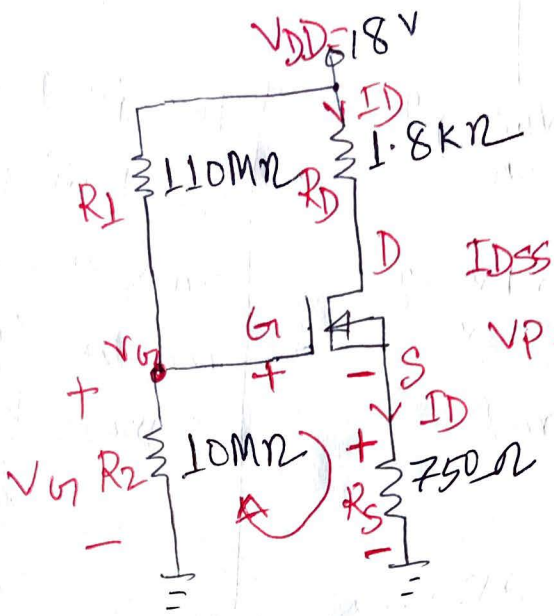
D- MOSFET: Voltage Divider Bias

Find I_{DQ}, V_{GSQ}, V_{DS}, V_D, V_S, V_{DG}



Applying KVL,

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

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

$$= 1.5V - I_D(750\Omega) \cdots (1)$$

$$V_G = \frac{R2 \times V_{DD}}{R1+R2}$$

$$= \frac{10M\Omega \times 18V}{(110M\Omega + 10M\Omega)}$$

$$= 1.5V$$

Short hand method:

(I) If $V_{GS} = 0$ | $I_D = I_{DSS} = 6mA$

(II) If $V_{GS} = 0.3V_P$
$= 0.3(-3V)$
$= -0.9V$ | $I_D = I_{DSS}/2 = \frac{6mA}{2} = 3mA$

(III) If $V_{GS} = 0.5V_P$
$= 0.5(-3)$
$= -1.5V$ | $I_D = I_{DSS}/4 = \frac{6mA}{4} = 1.5mA$

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(iv) If $V_{GS} = V_P = -3V$ | $I_D = 0$

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

Let $V_{GS} = +1V$

$\therefore I_D = 6mA\left(1 - \frac{+1V}{-3V}\right)^2$

$= 10.67\ mA$

This is D-MOSFET so it will work on (+ve) voltage on the Gate to source terminal.

From equation (1)

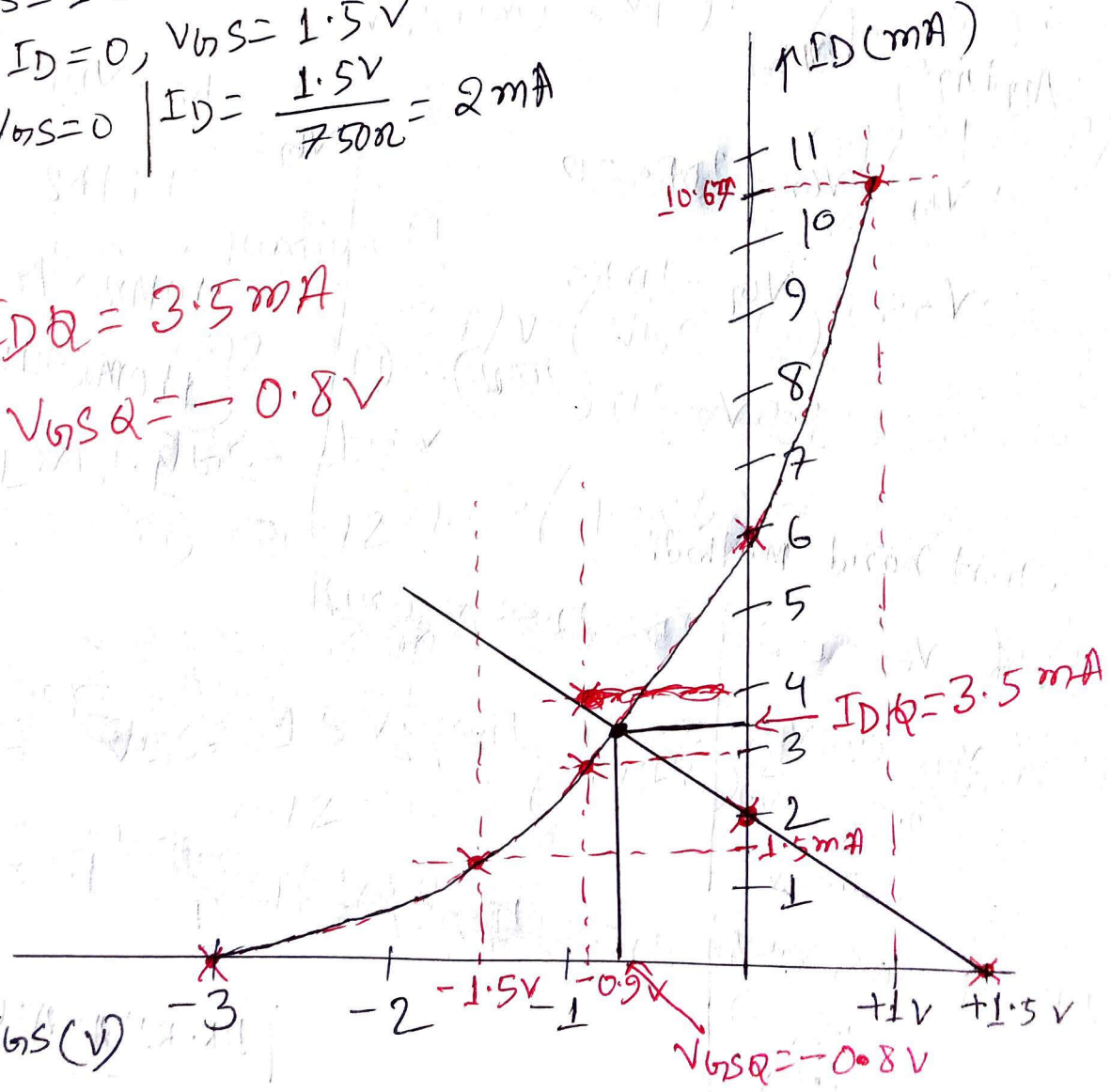
$V_{GS} = 1.5V - I_D(750\Omega)$

Let $I_D = 0$, $V_{GS} = 1.5V$

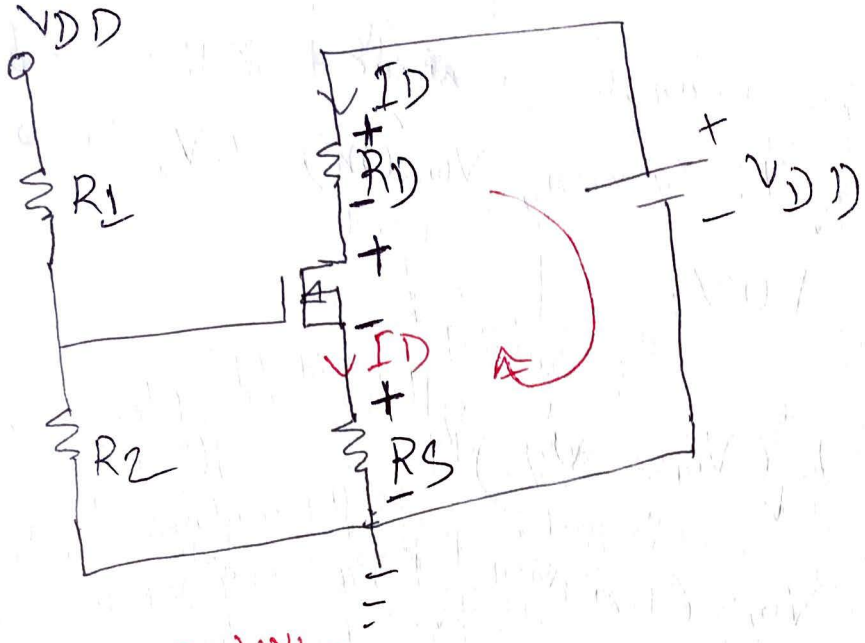
Let $V_{GS} = 0$ | $I_D = \frac{1.5V}{750\Omega} = 2mA$

$I_{DQ} = 3.5mA$

$V_{GSQ} = -0.8V$



(2)



Applying KVL,

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

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

$$= 18\,V - 3.5\,mA(1.8\,k\Omega + 750\times10^{-3}\,k\Omega)$$

$$\boxed{V_{DS} = 9.075\,V}$$

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

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

$$= 9.075 + 2.625$$

$$\boxed{V_D = 11.7\,V}$$

$$V_S = I_D R_S$$

$$= (3.5\times10^{-3}\,A)(750\,\Omega)$$

$$\boxed{V_S = 2.625\,V}$$

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

$$V_{DG} = V_D - V_G = 11.7\,V + 1.5\,V = 10.2\,V$$

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E- MOSFET

Sketch the transfer characteristics curve for EMOSFET. Given, $V_{GS(Th)} = 5V$, $I_{D(on)} = 3mA$, $V_{GS(on)} = 10V$.

$$I_D = K(V_{GS} - V_T)^2 \quad \cdots (1)$$

$$K = \frac{V_{GS(on)}}{1}$$

$$K = \frac{I_{D(on)}}{(V_{GS(on)} - V_T)^2} = \frac{3mA}{(10-5)^2}$$

$$= 0.12 \times 10^{-3} A/V^2$$

From equation (1)

$$I_D = 0.12 \times 10^{-3} A/V^2 (V_{GS} - 5)^2$$

Let, $V_{GS} = 10V$

$$\therefore I_D = 0.12 \times 10^{-3} (10-5)^2$$

$$= 3mA$$

Let $V_{GS} = 15V$

$$I_D = 0.12 \times 10^{-3} (15-5)^2$$

$$= 12mA$$

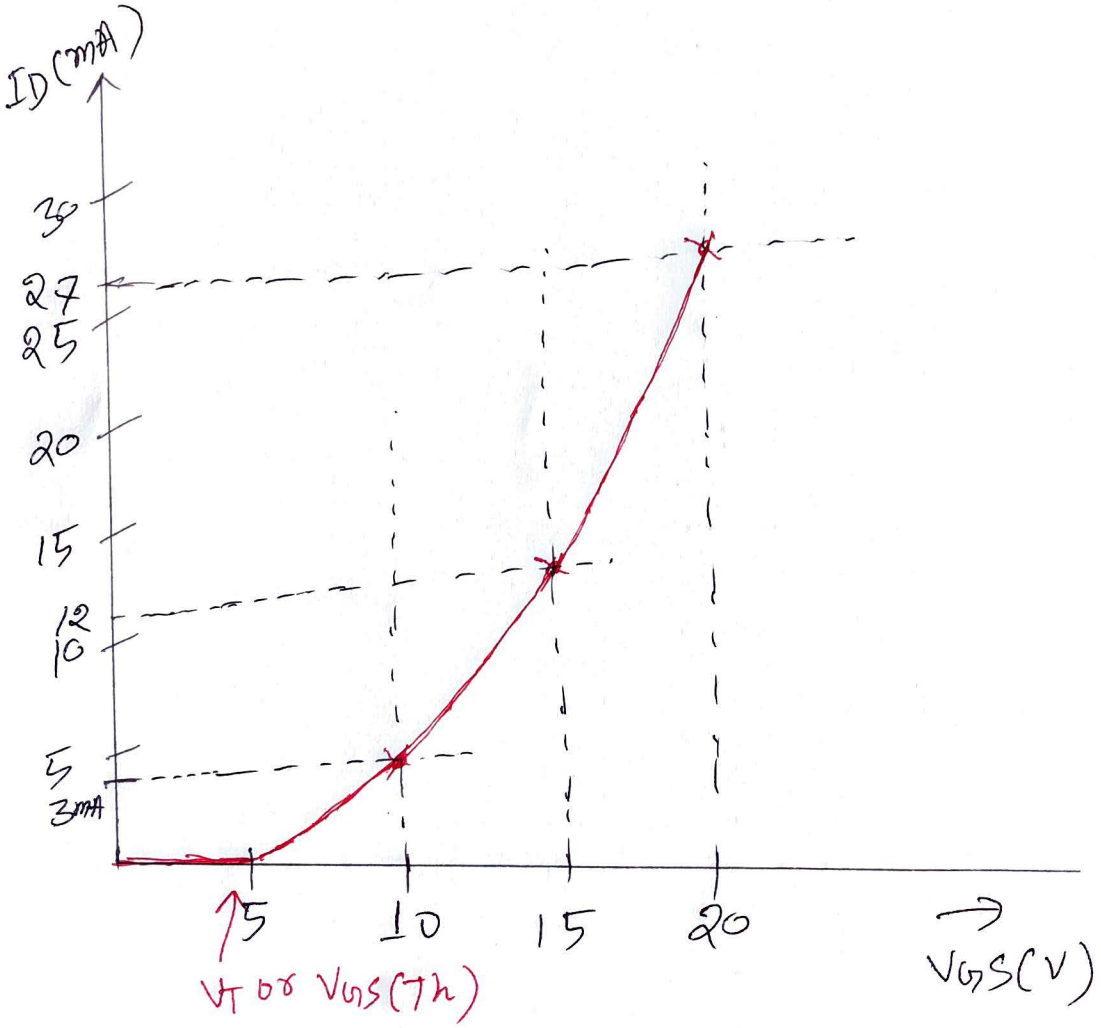
(3)

Let $V_{GS} = 20V$

$$I_D = 0.12 \times 10^{-3} (20-5)^2$$

$$= 27 \text{ mA}$$

** Take at-least 3 values of V_{GS}. The 3 values must be greater than V_T. Because below V_T, the I_D will be zero.



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