

### Answer to the Q. NO - 1(a)

Given,  $K' = 0.2 \text{ mA/V}^2$ ;  $V_t = 0.7 \text{ V}$ ;  $\frac{W}{L} = 10$

(a)  $V_{GS} = 5 \text{ V}$ ;  $V_{DS} = 1 \text{ V}$  [from graph]  $+V - 20 \text{ V} > 20 \text{ V}$

Here,  $V_{GS} > V_t$   $20 \text{ V} \left( 20 \text{ V} - \frac{1}{2} + V - 20 \text{ V} \right) \frac{W}{L} K' = I_D$

and  $V_{GS} - V_t = 5 - 0.7 = 4.3 \text{ V}$   $(\text{E.P.}) \times 0.1 \times 10 \times 10 =$

$\therefore V_{DS} < V_{GS} - V_t$  [Triode mode]  $\text{Ans 80.1} =$

$$\therefore I_D = K' \frac{W}{L} \left( V_{GS} - V_t - \frac{1}{2} V_{DS} \right) V_{DS} \quad (\text{b})$$

$$= 0.2 \times 10 \times \left( 4.3 - \frac{1}{2} \right) \quad +V < 20 \text{ V} \text{ (with}$$

$$= 7.6 \text{ mA} \quad (\text{Ans})$$

(b)  $V_{GS} = 2 \text{ V}$ ,  $V_{DS} = 1.3 \text{ V}$

Here,  $V_{GS} > V_t$   $(\text{P. 81}) = (\text{E.P.}) \times 0.1 \times \frac{10}{5} =$

and  $V_{GS} - V_t = 2 - 0.7 = 1.3$

$\therefore V_{DS} \geq V_{GS} - V_t$  [Saturation mode]

$$\therefore I_D = \frac{K'}{2} \frac{W}{L} \left( V_{GS} - V_t \right)^2$$

$$= \frac{0.2}{2} \times 10 \times (1.3)^2 = 1.69 \text{ mA} \quad (\text{Ans})$$

(c)  $V_{GS} = 5V$ ,  $V_{DS} = 0.2V$  (a)  $I_D \rightarrow 0V$ . It is off or inactive

Here,  $V_{GS} > V_t$ ;  $V_{DS} = 5V < V_{Ams} \Rightarrow$  on (d)

and  $V_{GS} - V_t = 5 - 0.7 = 4.3V$

$\therefore V_{DS} < V_{GS} - V_t$  [Triode mode]  $I_D = 0V$ ;  $V_D = 0V$  (e)

$$\therefore I_D = K' \frac{W}{L} \left( V_{GS} - V_t - \frac{1}{2} V_{DS} \right) V_{DS} \quad + V < 0V \text{ off}$$

$$= 0.2 \times 10 \times \left( 4.3 - \frac{0.2}{2} \right) \times 0.2 = 0V - 0V \text{ off}$$

$$= 1.68 \text{ mA} \quad [\text{from book ans}] \quad + V - 0V > 0V \therefore$$

(d)  $V_{GS} = V_{DS} = 5V$  ( $\frac{1}{2} - 0.1 = 0.45V$ )  $\frac{W}{L} K = 0I$

Here,  $V_{GS} > V_t$   $(0.45 - 0.1) \times 0.1 \times 5.0 =$

and  $V_{GS} - V_t = 4.3$   $(0.35) \times 0.1 \times 5.0 =$

$$\therefore V_{DS} \geq V_{GS} - V_t$$

$$\therefore I_D = \frac{K'}{2} \frac{W}{L} (V_{GS} - V_t)^2 \quad V_{C,I} = 0V < 5V \text{ off} \quad (f)$$

$$= \frac{0.2}{2} \times 10 \times (4.3)^2 = 18.4V \text{ mA} \quad [\text{book ans}]$$

$$C,I = 5V - 0V = 5V - 0V \text{ on}$$

$$[\text{from book ans}] \quad + V - 0V \leq 5V \therefore$$

$$+ (5V - 0V) \frac{W}{L} \frac{K}{2} = 0I \quad .$$

$$(\text{book ans}) \quad \text{from } C,I = 0.2 \times 10 \times \frac{5.0}{2} =$$

Answers to the Q. NO - 1(b)

$$V_{th} = 1 \text{ V}$$

$$V_D = 0 \text{ V}$$

case	$V_{GS}$	$V_{OV}$	$V_{DS}$	Region of operation
a	0	-1	1	cutoff; $V_{DS} < V_{th}$
b	1.5	0.5	1	saturation; $V_{DS} > V_{th}$ $V_{DS} \geq V_{OV}$
c	1.5	0.5	1	saturation; $V_{DS} \geq V_{OV}$
d	1.5	0.5	1	saturation;
e	2.5	1.5	1	Triode; $V_{DS} > V_{th}$ $V_{DS} < V_{OV}$

Answers to the Q. NO - 1(c)

1st circuit,

$$V_{GS} = 2.2 \text{ V}$$

$$V_S = 0 \text{ V}$$

$$V_D = 2.2 \text{ V}$$

$$V_T = 0.4 \text{ V}$$

$$\therefore V_{GS} = 2.2 - 0 = 2.2 \text{ V}$$

$$V_{OV} = 2.2 - 0.4 = 1.8 \text{ V}$$

$$V_{DS} = 2.2 - 0 = 2.2 \text{ V}$$

$$\therefore V_{DS} \geq V_{OV}$$

$\therefore$  Region of operation is saturation.

2nd circuit,

(Q) E - QN & out of noise

$$\therefore V_{GDS} = 0 - (-1) = 1 \text{ V}$$

$$V_{GS} = 0 \text{ V}$$

$$V_{DS} = \text{exact } 1 - 0.4 = 0.6 \text{ V}$$

$$V_S = -1 \text{ V} \rightarrow \text{no bias}$$

$$V_{DS} = -0.6 - (-1) = 0.4 \text{ V}$$

$$V_D = -0.6 \text{ V}$$

$$V_T = < 0.4 \text{ V} \quad \text{constraint: } V_{DS} < 0 \text{ V}$$

∴ Region of operation is triode.

3rd circuit,

$$V_S < 2 \text{ V}$$

$$V_{GS} > 2 \text{ V}$$

$$V_{GS} = 1 \text{ V}$$

$$V_S = 1 \text{ V}$$

$$V_D = 3 \text{ V}$$

$$V_T = 0.4$$

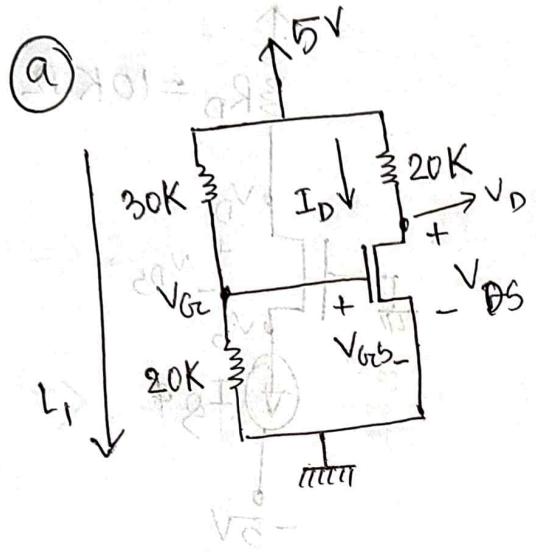
$$V_{S,S} = 0 - 5.5 = 5.5 \text{ V}$$

$$V_{S,S} = 5 \text{ V}$$

∴ Region of operation is cutoff.

~~Region of operation is triode to noise~~

## Answers to the Q. NO-2



Here,  $V_{DS} = 0 \text{ V}$  (sat) (D)

$$V_{th} = 1 \text{ V}$$

$$K_n = 0.1 \text{ mA/V}^2$$

$$\text{and } V_g = 0 \text{ V}$$

KVL in L<sub>1</sub>,

$$30I + 20I = 5 \Rightarrow 50I = 5 \Rightarrow I = 0.1 \text{ mA}$$

$$\text{Now, } \frac{V_G - 0}{20} = 0.1$$

} Easier to do voltage division:

$$V_G = \frac{20k}{20k + 30k} \times 5 = 2 \text{ V}$$

$$\therefore V_{GS} = 2 - 0 = 2 \text{ V} > V_{th}$$

Let's assume ~~active~~ saturation mode,

$$\therefore I_D = \frac{K_n}{2} (V_{GS} - V_{th})^2$$

$$\Rightarrow I_D = \frac{0.1}{2} \times (2 - 1)^2$$

$$\Rightarrow I_D = 0.05 \text{ mA}$$

At V<sub>D</sub> node,

$$\frac{5 - V_D}{20} = 0.05$$

$$\Rightarrow V_D = 4 \text{ V}$$

$$\therefore V_{DS} = 4 - 0 = 4 \text{ V}$$

$$V_{OV} = 2 - 1 = 1 \text{ V}$$

$$\therefore V_{DS} > V_{OV}$$

Assumption correct!

## Answers to the Q. NO - 3

S-04-N.B. out of 10 marks

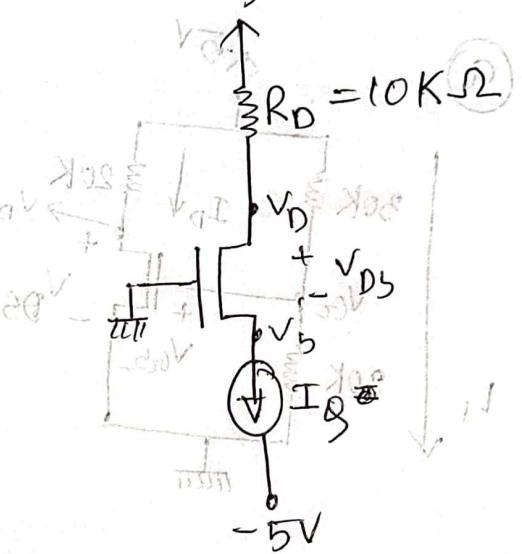
(a) Here,  $V_D = 2.5 \text{ V}$  (Ans)

$$V_{Th} = 0.8 \text{ V}$$

$$K'_n = 80 \text{ MA/V}^2$$

$$V_{Gr} = 0 \text{ V}$$

$$V_{GS} = 0 \text{ V}$$



$$V_D = 2.5 \text{ V} > V_{Gr}$$

∴ The mosfet is in saturation.

( $V_S$  not needed)

$$V_S < V_D$$

! Transistor not grounded

~~Let's assume~~ & saturation,

$$I_D = \frac{K_n}{2} \frac{W}{L} (V_{GDS} - V_{Th})^2$$

$$\Rightarrow 250 = \frac{80}{2} \frac{W}{L} (-V_b - 0.8)^2$$

$$\Rightarrow \frac{W}{L} = \frac{25}{40} \times \frac{1}{V_b + 1.6V_b + 0.64}$$

$$V_{DSD} = 0 - V_{DS} = -0.8V$$

(b) Here,  $V_H = 1 - \bar{v} = 0.8V$

$$V_{ThL} = V_{ThD} = 1V$$

$$K_n D = 50 \text{ Ma/V}^2$$

$$K_n L = 10 \text{ Ma/V}^2$$

$$V_{DD} = 5V$$

No need to assume.  
we know this.

let's assume  $M_L$  in saturation and  $M_D$  in triode,

Here,  $I_{DL} = I_{DD}$

$$\Rightarrow \frac{K_n L}{2} (V_{GSL} - V_{ThL})^2 = K_n D \times (V_{GSD} - V_{ThD} - \frac{1}{2} V_{DSD}) V_{DSD}$$

$$\Rightarrow \frac{10}{2} (5 - V_0 - 1)^2 = 50 \times (5 - 0 - 1 - \frac{1}{2} V_0) V_0$$

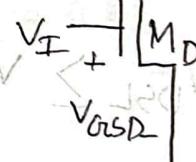
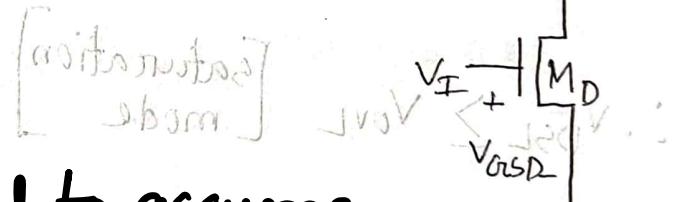
$$\Rightarrow 5 \times (4 - V_0)^2 = 50 \times (4 - \frac{1}{2} V_0) V_0$$

$$V_{DS} = 1 - V_{DS} = 0.8V$$

$$V_{GSL} =$$



$$V_{GSL} = 1 - V_{DS} = 0.8V$$



$$\Rightarrow 16 - 8V_0 + V_0^2 = 40V_0 - 5V_0^2$$

$$\Rightarrow 6V_0^2 - 48V_0 + 16 = 0$$

$$\therefore V_0 = \frac{7.65, 0.35}{x}$$

$$\therefore V_{GSD} = 5 - V_0 = 5 - 0.35 \\ = 4.65 \text{ V}$$

$$V_{DSL} = 5 - V_0 = 5 - 0.35 \\ = 4.65 \text{ V}$$

$$V_{OVL} = 4.65 - 1 = 3.65 \text{ V}$$

$$\therefore V_{DSL} \geq V_{OVL} \quad [\text{saturation mode}]$$

$\therefore$  assumption correct!

$$\frac{1}{P_{DS} + V_0} \cdot I + \frac{V}{R_D} = 5 - 0.35 = 5 \text{ V}$$

$$V_{DSD} = 0.35 - 0 = 0.35 \text{ V}$$

$$V_{DVD} = 5 - 1 = 4 \text{ V}$$

$$\therefore V_{DSD} < V_{DVD} \quad [\text{triode mode}]$$

$\therefore$  assumption correct!

$$V_D = 0.35 \text{ V}$$

c) Given,

$$V_{ov} = 5 - 0.6 = 4.4 \text{ V}$$

$$I_D = 12 \text{ mA}$$

$$V_G = 5 \left( \frac{1}{R_D} + \frac{1}{R_S} \right) \times 0.6 \text{ V}$$

$$V_S = 0 \text{ V}$$

$$I_D = 12 \text{ mA} \quad \text{and} \quad V_D = 0.35 \text{ V}$$

$$V_{DS} < V_{ov}$$

$$V_{GDS} = 5 - 0.35 = 4.65 \text{ V}$$

$$V_{DS} = 0.15 \text{ V}$$

$$V_{Th} = 0.6 \text{ V}$$

operation is triode.

$$I_D = K_n \frac{W}{L} \left( V_{GS} - V_{Th} - \frac{1}{2} V_{DS} \right) V_{DS}$$

with  $V_{DS} = 0.15$  V

$$\Rightarrow \frac{W}{L} = \frac{I_D}{K_n (V_{GS} - \frac{1}{2} V_{DS}) V_{DS}}$$

with  $V_{GS} = 1.6$  V

$$\Rightarrow \frac{W}{L} = \frac{12 \times 10^{-3}}{80 \times 10^{-6} \times \left( 1.6 - \frac{0.15}{2} \right) 0.15}$$

$$\Rightarrow \frac{W}{L} = 231.21 \cong 231 \quad (\text{Ans})$$

Now,  $V_a - V_D = 1.6$  V

$$\Rightarrow V_a = 1.6 + 0.15$$

$$\Rightarrow V_a = 1.75$$

$$\begin{aligned} V_{DS} &= V_D - V_S \\ &\Rightarrow 0.15 = V_D - 0 \\ &\Rightarrow V_D = 0.15 \end{aligned}$$

$$\therefore \frac{5 - V_a}{R_D} = I_D$$

$$\Rightarrow \frac{5 - 1.75}{R_D} = 12 \times 10^{-3}$$

$$\Rightarrow R_D = 270.83 \Omega \cong 271 \Omega$$

with  $V_{DS} = 0.15$  V

Answers to the Qs, NO - 4

Let,  $V_{CE(\text{sat})} = 0.2 \text{ V}$  [For active mode]

Case - 1

$$V_{BE} = 0.7 \text{ V}$$

$$V_{CE} = 0.7 \text{ V}$$

$$\therefore V_{CE} > V_{CE(\text{sat})}$$

$$\frac{I}{K_B(V_A + \frac{1}{2}AV^2)} = \frac{W}{T} \leftarrow$$

$\therefore$  Mode of operation is Active.

$$\frac{e^{-0.7/(0.7+0.1)}}{80 \times 10^{-12}} = \frac{W}{T} \leftarrow$$

Case - 2

$$V_{BE} = 0.8 \text{ V}$$

$$V_{CE} = 0.1 \text{ V} = 0.1 \text{ V} \quad \therefore \text{Mode of operation is Saturation.}$$

$$[0.1 = 0 \text{ V}]$$

Case - 3

$$V_{BE} = 0.7 \text{ V}$$

$$V_{CE} = 1.4 \text{ V} \quad \therefore \text{Mode of operation is Active.}$$

$$\therefore V_{CE} > V_{CE(\text{sat})}$$

$$e^{-0.7/(0.7+0.1)} = \frac{Tf(1-T)}{80} \leftarrow$$

Case - 4

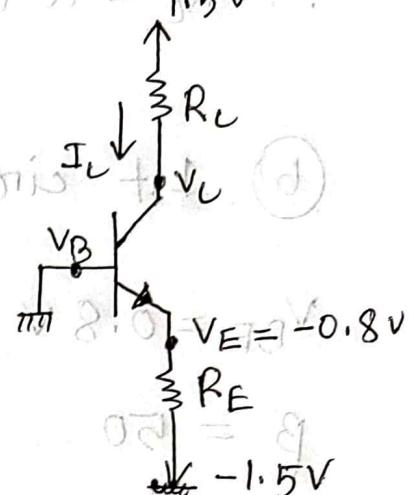
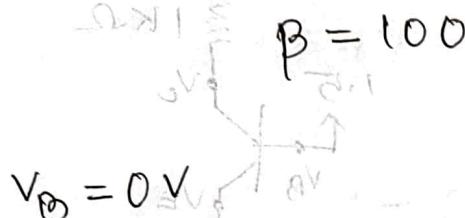
$$V_{BE} = 0.7 \text{ V}$$

$$V_{CE} = 2.7 \text{ V} \quad \text{Semi. Mode of operation is Active.}$$

$$\therefore V_{CE} > V_{CE(\text{sat})}$$

Answer to the Q. NO-5

(a) Here,  $V_{BE} = 0.8 \text{ V}$ ,  $V_C = 0.5 \text{ V}$



$$\beta = 100$$

$$V_B = 0 \text{ V} \quad \therefore V_{CE} = 0.5 + 0.8 \\ \therefore V_E = -0.8 \text{ V} \quad \therefore V_{CE} = 0.5 + 0.8 \\ = 1.3 > V_{CE(\text{sat})}$$

$\therefore$  Operation in active mode.

$$I_C = 1 \text{ mA}$$

$$I_C = \beta I_B$$

$$\Rightarrow I_B = \frac{1}{100} = 0.01 \text{ mA}$$

$$\text{Now, } I_C = 0.1 \text{ mA}$$

$$\frac{1.5 - V_C}{R_C} = I_C \quad \leftarrow \frac{1.5 - 0.5}{1k\Omega} = 0.1 \text{ mA}$$

$$\Rightarrow R_C = \frac{1.5 - 0.5}{0.1} = 10 \text{ k}\Omega$$

$$I_E = I_B + I_C = 0.11 \text{ mA}$$

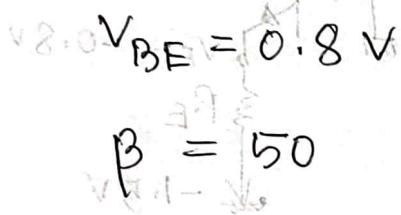
$$\Rightarrow I_E = 0.01 + 0.1 \\ = 0.11 \text{ mA}$$

$$\text{Again, } \frac{V_E - (-1.5)}{R_E} = I_E$$

$$\Rightarrow R_E = \frac{-0.8 + 1.5}{0.11} = 6.36 \text{ k}\Omega$$

$\therefore R_C = 10 \text{ k}\Omega$  and  $R_E = 6.36 \text{ k}\Omega$  (Ans)

(b) 1st circuit,  $V_{B.0} = V_B$ ,  $V_{E.0} = 38 \text{ V}$  (Ans)



$$\text{Here, } V_B = 1.5 \text{ V} \quad 8.0 + 0.7 = 38 \text{ V} \quad V_{E.0} = 0.7 \text{ V}$$

$$\begin{aligned} \therefore V_E &= V_B - V_{BE} \\ &= 0.7 \text{ V} \end{aligned}$$

Let's assume active mode,

$$\therefore V_{BE} = 0.7$$

$$\text{and } V_{CE} > 0.2$$

At  $V_E$  Node,

$$\frac{V_E - 0}{0.47} = I_E \Rightarrow I_E = \frac{0.7}{0.47} \Rightarrow I_E = 1.48 \text{ mA}$$

$$I_C = \beta \times I_E \Rightarrow I_C = \frac{\beta}{\beta + 1} I_E \Rightarrow I_C = \frac{50}{50 + 1} \times 1.48 \text{ mA} = 1.46 \text{ mA}$$

$$\begin{aligned} \therefore I_B &= I_E - I_C \\ &= 1.48 - 1.46 \\ &= 0.03 \text{ mA} \end{aligned}$$

At  $V_C$  node,

$$\frac{(0.1 -) - 3V}{2.2k\Omega} = \beta I$$

$$\frac{3 - V_C}{1} = 1.46$$

$$Am 81\delta,0 = \frac{2.1 + 8.0}{2.2} = \beta I \Leftarrow$$

$$\Rightarrow V_C = 1.54V$$

$$\therefore V_{CE} = 1.54 - 0.7 = 0.84 > 0.2$$

∴ assumption correct!

$$V_E = 0.7V$$

$$I_{E(0)} = 1.489 \text{ mA}$$

$$V_B = 1.5V$$

$$I_B = 0.030 \text{ mA}$$

$$V_C = 1.54V$$

$$I_C = 1.46 \text{ mA}$$

(Ans)

2nd circuit,

$$81\delta,0 = \frac{5V - 0.1}{1.5V}$$

let's assume active mode,

$$V_{BE} = 0.8V$$

$$\beta = 50$$

$$V_{CE} > 0.2$$

$$V_B = 0V$$

$$\therefore V_E = -0.8V$$

$$Am 81\delta,0 = \beta I$$

$$Am 81\delta,0 = \beta I$$

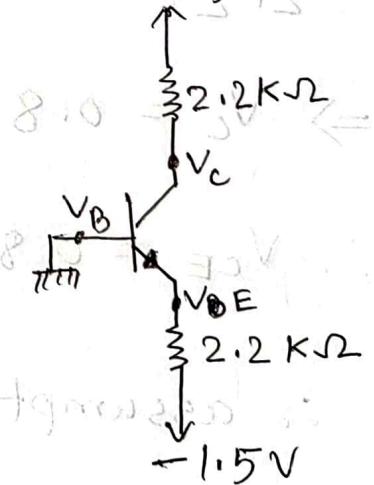
(contd)

$$Am 81\delta,0 = \beta I$$

$$V_{B(0)} = -5V$$

$$V_B = -5V$$

$$V_{B(0)} = 5V$$



$$\therefore I_E = \frac{V_E - (-1.5)}{2.2}$$

$$\Rightarrow I_E = \frac{-0.8 + 1.5}{2.2} = 0.318 \text{ mA}$$

$$I_C = \frac{\beta}{\beta + 1} \times I_E$$

$$= \frac{50}{50+1} \times 0.318 = 0.312 \text{ mA}$$

$$I_B = I_E - I_C = 0.318 - 0.312$$

$$= 0.006 \text{ mA}$$

(Ans)

At  $V_C$  node,

$$\frac{1.5 - V_C}{2.2} = 0.318$$

$$\Rightarrow V_C = 0.8$$

$$\therefore V_{CE} = 0.8 - (-0.8) = 1.6 > 0.2$$

$\therefore$  assumption correct!

$$V_E = -0.8 \text{ V}$$

$$V_B = 0 \text{ V}$$

$$V_C = 0.8 \text{ V}$$

$$I_E = 0.318 \text{ mA}$$

$$I_B = 0.006 \text{ mA}$$

$$I_C = 0.312 \text{ mA}$$

(Ans)

## Answers to the Q.No - 6

a) Circuit-1:

Let's assume active mode,

$$V_{BE} = 0.7 \text{ V}$$

$$V_{CE} > 0.2 \text{ V}$$

$$\beta = 75 - 100$$

KVL in L<sub>1</sub>,

$$10(I_B + I_C) + 20I_B + 2I_E = 5 - 0.7 \quad \textcircled{1} = 5 \text{ V}$$

$$I_E = I_B + I_C \quad \text{--- } \textcircled{11}$$

$$\text{and, } I_C = \frac{\beta}{\beta+1} I_E = \boxed{0.99} I_E \quad \text{Here } \beta = 100 \text{ was used.}$$

Putting  $I_C = 0.99 I_E$  in eqn  $\textcircled{11}$ ,

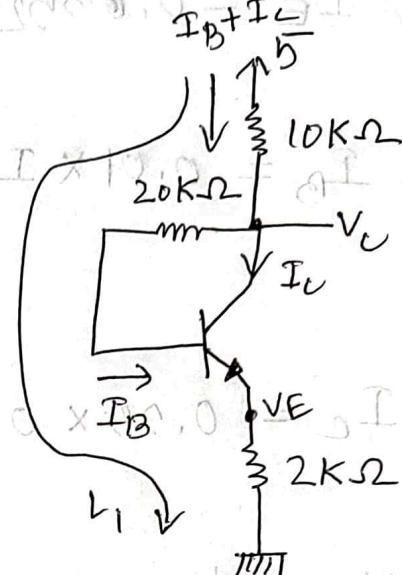
$$I_E = I_B + 0.99 I_E$$

$$\Rightarrow I_B = 0.01 I_E \quad \text{from } F = P_{OF,0} - P_{PS,0} = 30 \text{ V.}$$

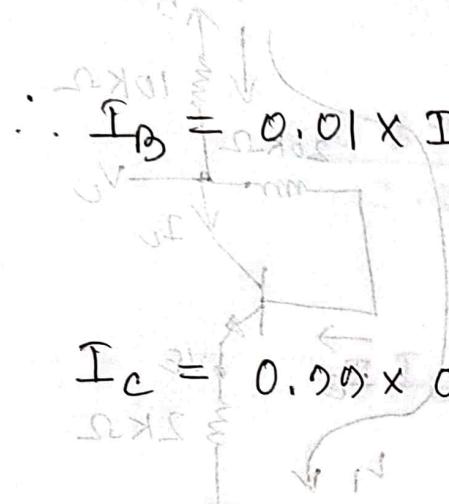
Putting  $I_B = 0.01 I_E$  in eqn  $\textcircled{1}$ ,

$$10I_E + 20 \times 0.01 I_E + 2I_E = 4.3$$

$$\Rightarrow 12.2 I_E = 4.3$$



$$\Rightarrow I_E = 0.0352 \text{ mA}$$



$$I_C = 0.99 \times 0.0352 = 0.348 \text{ mA}$$

At  $V_C$  node,

$$\frac{5 - V_L}{10} = I_C + I_B$$

$$\Rightarrow V_C = 5 - 10(0.00352 + 0.348)$$

$$\Rightarrow V_C = 1.48 \quad \checkmark$$

At node  $V_E$  node,

$$\frac{V_E}{2} = I_E$$

$$\Rightarrow V_E = 0.704 \quad \checkmark$$

$$\therefore V_{CE} = 1.48 - 0.704 = 0.776$$

$\checkmark$  [Active mode]

$\therefore$  assumption correct!

$$\therefore V_C = 1.48 \text{ V}$$

$$A_m \approx 80.0 = \alpha^2 \approx$$

$$I_B = 0.00352 \text{ mA}$$

(Ans)

$$A_m \text{ (P.F.)} = 880.0 \times \frac{10}{100} = 88.0$$

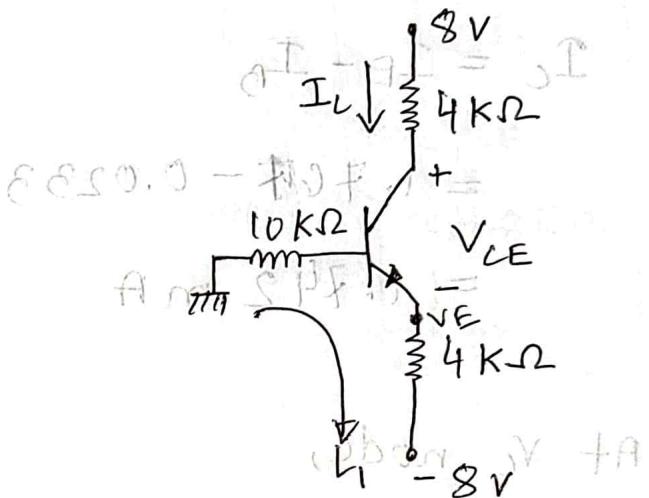
### Circuit-2:

Let's assume active mode,

$$V_{BE} = 0.7 \text{ V}$$

$$V_{CE} > 0.2 \text{ V}$$

$$\beta = 75$$



KVL on  $L_1$ ,

$$10I_B + 4I_E = 0 - 0.7 + 8$$

$$\Rightarrow 10I_B + 4I_E = 7.3 \quad \text{--- (1)}$$

We know,  $I_E = I_B + I_C$  and,  $I_E = \frac{\beta}{\beta+1} I_B$

$$V = \frac{75}{0.99} I_B \quad \text{--- (11)}$$

Putting eqn (11) values on eqn (1),  $\frac{75}{0.99} I_B + 80.0 I_B = 7.3$   $\Rightarrow \frac{75}{76} = 0.986$

$$10I_B + 4 \times \frac{75}{0.99} I_B = 7.3$$

$$\Rightarrow 313.03 I_B = 7.3$$

$$\Rightarrow I_B = 0.0233 \text{ mA}$$

$$\therefore I_E = \frac{0.75}{0.09} \times 0.0233 = 1.765 \text{ mA}$$

and,

$$I_C = I_E - I_B$$

$$= 1.765 - 0.0233$$

$$= 1.742 \text{ mA}$$

At  $V_C$  node,

$$\frac{8 - V_C}{4} = 1.742$$

$$\Rightarrow V_C = 1.032 \text{ V}$$

At  $V_E$  node,

$$\frac{V_E + 8}{4} = 1.765$$

$$\Rightarrow V_E = -0.04 \text{ V}$$

$$\therefore V_{CE} = 1.032 + 0.04 = 1.072 > 0.2$$

[Active mode]

∴ assumption correct!

$$\therefore I_C = 1.742 \text{ mA}$$

$$Q_E = \frac{0.05 \text{ A}}{500 \text{ k}\Omega} = \frac{1}{10^4} = 10 \mu\text{A}$$

(Ans)

$$V_{CE} = 1.072 \text{ V}$$

(b) Let's assume active mode,

$$V_{BE} = 0.7 \text{ V}$$

$$V_{CE} > 0.2$$

$$\text{Here, } V_B = -1 \text{ V}$$

$$\therefore V_E = -1 + 0.7 = -1.7 \text{ V}$$

At  $V_E$  node,

$$\frac{V_E + 3}{4.8} = I_E$$

$$\Rightarrow I_E = \frac{-1.7 + 3}{4.8}$$

$$\Rightarrow I_E = 0.271 \text{ mA}$$

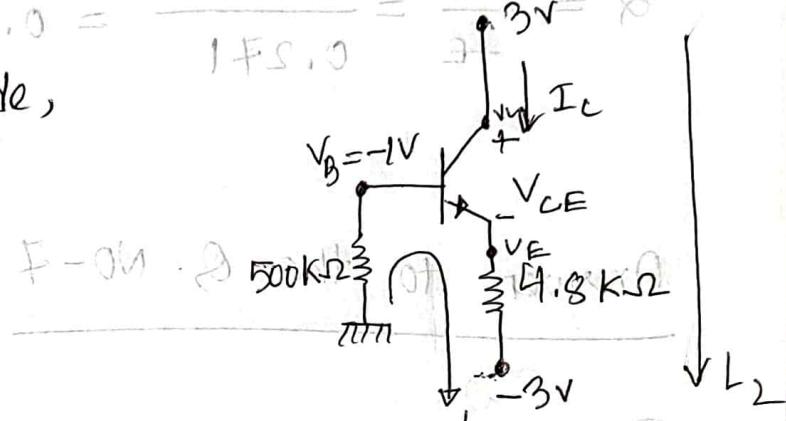
Now, KVL on  $L_1$ ,

$$500 I_B + 4.8 I_E = -0.7 + 3$$

$$\Rightarrow 500 I_B + 4.8 \times 0.271 = -0.7 + 3$$

$$\Rightarrow I_B = 0.002 \text{ mA}$$

$$Q_E = \frac{0.05 \text{ A}}{1.75 \text{ k}\Omega} = \frac{1}{35} = 30 \mu\text{A}$$



$$V_F = 3 \text{ V} \quad Q_E = 30 \mu\text{A}$$

$$\therefore I_C = I_E - I_B$$

$$= 0.271 - 0.002 = 0.269 \text{ mA}$$

$$V_F = 3 - V_{CE} = 0.269 \text{ mA}$$

KVL on  $L_2$ , we get

$$4.8 I_E = 3 - V_{CE} + 3$$

$$\Rightarrow V_{CE} = 6 - (4.8 \times 0.271)$$

$$\Rightarrow V_{CE} = 4.7 > 0.2$$

$\therefore$  assumption correct!

Easier to just:

$$V_{CE} = 3 - (-1.7) > 0.2$$

$$\therefore \beta = \frac{I_C}{I_B} = \frac{0.269}{0.002} = 134.5$$

(Ans)

Am SF.F.1 = 3.2

V or SF.O.1 = 3V

$$\alpha = \frac{I_C}{I_E} = \frac{0.269}{0.271} = 0.99$$

abnormal saturation mode (Ans) (P)

Answer to the Q. NO-7

(a) let's assume active mode,

$$\beta = 100 \rightarrow V_{BE} = 0.7V$$

$$\alpha = 0.99, V_{CE} > 0.2$$

$$V_{FB} = 0V$$

$$\therefore V_E = 0 - 0.7 = -0.7V$$

We know,

$$I_E = I_B + I_C$$

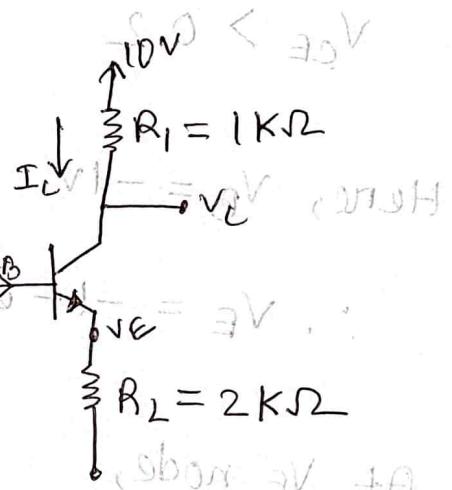
$$\Rightarrow I_B + I_C - I_E = 0 \quad \text{--- (1)}$$

$$I_C = \beta I_B \quad V_F.F.1 = 3V$$

$$\Rightarrow 100 I_B - I_C = 0 \quad \text{--- (2)}$$

$$I_C = \alpha I_E$$

$$\Rightarrow I_C - 0.99 I_E = 0 \quad \text{--- (3)}$$



$$V_F.O.1 = \frac{3 + 3}{3.2} = 3V$$

$$\frac{3 + 3}{3.2} = 3V$$

$$Am SF.O.1 = 3V$$

$$V_F.O.1 = 3V + 3V = 6V$$

$$SF.O.1 = 100 \times 3V + 100 \times 3V = 600V$$

$$Am SF.O.1 = 600V$$

Solving eqn ①, ⑪, ⑬ we get,

$$I_B = I_C = I_E = 0 \text{ mA}$$

$$\therefore V_C = 10 \text{ V}$$

$$\therefore V_{CE} = 10 + 0.7 = 10.7 > 0.2 \quad [\text{active mode}]$$

∴ assumption correct!

$$I_C = I_B = I_E = 0 \text{ mA}$$

$$\text{and } V_C = 10 \text{ V} \quad (\text{Ans})$$

b) Here,

$$V_{OL} = 10 \text{ V}$$

$$V_b = \left( \frac{1}{3} - 0 \right) \text{ V} = \frac{1}{3} \text{ V}$$

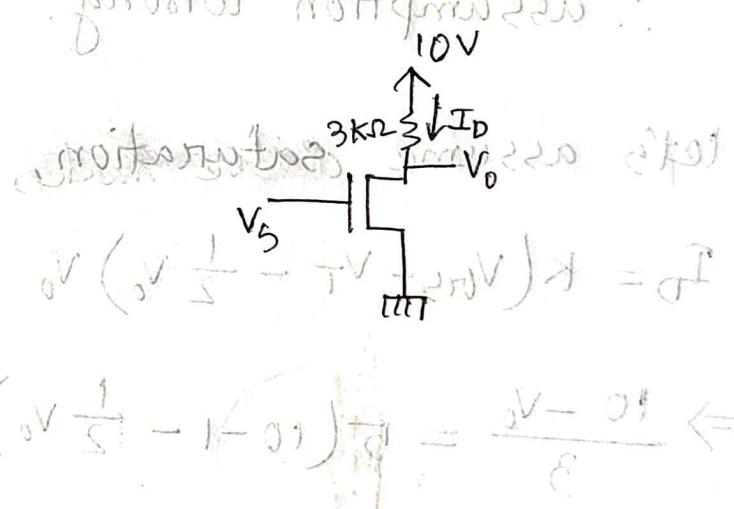
$$V_T = 1 \text{ V}$$

$$K = 5 \text{ mA/V}^2$$

$$\text{Now, } V_{OES} = 10 - 0 = 10 \text{ V}$$

Let's assume saturation mode,

$$I_D = \frac{K}{2} (V_{OES} - V_T)^2$$



$$\Rightarrow I_D = \frac{5}{2} (10 - 1)$$

$$\Rightarrow I_D = 202.5 \text{ mA}$$

At node  $V_0$ ,

$$\frac{10 - V_0}{3} = 202.5$$

$$\Rightarrow V_0 = -507.5 = V_D$$

$$\therefore V_{DS} = -507.5 \not> V_{OV}$$

$\therefore$  assumption wrong.

let's assume active mode,

$$I_D = K(V_{DS} - V_T - \frac{1}{2}V_0)V_0$$

$$\Rightarrow \frac{10 - V_0}{3} = 5(10 - 1 - \frac{1}{2}V_0)V_0 = 5V_0 (9 - \frac{1}{2}V_0) = 0$$

$$\Rightarrow \frac{10 - V_0}{3} = 45V_0 - \frac{5}{2}V_0^2$$

$$\Rightarrow 10 - V_0 = 135V_0 - 7.5V_0^2$$

$$\Rightarrow 7.5V_0^2 - 136V_0 + 10 = 0$$

$$\therefore V_0 = \frac{18.06, 0.074}{2}$$

$$V_{OV} = 10 - 1$$

$$Am \ 30 = 3I = 3L = 3I$$

$$V_O = 3V$$

! terminals not connected

$$Am \ 30 = 3I = 3L = 3I$$

$$(Ans) \quad V_O = 3V \text{ bns}$$

$$Ans \ 30 = 3I = 3L = 3I$$

$$V_O = 3V$$

$$-V_A = K$$

$$V_{DS} = -0.1074 < V_{OV}$$

assumption correct!

$$(V_T - 3V) \cdot \frac{K}{3} = 0$$

$$\therefore I_{DS_2} = \frac{10 - 0.074}{3} = \cancel{3.300} \text{ mA } 3.300 \text{ mA}$$

$$\text{and } V_o = 0.074 \text{ V} \quad (\text{Ans})$$