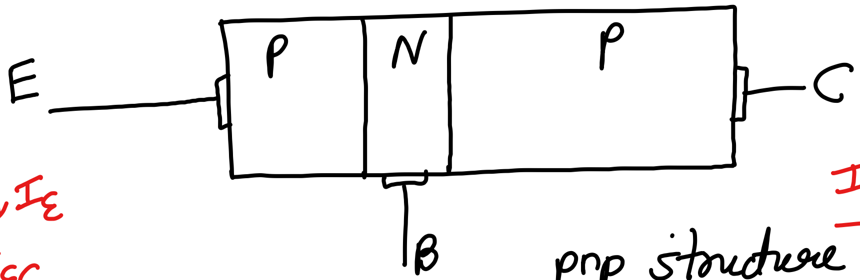
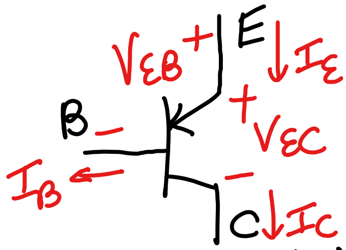
AEC lec 9 4/8/23

PNP transistor:



pnp structure



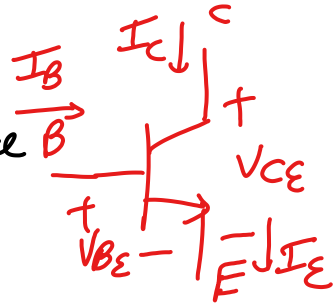
pnp symbol

$V_{EB} = 0.7V$

$$i_C = I_S \exp\left(\frac{V_{EB}}{V_T}\right)$$

$$i_E = \frac{i_C}{\alpha} = \frac{I_S}{\alpha} \exp\left(\frac{V_{EB}}{V_T}\right)$$

$$i_B = \frac{i_C}{\beta} = \frac{I_S}{\beta} \exp\left(\frac{V_{EB}}{V_T}\right)$$



$V_{BE} = 0.7V$

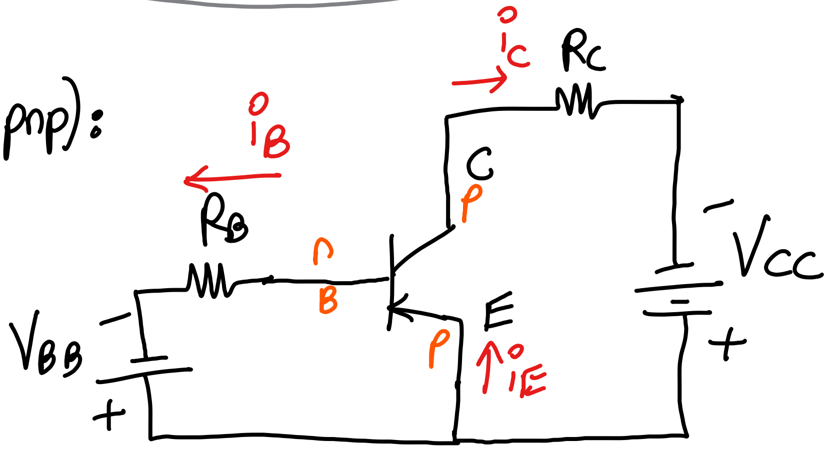
$i_C = \alpha i_E$

$i_C = \left(\frac{\beta}{1+\beta}\right) i_E$

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

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

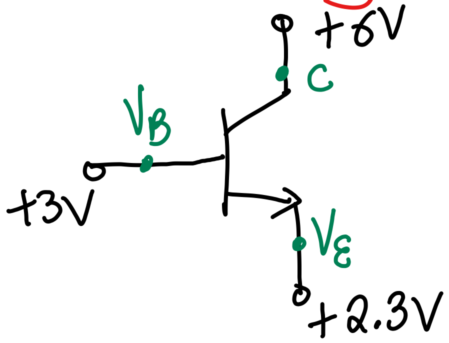
Common-emitter ckt (pnp):



"5m"

Mini Numerical 1:- Identify region of operation of given device

(i)



$V_C = 6V$, $V_B = 3$, $V_E = 2.3V$

$V_{BE} = V_B - V_E = 0.7V$

↳ B-E J^n is F.B

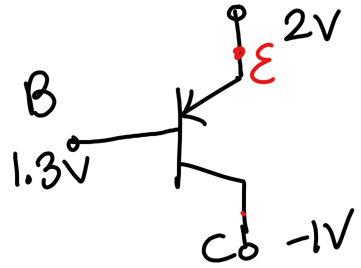
$V_{BC} = V_B - V_C = 3 - 6V$

$V_{BC} = -3V$

↳ B-C J^n is R.B

→ Since B-E J^n is F.B
& B-C J^n is R.B
Given npn bjt is in forward-Active mode

(2)



pnp bjt is in Active region

$V_C = -1V$, $V_B = 1.3V$, $V_E = 2V$

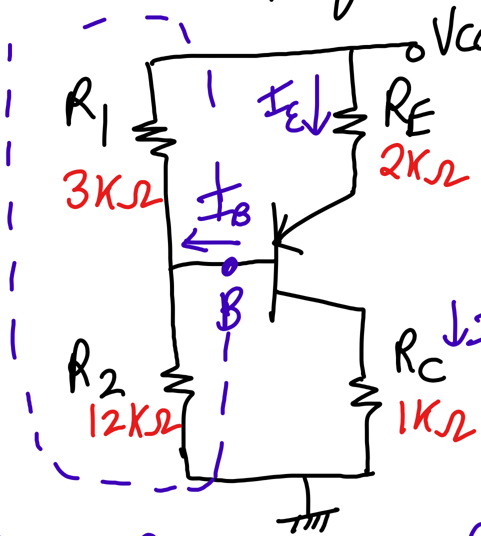
$V_{EB} = V_E - V_B = 2 - 1.3 = 0.7V$

$V_{EB} = 0.7V \rightarrow$ BE j^n is F.B

$\rightarrow V_{CB} = V_C - V_B = -1 - 1.3 = -2.3V$

$\hookrightarrow$ CB j^n is R.B

Numerical 10: Find I_{CQ} & V_{ECQ} for ckt shown below

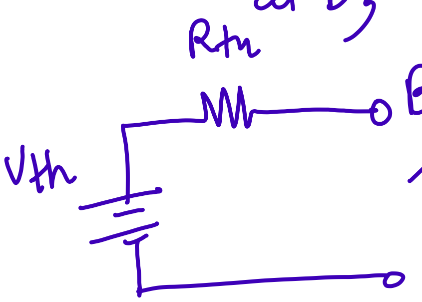


$\beta = 100V$

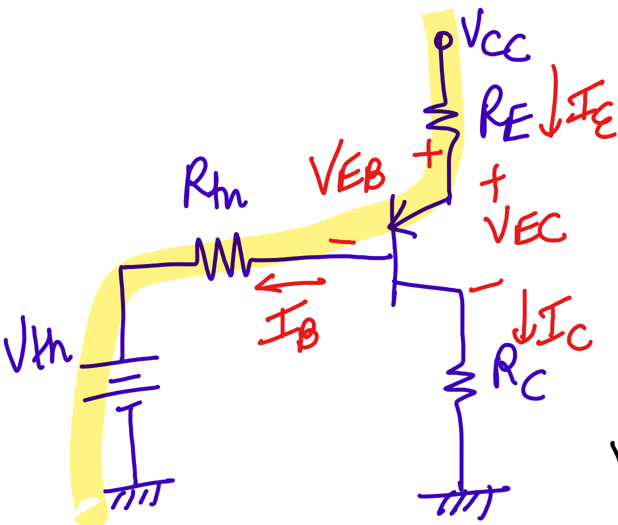
$V_{EB(ON)} = 0.7V$

Sol^n:

1) Apply thevenin's th^m at B,



$$V_{th} = \frac{R_2}{R_1 + R_2} V_{CC} \quad ; \quad R_{th} = R_1 \| R_2$$



$$V_{th} = \left(\frac{12}{12+3}\right) \times 20 = \underline{16V}$$

$$R_{th} = 3k \| 12k = \underline{2.4K\Omega}$$

KVL to I/P (B-E) loop,

$$V_{th} + I_B R_{th} + V_{EB} + I_E R_E - V_{CC} = 0$$

$I_E \rightarrow (1+\beta) I_B$

$$V_{th} + I_B R_{th} + V_{EB} + (1+\beta) I_B R_E - V_{CC} = 0$$

$I_E = I_C + I_B$

$I_E = \beta I_B + I_B$

$I_E = I_B(1+\beta)$

$$I_{BQ} = \frac{V_{CC} - V_{th} - V_{EB}}{R_{th} + (1+\beta) R_E}$$

$$\text{i.e. } I_{BQ} = \frac{20 - 16 - 0.7}{2.4 \times 10^3 + 101 \times 2 \times 10^3}$$

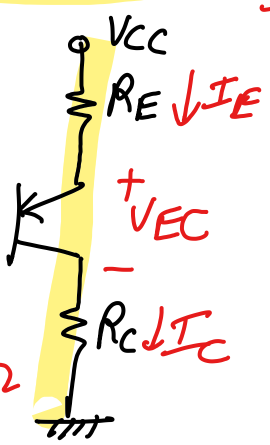
$$I_{BQ} = \underline{16.14} \ \mu A$$

$I_{CQ} = \beta I_{BQ} = 100 \times 16.14\,\mu A = \underline{1.614\,mA}$

$I_E = I_B + I_C$
$= 1.63mA$

KVL to o/p (CE) loop,

$V_{CC} - I_E R_E - V_{EC} - I_C R_C = 0$



$V_{ECQ} = V_{CC} - I_C R_C - I_E R_E$

$V_{ECQ} = 20 - 1.614mA \times 2K\Omega - 1.63mA \times 1K\Omega$

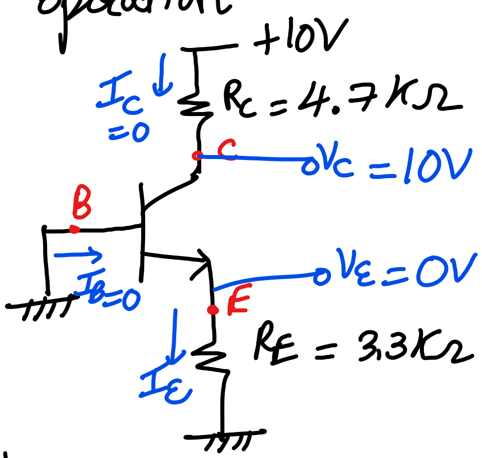
$V_{ECQ} = 15.1V$

Mini Numerical 2:

① Identify region of operation

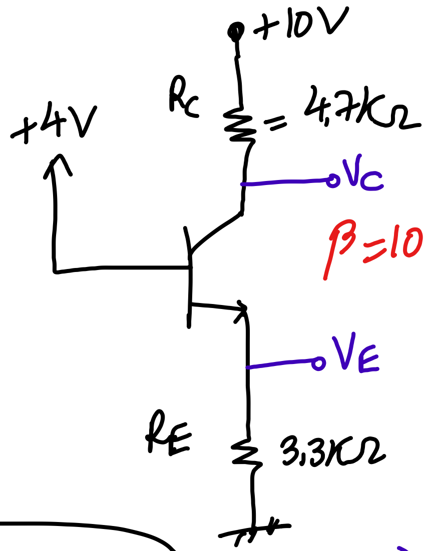
"Cut-off region"

$V_B = 0$



② "H.W"

I_B
I_C
V_{BE}
V_{BC}



$\beta = 100$

$$\boxed{\begin{array}{l} 95, 93, 101, 40, 44, \\ 97, 80, 100, 85, 7, \\ 8, 26, 64, 6, 70, 58 \end{array}}$$

$\alpha = \frac{\beta}{1+\beta} = \frac{100}{101} = 0.99$

Solution:

a) $V_{BE} = V_B - V_E$; $V_B = 4V$

$V_E = V_B - V_{BE} = 4 - 0.7$

$\underline{V_E = 3.3V}$

b) $V_E = I_E R_E$

$I_E = \frac{V_E}{R_E} = \frac{3.3}{3.3K\Omega} = \underline{1mA}$

c) $I_C = \alpha I_E = 0.99 \times 1mA = \underline{0.99mA}$

d) $V_C = V_{CC} - I_C R_C = 100 - 0.99 \times 4.7$

$V_C = \underline{5.3V}$

e) $I_C = \beta I_B \rightarrow I_B = \frac{I_C}{\beta} = \frac{0.99mA}{100} = \underline{9.9\mu A}$

f) $V_{BC} = V_B - V_C = 4 - 5.3 = -1.3V$

↳ BC junction is reverse-biased

g) $V_{BE} = 0.7$

↳ BE junction is forward-biased

h) BJT is in Active mode of operation

— × —