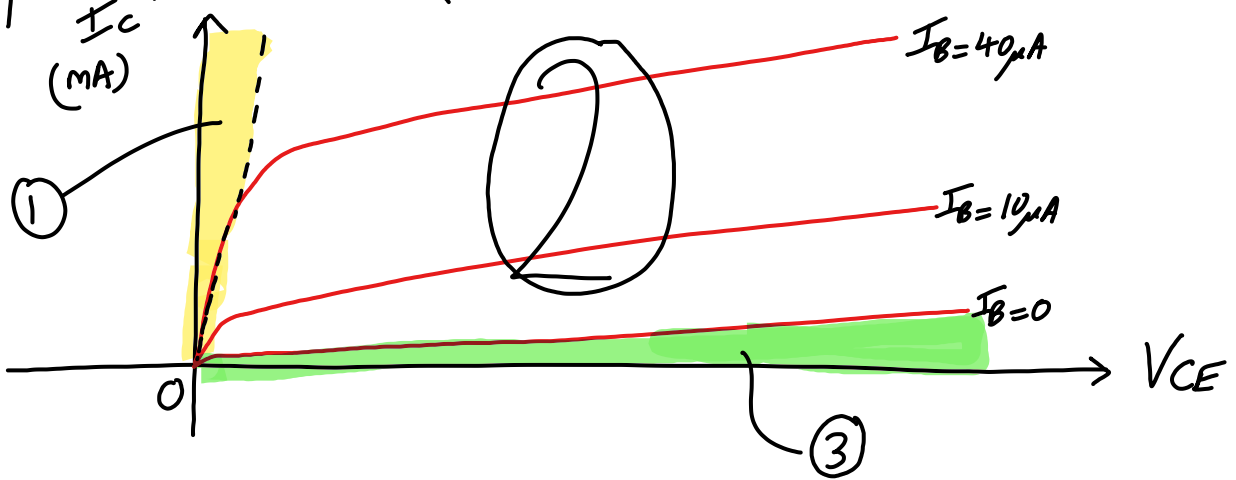
($R_{in}$)

$$R_{in} = \left.\frac{\Delta V_{BE}}{\Delta I_B}\right|_{V_{CE}\ \text{constant}}$$

→ large value (in KΩ)




⑤ Output characteristics ( $V_{CE}$ Vs $I_C$ at constant $I_B$ value)



Region 1 – Saturation

Region 2 – Active

Region 3 – Cut-off

⑥ In active region → As $I_B$ ↑ses → $I_C$ ↑ses ($I_C = \beta I_B$)

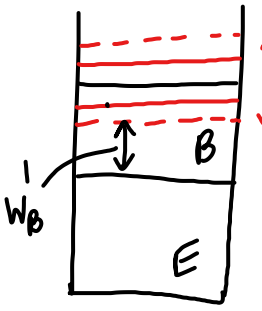
→ As $V_{CE}$ ↑ses → $I_C$ also ↑ses slightly

a) Since $V_{CE} = V_{CB} + V_{BE}$

↓

b) $V_{BE}$ being constant ($I_B$ constant) → As $V_{CE}$ ↑ → $V_{CB}$ ↑ses

↓




c) As $V_{CB}$ ↑ses, CB depletion layer width ↑ses

↓

d) ∴ Effective base width will reduce ($W_B'$)

↓

e) i.e $I_B$ contribution will reduce (as less of electron's will recombine with holes in base region)

↓

f) i.e most of e⁻s travelling via base will be collected by collector

i.e $I_C$ ↑ses

∴ As $V_{CE}$ ↑ses → $I_C$ ↑ses with it

(BJT is used as an amplifier in active region of bjt)

⑦ Since, $I_B$ – I/p current , $I_C = \beta I_B$ — o/p current

$$\beta_{dc} = \frac{I_C}{I_B}$$

"DC"
CE current gain

$\beta_{dc}$ almost same as $\beta_{AC}$

$$\beta_{AC} = \frac{\Delta I_C}{\Delta I_B}$$

⑧ In saturation region, as the value of $V_{CE}$ reduces

a) $V_{CE} = V_{CB} + V_{BE}$ — $V_{BE}$: constant

i.e As $V_{CE} \downarrow \rightarrow V_{CB} \downarrow$ sig

b) CB becomes lesser R.B & finally at very low value of $V_{CE}$ → CB J$^n$ becomes F.B

c) BE J$^n$ is already F.B

d) As CB J$^n$ becomes F.B → $e^-$ will not reach collector & ∴ $I_C$ reduces to zero as $V_{CE}$ is reduced to lower value

e) ie BJT operates in saturation region

⑨ npn bjt operates in cut-off region when $I_B = 0$ but here $I_C \neq 0$ ?

a) When $I_E = 0 \rightarrow$ leakage current $I_C = I_{CBO}$

i.e $I_C = \alpha I_E + I_{CBO}$ — (1)

but $I_E = I_C + I_B$

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

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

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

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

In cut-off region $\rightarrow I_B = 0$

$\therefore I_C \approx \left(\frac{1}{1-\alpha}\right) I_{CBO}$

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

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

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

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

value of leakage current at $I_B = 0$

called as "$I_{CEO}$" → Collector to emitter leakage current with base open

ie $\boxed{I_{CEO} = (1+\beta) I_{CBO}}$

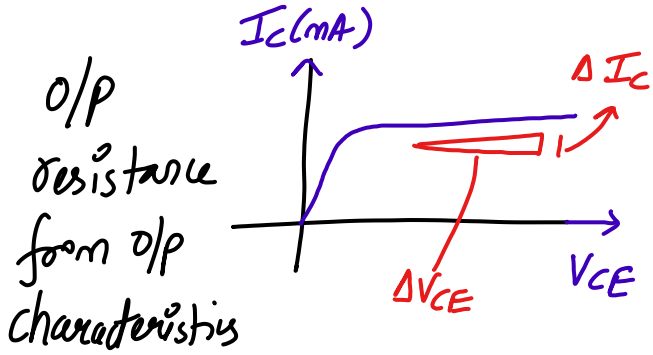
(10) Properties of CE configurations:

a) Moderate current gain

b) Moderate voltage gain

c) Moderate $R_{in}$ & $R_{out}$

d) High power gain




o/p resistance from o/p characteristics

$$R_{out} = \left.\frac{\Delta V_{CE}}{\Delta I_C}\right|_{I_B \text{ constant}}$$

large value (in KΩ)

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