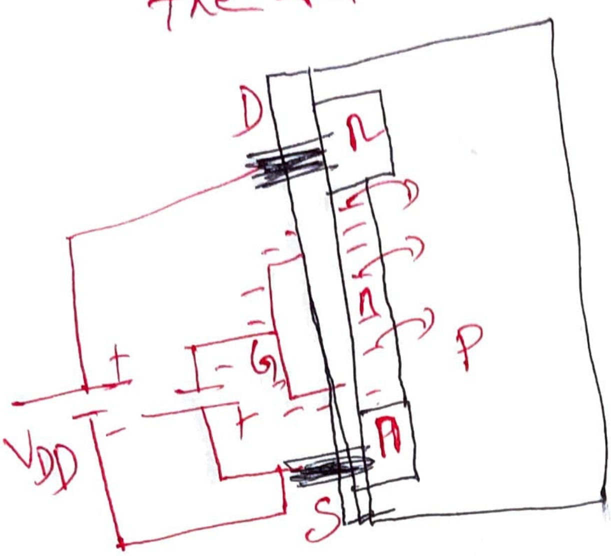
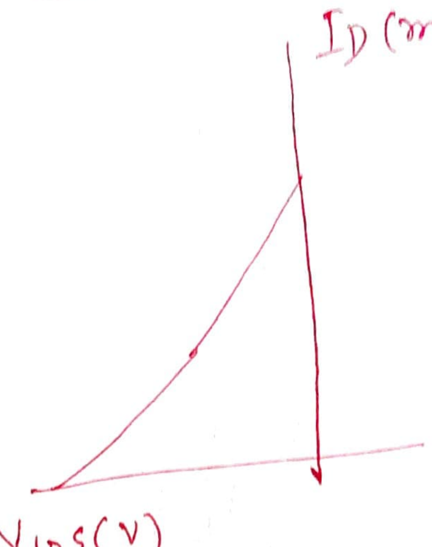
DMOSFET

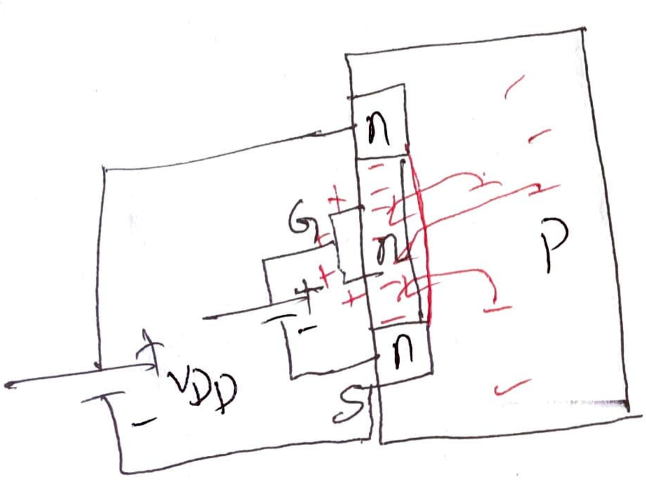
Applying negative voltage in the gate terminal

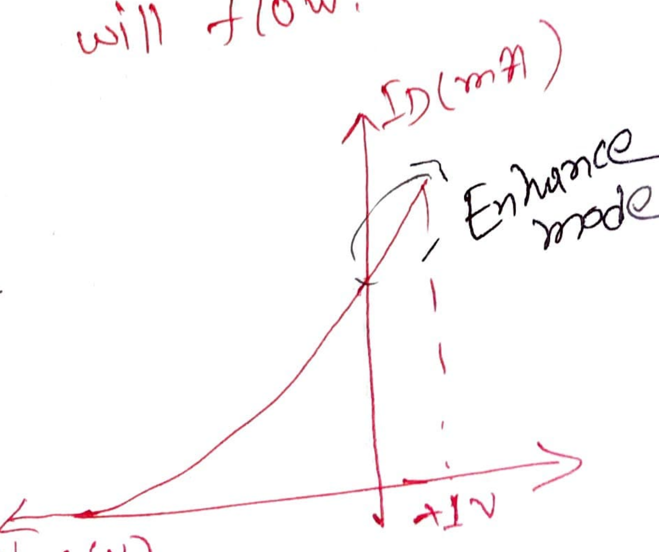




Applying positive voltage in the gate.

Channel length will increase. So more current will flow.





$$V_{GS} = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$= I_{DSS}\left(1 - \frac{+1V}{V_P}\right)^2$$

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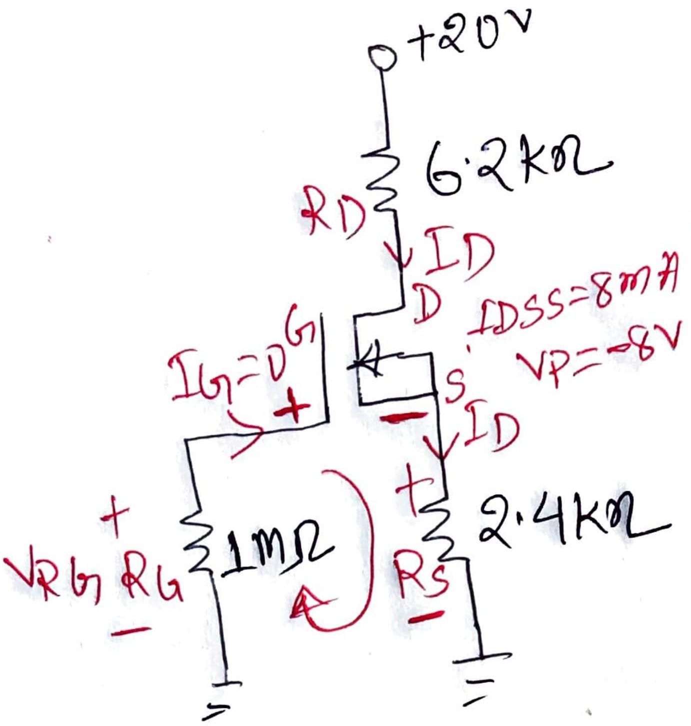
D-MOSFET : SELF BIAS

Find, I_{DQ}, V_{GSQ}, V_{DS}, V_S, V_G.



$I_G = 0$

so $V_{RG} = I_G \times R_G$
$= 0$

Applying KVL,

$-V_{GS} - I_D R_S = 0$

$\Rightarrow V_{GS} = -I_D R_S$

$\therefore V_{GS} = -I_D(2.4k\Omega)$ ------ (1)

Let's apply shorthand method, $I_{DSS} = 8mA$, $V_P = -8V$

(i) If $V_{GS} = 0$, | $I_D = I_{DSS} = 8mA$

(ii) If $V_{GS} = 0.3V_P$
$= 0.3(-8V)$
$= -2.4V$
| $I_D = I_{DSS}/2 = 8/2 = 4mA$

(iii) If $V_{GS} = 0.5V_P$
$= 0.5(-8V)$
$= -4V$
| $I_D = I_{DSS}/4 = 8/4 = 2mA$

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(iv) If $V_{GS} = V_P$
$= -8V$

$I_D = 0$

As this is depletion type MOSFET, so it will work on positive Gate to source (V_{GS}) voltage.

So we need to apply some positive voltage in V_{GS} to find I_D.

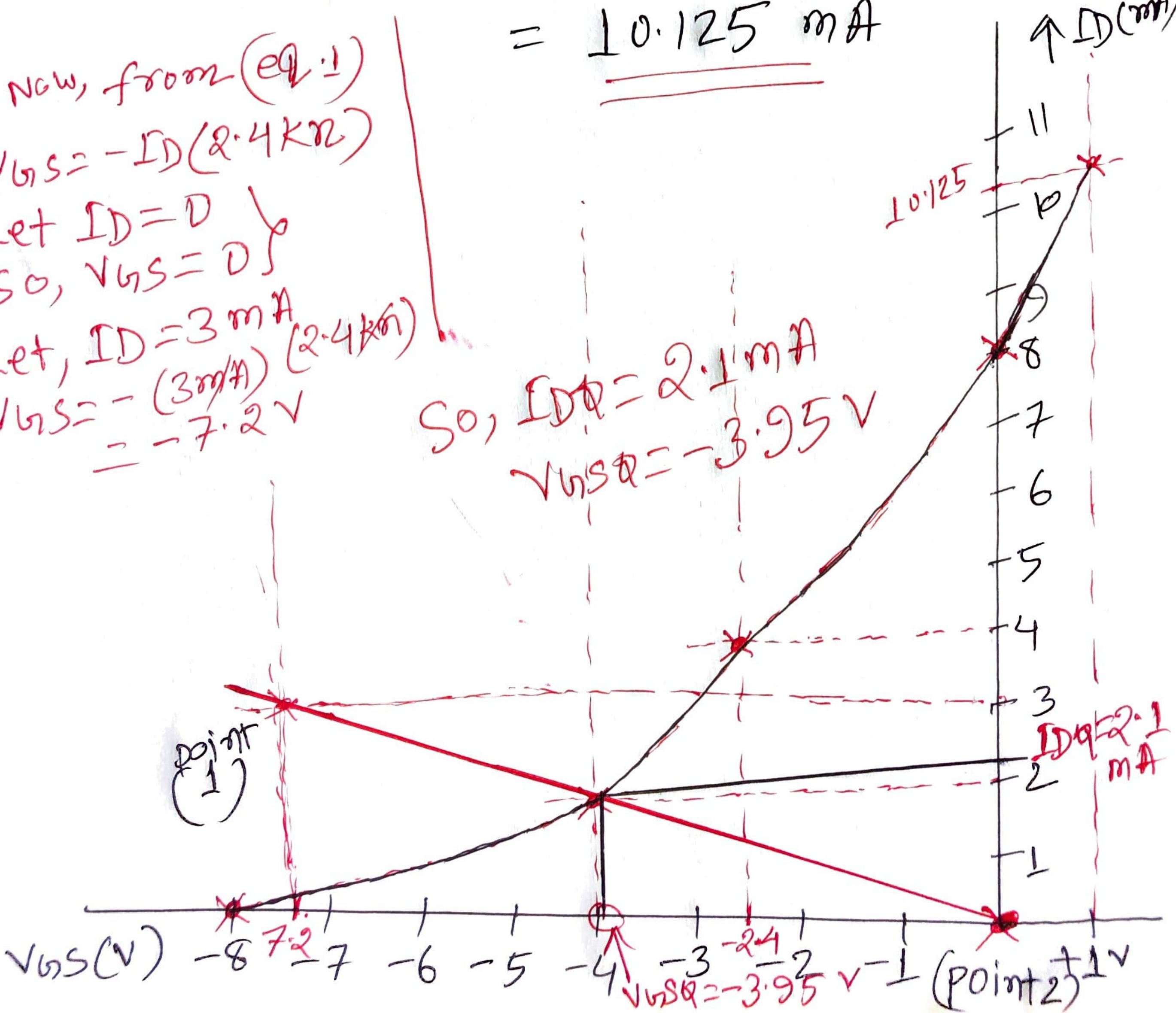
We know, $I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$

Let, $V_{GS} = +1V$

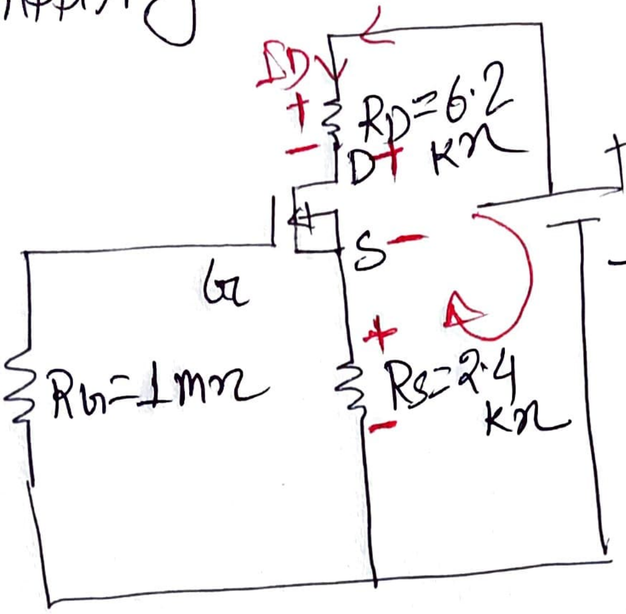
So, $I_D = 8mA\left(1 - \frac{+1V}{-8V}\right)^2$
$= \underline{10.125\ mA}$

Now, from (eq.1)
$V_{GS} = -I_D(2.4K\Omega)$
Let $I_D = 0$
So, $V_{GS} = 0$
Let, $I_D = 3mA$
$V_{GS} = -(3mA)(2.4K\Omega)$
$= -7.2V$

So, $I_{DQ} = 2.1mA$
$V_{GSQ} = -3.95V$



Now,
Applying KVL in the output side



$$+I_D R_S + V_{DS} + I_D R_D - V_{DD} = 0$$

$$\Rightarrow V_{DS} = V_{DD} - I_D(R_D + R_S)$$

$$= 20V - 2.1\,mA\,(6.2\,k\Omega + 2.4\,k\Omega)$$

$$= 20V - 18.06$$

$$\boxed{V_{DS} = 1.94V}$$

$$V_{DS} = V_D - V_S$$

$$\Rightarrow V_D = V_{DS} + V_S$$

$$= 1.94V + 5.04V$$

$$= 6.98V$$

$$V_S = I_D R_S$$

$$= (2.1\,mA)(2.4\,k\Omega)$$

$$\boxed{V_S = 5.04V}$$

OR, $V_D = V_{DD} - I_D R_D$

$$V_{GS} = V_G - V_S$$

$$\Rightarrow V_G = V_{GS} + V_S = -I_D R_S + I_D R_S$$

$$= 0V$$

$$V_{GS} = -I_D R_S$$

$$V_S = I_D R_S$$

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