Transistor Biasing Methods continue……….

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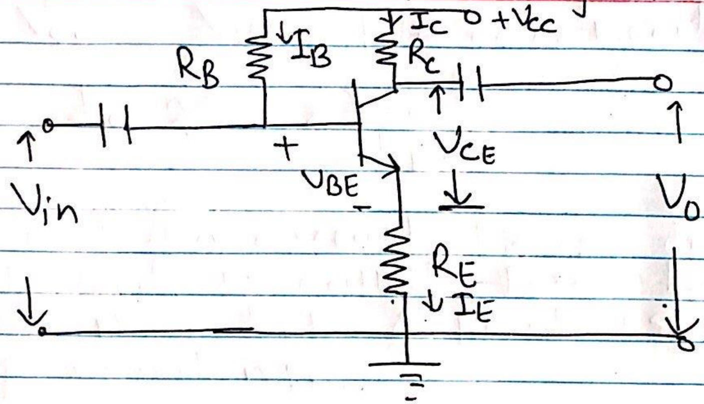
2) Emitter feedback biasing method:



→ Used to reduce the unstability of Q point due to β variations; Idea used is, RE ~~is~~ connected at emitter to offset the unstability of Q point due to β change.

Applying KVL at I/P

$$V_{cc} = I_B R_B + V_{BE} + I_E R_E$$

or $$V_{cc} = I_B R_B + V_{BE} + (\beta+1) I_B R_E \quad [I_E = (\beta+1) I_B]$$

or $$I_B = \frac{V_{cc} - V_{BE}}{R_B + (\beta+1) R_E}$$

[only difference between fixed bias & this is, term $(\beta+1)R_E$.]

$$\therefore I_C = \beta I_B$$

Applying KVL at O/P:

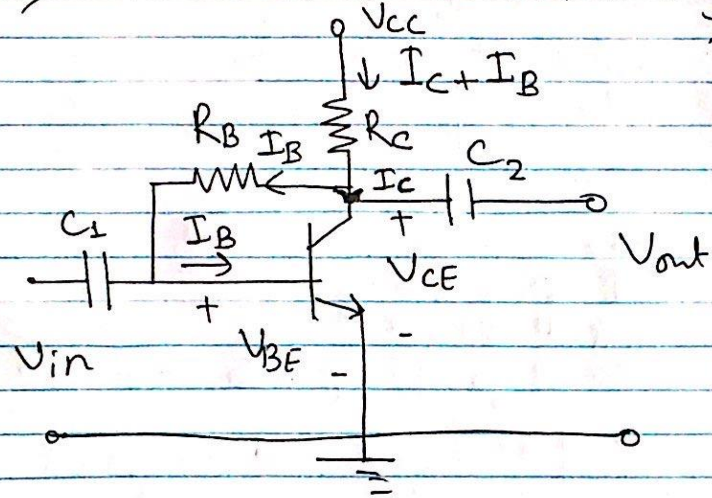
$$V_{cc} = I_C R_C + V_{CE} + I_E R_E$$

$$\therefore V_{cc} = I_C (R_C + R_E) + V_{CE} \quad [I_C \approx I_E]$$

$\therefore$

$$\therefore I_C' = \frac{V_{CC} - V_{CE}}{(R_C + R_E)}$$

3) Collector feed back biasing method.



Applying KVL at O/p.

$\Rightarrow V_{CC} = (I_C + I_B) R_C + V_{CE}$

$\approx$

$\therefore V_{CE} = V_{CC} - I_C R_C$

→ Better than emitter feedback biasing.

→ Like fixed bias except that the base resistor R_B is returned to the collector terminal instead of supply V_{CC}.

→ If I_C tends to increase, V_{CE} decreases due to larger voltage drop across R_C. The result I_B is reduced, the reduced base current in turn reduces the original increase in I_C.

Applying KVL at I/P.

$$V_{CC} = (I_B + I_C) R_C + I_B R_B + V_{BE}$$

$$\therefore I_B = \frac{V_{CC} - V_{BE}}{(\beta + 1) R_C + R_B}.$$

4) Voltage divider Biasing.

→ Most widely used, enables operation of transistor independent with β.

→ For this method we can find zero signal Collector current and collector emitter voltage using thevenin's method or approximate method.

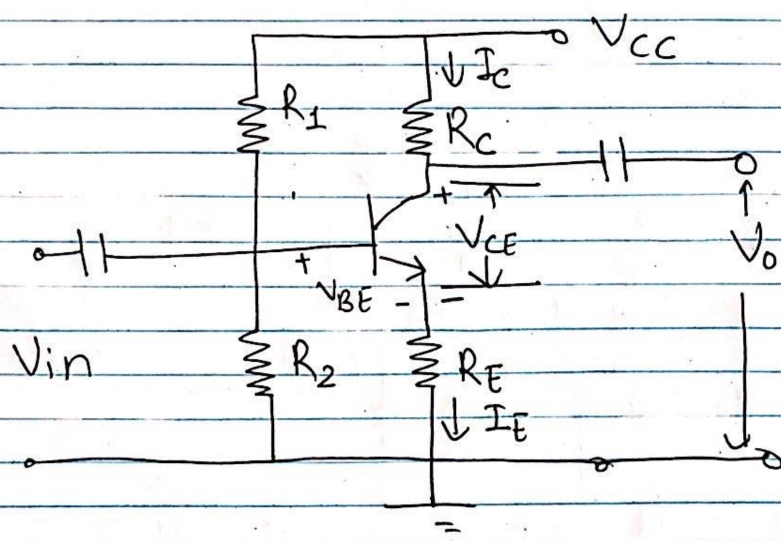
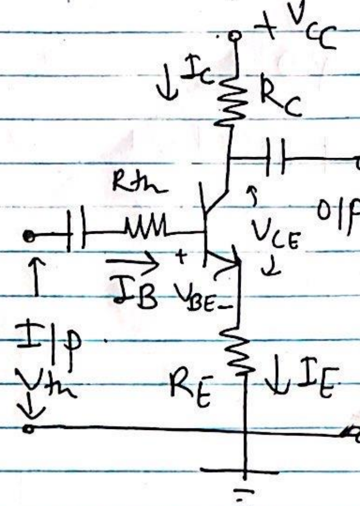
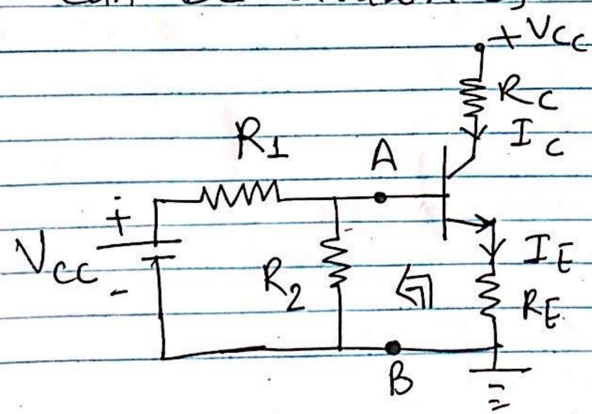


figure:- voltage divider circuit.



Thevinin equivalent circuit.

can be drawn as.



Here,

$$R_{th} = R_1 \| R_2 = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$V_{th} = V_{AB} = \frac{V_{cc} \times R_2}{R_1 + R_2}$$

Applying KVL at I/P

$$V_{th} = I_B R_{th} + V_{BE} + I_E R_E$$

$$\therefore I_B = \frac{V_{th} - V_{BE}}{R_{th} + R_E(\beta+1)}$$

$$\therefore I_C = \beta I_B$$

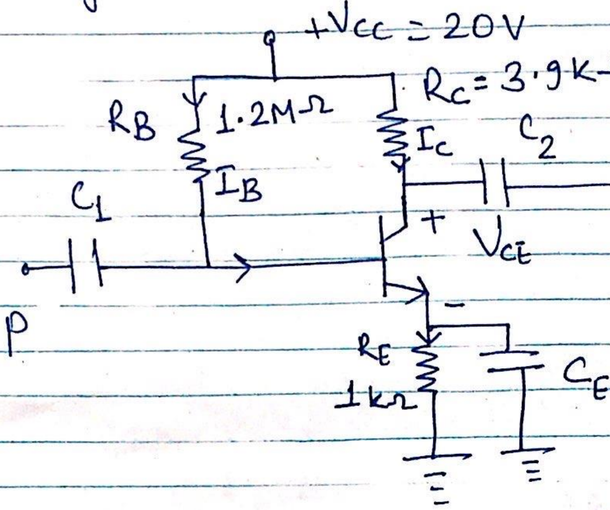
Now,

Applying KVL at O/P loop.

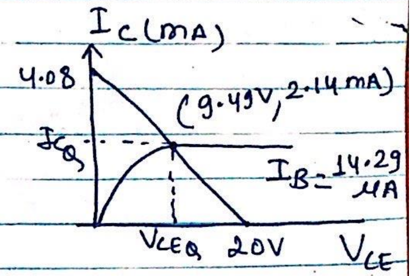
$$V_{CC} = I_C R_C + V_{CE} + I_E R_E$$

$$\therefore V_{CE} = V_{CC} - I_C(R_C + R_E) \quad [\because I_C \approx I_E]$$

for given circuit determine Q point & load line.



$\beta = 150$



Applying KVL at O/P Loop.

① $-V_{CC} = I_C R_C + V_{CE} + I_E R_E$ $\quad [I_C \approx I_E]$

when, $I_C = 0$, $V_{CC} = V_{CE\,max} = 20\,V$

when, $V_{CE} = 0$, $I_{C\,max} = \dfrac{V_{CC}}{R_C + R_E} = 4.08\,mA$

for Q point, Applying KVL at I/P Loop,

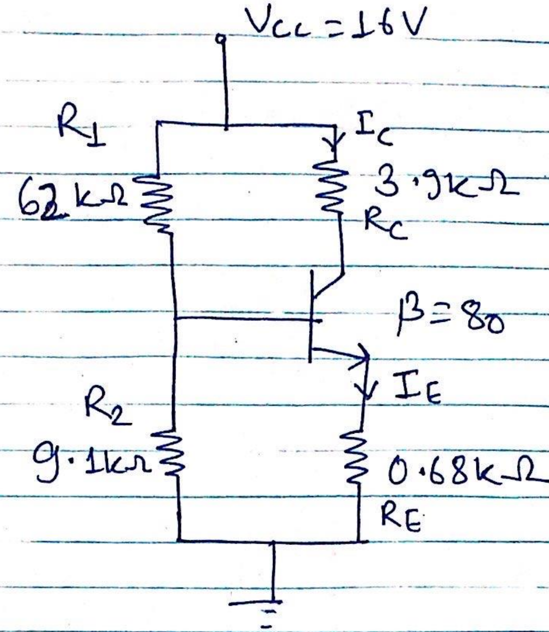
$$V_{CC} = I_B R_B + V_{BE} + I_E R_E$$

$$V_{CC} = \frac{I_C}{\beta} R_B + 0.7 + I_C R_E$$

$$I_{CQ} = \frac{20 - 0.7}{\left(\frac{1.2M\Omega}{150} + 1k\Omega\right)} = 2.144\,mA$$

Now from ① calculate $V_{CEQ} = 9.49\,V$

Draw load line & find Q point for given circuit.

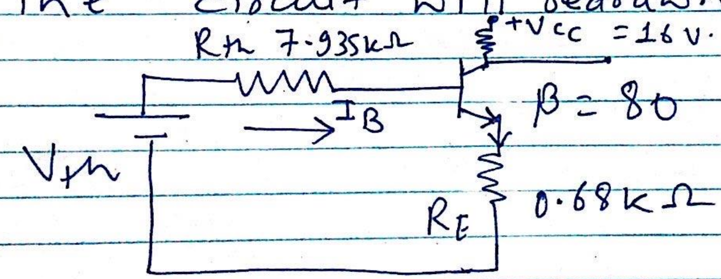


Here, converting into thevenin's circuit,

$$R_{th} = \frac{R_1 \times R_2}{R_1 + R_2} \; (R_1 \| R_2) = \frac{62 \times 9.1}{62 + 9.1} = 7.935k\Omega$$

$$V_{th} = \frac{R_2}{R_1 + R_2} \times V_{cc} = \frac{9.1}{(62 + 9.1)} \times 16 = 2.048V$$

The circuit will redrawn as,



Applying KVL at O/P.

$$V_{CC} = I_C R_C + V_{CE} + I_E R_E \qquad (I_C \approx I_E)$$

① $I_C = 0, \quad V_{CC} = V_{CE\,max} = 16V$

② $V_{CE} = 0, \quad I_{C\,max} = \dfrac{V_{CC}}{(R_C + R_E)} = \dfrac{16}{(3.9 + 0.68)} = 3.49mA.$

Now, Applying KVL at I/P.

$$V_{th} = I_B R_{th} + V_{BE} + I_E R_E$$

$$I_B = \frac{V_{th} - V_{BE}}{[R_{th} + (1+\beta)R_E]} = \frac{2.048 - 0.7}{7.935\times10^3 + (80+1)\,0.68\times10^3}$$

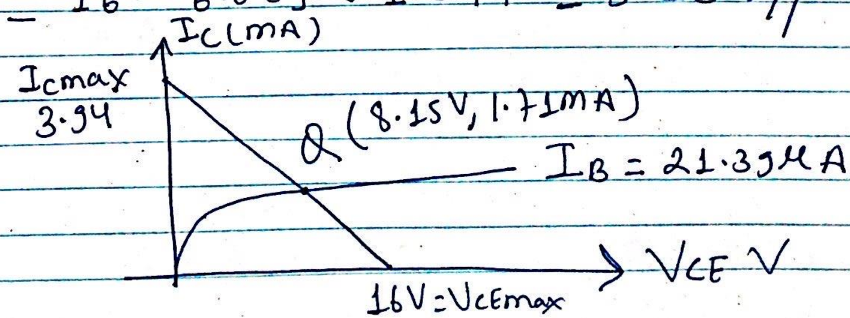
$\therefore I_B = 21.392\,\mu A.$

Now, $I_{CQ} = \beta I_B = 80 \times 21.392 \times 10^{-6} = 1.71\ mA$ //

$$V_{CEQ} = V_{CC} - I_C R_C - (I_C + I_B) R_E$$

$$= 16 - 1.71 \times 3.9k\Omega - (1.71 + 21.392\times10^{-3}) \times 0.68$$

$$= 16 - 6.669 - 1.177 = 8.15V$$ //



Hybrid π model of a BJT

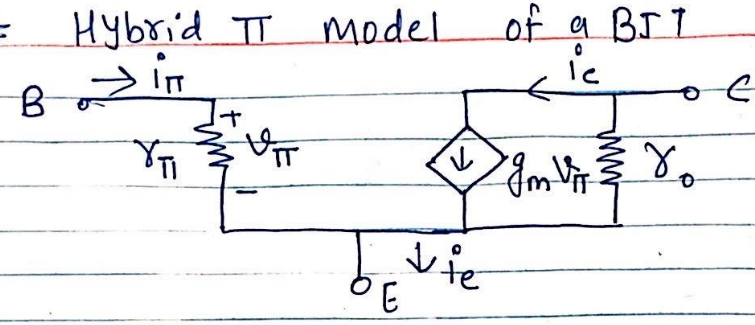


figure: simple π model of BJT

B, C and E nodes represent the Base, collector and Emitter respectively. r_π is the resistance between B-E junction when looking into base. r_o is the output impedance (resistance), g_m is transconductance.

$$g_m = \frac{i_c}{v_{be}} = \frac{\text{Small signal ac collector current}}{\text{Small signal ac base to emitter voltage}}$$

$$r_\pi = \frac{v_\pi}{i_\pi} = \frac{v_{be}}{\frac{i_c}{\beta}} = \frac{\beta}{g_m} // \quad i_c = g_m v_{be} //$$

T- model

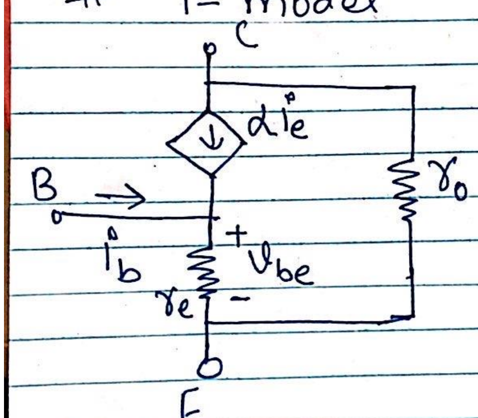


figure:- T model of BJT

$r_e \rightarrow$ resistance between base & emitter

$\alpha i_e \rightarrow$ current controlled current source and equal to i_c.

$$r_e = \frac{v_{be}}{i_e} = \frac{v_{be}}{i_e} = \frac{v_{be}}{\frac{i_c}{\alpha}}$$

$$\text{or } r_e = \frac{\alpha v_{be}}{i_c} = \frac{\alpha}{g_m} //$$

$$\therefore \boxed{r_e = \frac{\alpha}{g_m} //}$$