FINAL ASSIGNMENT

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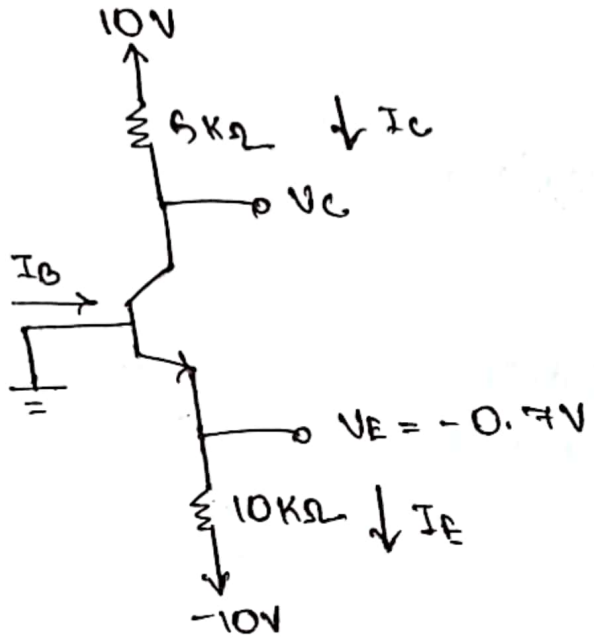
SECTION: 12

SET 1

(i)



Let the BJT be in active state

$V_{BE} = 0.7V$

$$I_E = -\frac{0.7-(-10)}{10} \Rightarrow I_E = 0.93 \text{ mA}$$

$I_B + I_C = I_E \quad [I_C = \beta I_B]$

$I_B + \beta I_B = I_E \quad [\beta = 50]$

$I_E = 51 I_B$

$$I_B = \frac{0.93}{51} \Rightarrow I_B = 0.0182 \text{ mA}$$

$I_C = \beta I_B \Rightarrow I_C = (50)(0.0182) \Rightarrow I_C = 0.9118 \text{ mA}$

$$I_C = \frac{10-V_C}{5}$$

$$0.9118 = \frac{10-V_C}{5}$$

$V_C = 5.44V$

(ii) For static discipline,

$V_{OL} < V_{IL} < V_{IH} < V_{OH}$

$\Rightarrow 1.5 < 2 < 3.5 < 4$

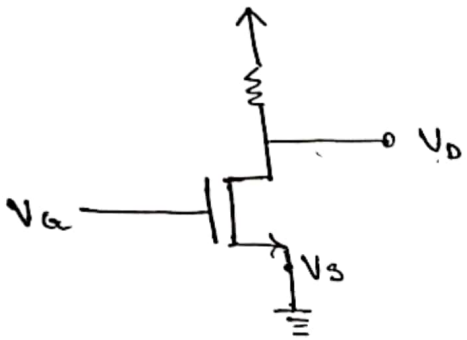
∴ The circuit follows static discipline

For noise margins,

$NM_0 = V_{IL} - V_{OL} = 2 - 1.5 = 0.5\,V$

$NM_1 = V_{OH} - V_{IH} = 4 - 3.5 = 0.5\,V$

SET 2



The mosfet is in saturation region.

$I_D = \frac{1}{2} K (V_{GS} - V_T)^2$ $\quad [I_{D*} = 100\,\mu A,\ K = K_n' \frac{W}{L} = (387)\left(\frac{2}{0.18}\right) = 4300,$
$V_T = 0.5V]$

$100 = \frac{1}{2}(4300)(V_{GS} - 0.5)^2$

$(V_{GS} - 0.5)^2 = 0.0466$

$V_{GS}^2 - V_{GS} + 0.2034 = 0$

$V_{GS} = 0.716V$ ✓ $[V_{GS} > V_T]$

$V_{GS} = 0.284V$ ✗ $[V_{GS} < V_T]$

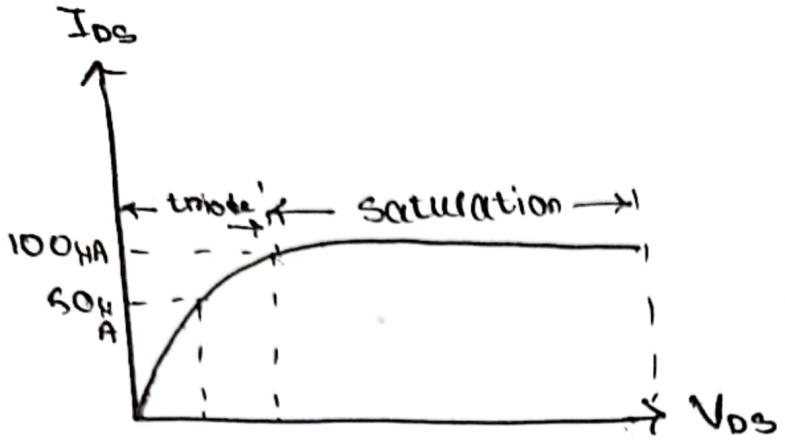
$\therefore V_{GS} = 0.\quad V$

$V_{DS} > (V_{GS} - 0.5)$

$V_{DS} > (0.716 - 0.50)$

$V_{DS} > 0.216$

$V_{DS} = 0.216V$



For $I_D = 50\mu A$, the mosfet is in triode region.

$$I_D = K\left[(V_{GS} - V_T)V_{DS} - \frac{1}{2}V_{DS}^2\right]$$

$$50 = (4300)\left[(0.714 - 0.5)V_{DS} - \frac{1}{2}V_{DS}^2\right]$$

$$0.0116 = 0.214V_{DS} - 0.5V_{DS}^2$$

$$0.5V_{DS}^2 - 0.214V_{DS} + 0.0116 = 0$$

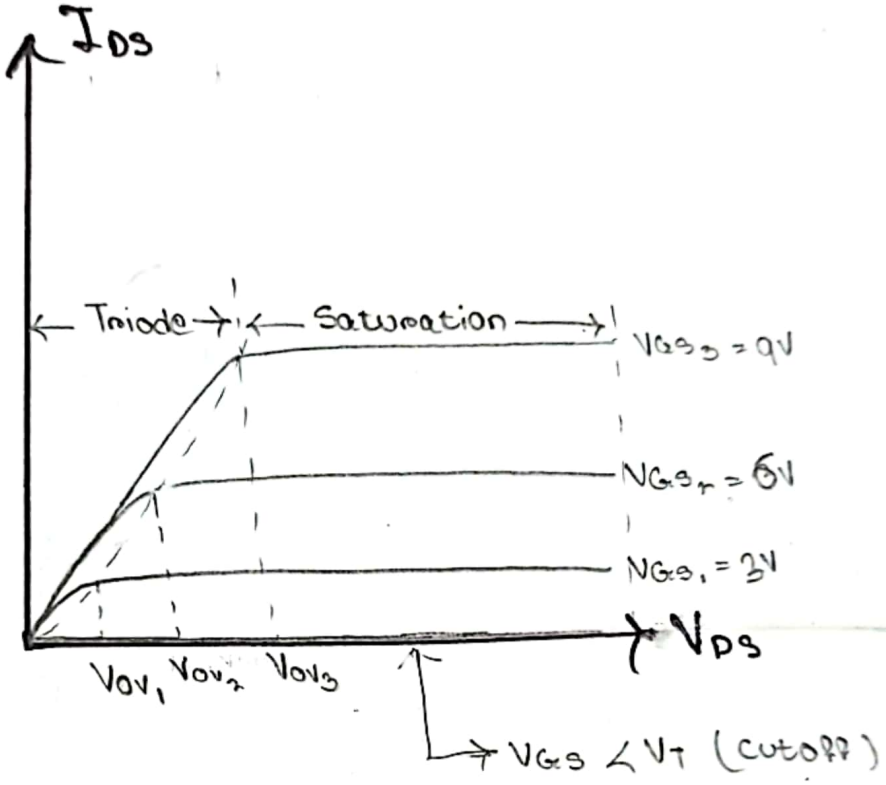
$V_{DS} = 0.364\,V$ ✗ $V_{DS} \not< 0.216$ ($\downarrow V_{TH}$)

$V_{DS} = 0.0637\,V$ ✓ $V_{DS} < V_T$

$\therefore V_{DS} = 0.0637V$

SET 3

(i) I-V graph for mosfet



(ii) I-V graph for BJT