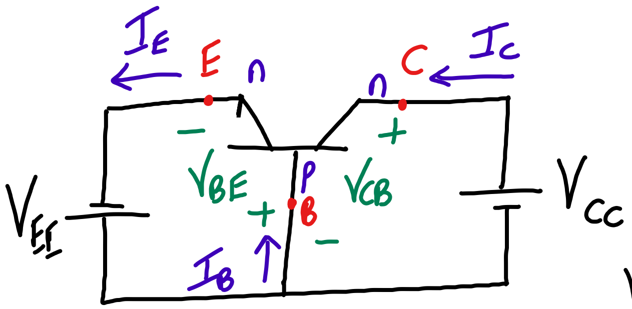
EEEE BJT CB configuration 12/1/23



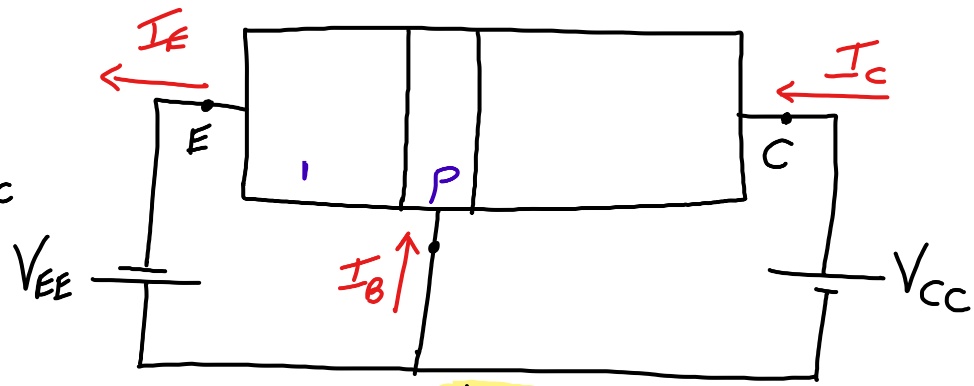


fig 1

① In common base (CB) configuration, inp t is applied between 'B' and 'E' and output is taken between 'C' and 'B'

② For BJT to be used as an amplifier ⟶ npn bjt should be operated in active region

i.e B-E junction → forward bias
and B-C junction → reverse bias

③ Terminal current in bjt,

$$\boxed{I_E = I_C + I_B}$$

④ Behavior of bjt in CB mode can be described by two characteristics :

a) Input characteristics

b) Output characteristics

⑤ I_E : input current

V_{BE} : input voltage

Input characteristics:

V_{BE} Vs I_E at fixed V_{CB}

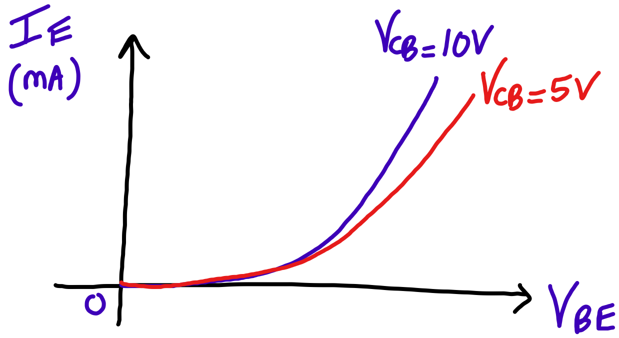


fig2: I/P characteristics in npn bjt in CB mode

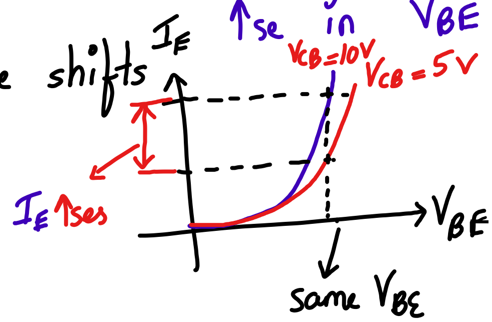
⑥ Fig 2 shows input characteristics of npn bjt in CB mode → it is similar to forward characteristics in PN junction diode

(Since BE junction is made of PN junction) (fig 1)

⑦ As V_{BE} ↑ses → it will F.B B.E junction more → more carriers e's will reach collector (as V_{CB} is fixed) and I_E ↑ses exponentially with ↑se in V_{BE}

(CB J^n is reverse-biased)

○ From fig 2, as V_{CB} ↑ses → curve shifts to L.H.S & I_E ↑ses slightly



Reason:

a) As CB junction gets more R.B

↓

b) Width of CB depletion region will ↑se

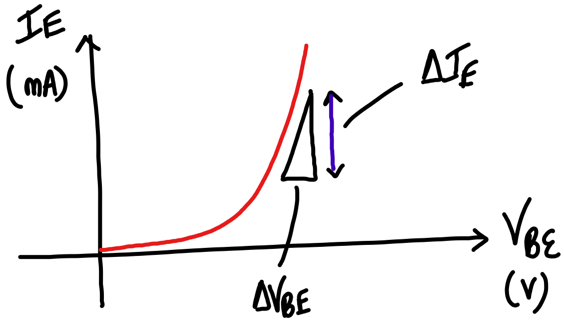
↓

c) So, less voltage is required to F.B BE junction

↓

Thus, curve shifts to L.H.S ie for same V_{BE} → V_{CB} ↑ses from 5V to 10V current I_E ↑ses slightly

9 From input characteristics, we can find the input impedance of the device

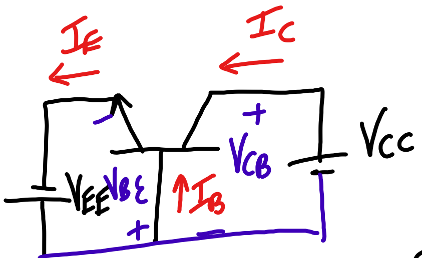


$$R_{in} = \frac{\Delta V_{BE}}{\Delta I_E}\Bigg|_{V_{CB}\ \text{constant}}$$

small chan

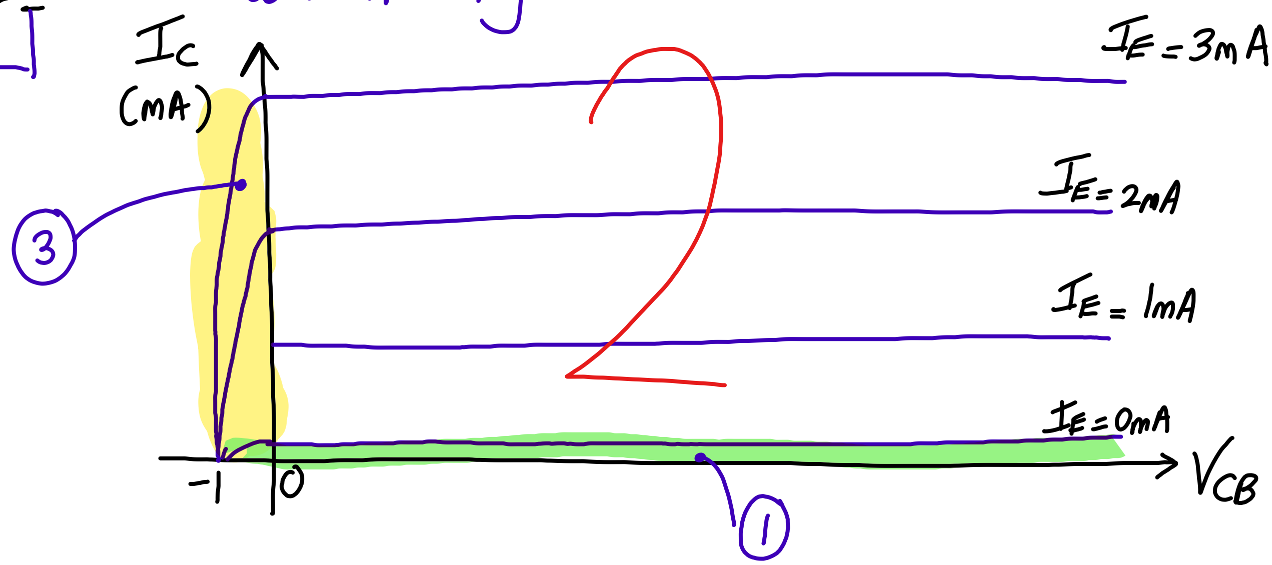
huge changes

Thus, R_{in} is very low (in ohms) for npn BJT in CB configuration



I_C : o/p current

V_{CB} . o/p voltage



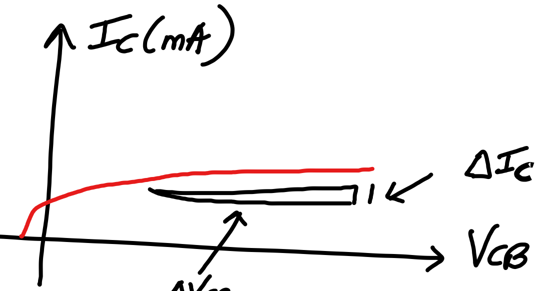
Region 1 : Cut-off

Region 2 : Active

Region 3 : Saturation

fig 3 : Output characteristics of npn bjt in CB configuration

$$V_{CB}\ \text{Vs}\ I_C \Big|_{I_E\ \text{constant}}$$



o/p resistance

$$R_{out} = \frac{\Delta V_{CB}}{\Delta I_C}\Bigg|_{I_E\ \text{constant}}$$

v. high for CB configuration

a) In active region → I_C is constant due to constant V_{BE}

↓

even if V_{CB} ↑ses → $I_C = \alpha I_E$ remains almost constant

↓

CB J^n becomes more R.B

$I_C = \alpha I_E$

o/p current

I/p current

npn bjt behaves like a constant current source

(Due to this, this region is used amplification purposes)

$\alpha = \frac{I_C}{I_E}$

→ current gain in CB mode

b) In cut-off region → $I_E = 0mA$ → As V_{CB} ↑ses, I_C remain almost at 0mA

→ as $V_{EE} = 0V$ → $I_E = 0$, $I_C \approx 0$

→ But I_C will exist due to minority charge carriers (as CB J is R.B) only (I_{CBO})

$I_C = \alpha \overset{\nearrow 0}{I_E} + I_{CBO}$

↳ leakage current

→ reverse saturation current with emitter open

$\boxed{\text{i.e } I_C \approx I_{CBO}}$

c) In saturation region → as we reduce value of V_{CB} (i.e less R.B)

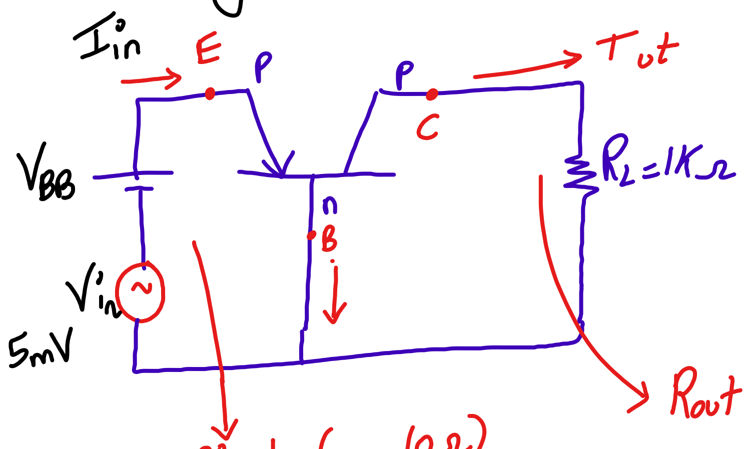
↓

I_C starts reducing

(Since as R.B is ↓ → e^- which have entered into B from E will removed bet^n C & B will not be able to cross collector → ∴ I_C reduces)

i.e here BE J^n & BC J^n → both are F.B → saturation region

(10) How signal is getting amplified in CB configuration



v.high

$R_{in} \propto$ low (say 10Ω)

$I_{in} = \frac{mV}{10} = 0.5mA$

$\alpha = 1$ $\quad (I_C = \alpha I_E$, $I_C \approx I_E)$

$I_{out} = I_{in} = \underline{0.5mA}$

$V_{out} = I_{out} R_L$

$= 0.5m \times 1K\Omega$

$V_{out} = 0.5V - 500mV$

$$A_v = \frac{V_{out}}{V_{in}} = \frac{50\ mV}{5mV} = 100$$

i.e Input sign got amplified by facto of 100 (Typ: 50-300)

→ Current gain $I_C \approx I_E$

$$\boxed{\alpha \approx \frac{I_C}{I_E} \approx 1}$$

——x——