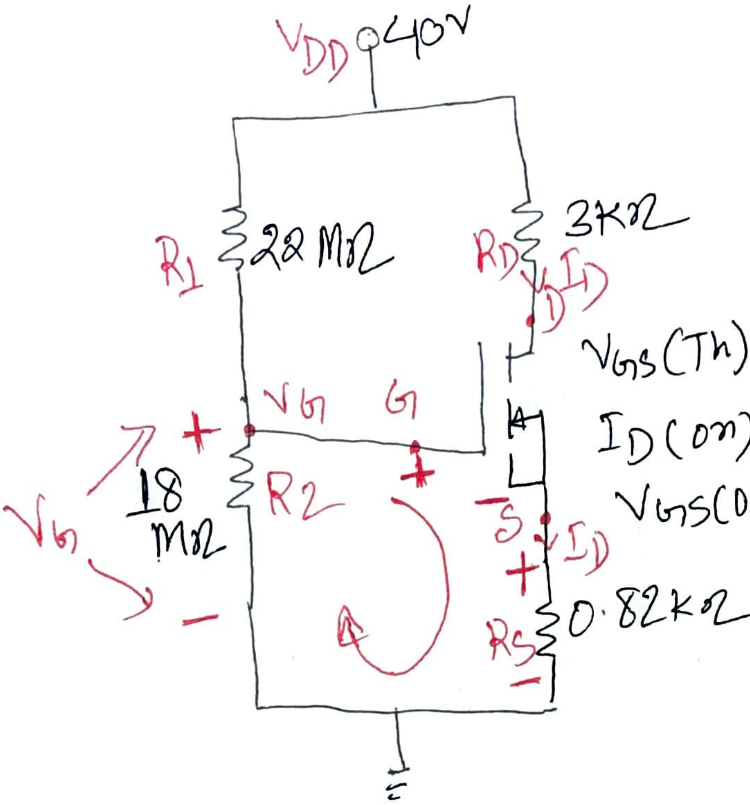
E-MOSFET : Voltage Divider Bias



Find, I_{DQ}, V_{GSQ}, V_{DS}, V_S, V_D, V_{GD}.

$V_{GS(Th)} = 5\,V$

$I_{D(on)} = 3\,mA$

$V_{GS(on)} = 10\,V$

~~Applying KVL~~,

$$V_G = \frac{R_2 \times V_{DD}}{R_1 + R_2} = \frac{18\,M\Omega \times 40}{22\,M\Omega + 18\,M\Omega} = 18\,V$$

Applying KVL,

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

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

$$\Rightarrow V_{GS} = 18V - I_D(0.82\,K\Omega) \quad \ldots\ldots (I)$$

we know, $I_D = K(V_{GS} - V_T)^2$

$$\therefore I_D = K(V_{GS} - 5V)^2 \quad \ldots\ldots (II)$$

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

$$= \frac{3 \times 10^{-3} A}{(10V - 5V)^2}$$

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

From equation (II)

$$I_D = 0.12 \times 10^{-3} (V_{GS} - 5V)^2 \quad \cdots \text{(III)}$$

Now, we need to draw transfer characteristics curve from eq. (III).

From eq. (III),

Let, $V_{GS} = 10V$

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

Let, $V_{GS} = 15V$

$\therefore I_D = 0.12 \times 10^{-3} (15 - 5)^2 = 12\,mA$

Let, $V_{GS} = 20V$

$\therefore I_D = 0.12 \times 10^{-3} (20 - 5)^2 = 27\,mA$

Next, we need to draw the transfer characteristics curve based on this point.

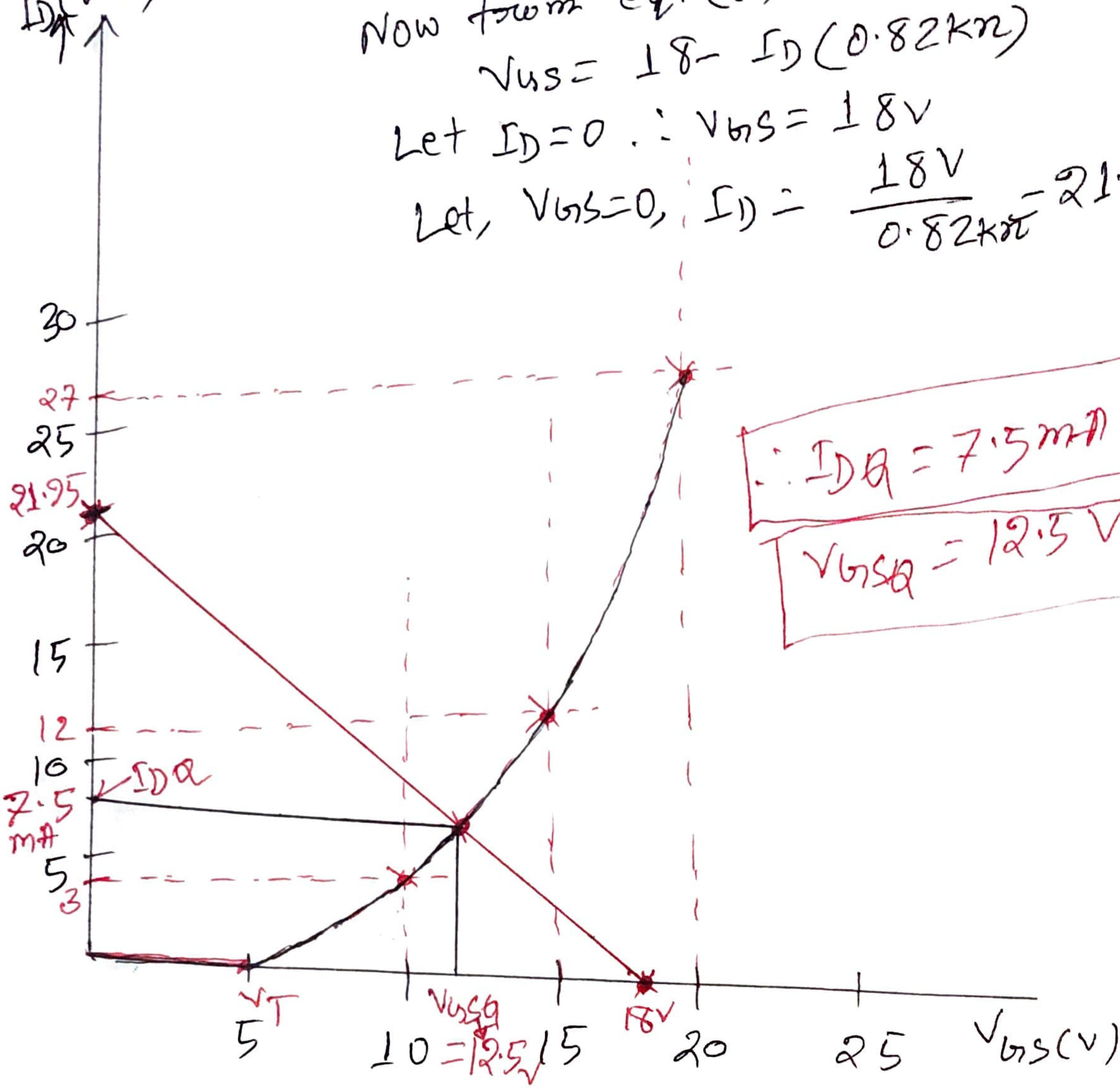
(P)

Now from eq. (1)

$V_{GS} = 18 - I_D(0.82\,k\Omega)$

Let $I_D = 0$ $\therefore V_{GS} = 18\,V$

Let, $V_{GS} = 0$, $I_D = \dfrac{18\,V}{0.82\,k\Omega} = 21.95\,mA$



$\therefore I_{DQ} = 7.5\,mA$

$V_{GSQ} = 12.5\,V$

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

$= 40V - (7.5\,mA)(3.0\,k\Omega + 0.82\,k\Omega)$

$\boxed{V_{DS} = 11.35\,V}$

$V_{DS} = V_D - V_S$

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

$= 11.35\,V + 6.15\,V$

$\boxed{V_D = 17.5\,V}$

$V_S = I_D R_S$

$= (7.5\,mA)(0.82\,k\Omega)$

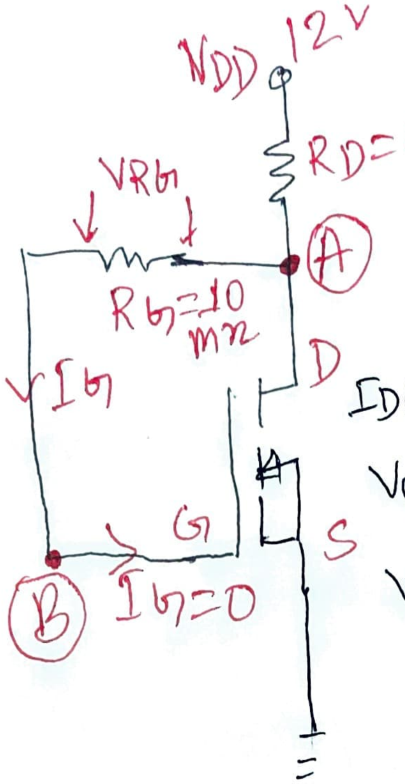
$\boxed{V_S = 6.15\,V}$

$\cancel{V_{GS}}$ $V_{GD} = V_G - V_D$

$= 18V - 17.5V$

$\boxed{V_{GD} = 0.5\,V}$

E-MOSFET Feedback Bias

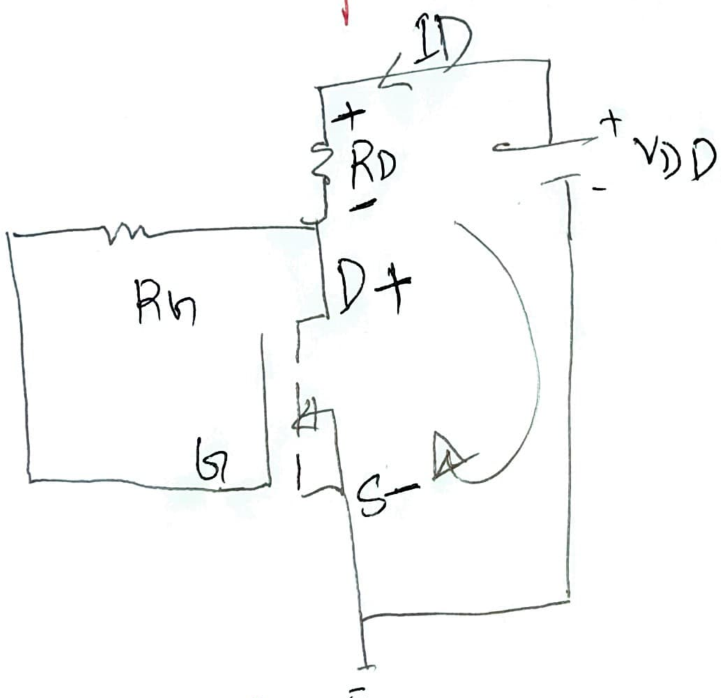


$I_{D(on)} = 6\,mA$
$V_{GS(on)} = 8\,V$
$V_{GS(Th)} = 3\,V$

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

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

$\therefore V_D = V_G$ | OR G=D



Applying KVL,

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

$\therefore V_{DS} = V_{DD} - I_D R_D$

$V_{GS} = V_{DD} - I_D R_D \ldots \ldots (1)$ [$\because$ G=D] we know,

$\cancel{V_{GS} = K}$

$$I_D = K(V_{GS} - V_T)^2 \quad \dots \text{(ii)}$$

Now, $K = \dfrac{I_{D(on)}}{(V_{GS(on)} - V_T)^2} = \dfrac{6 mA}{(8V - 3V)^2}$

$$= \frac{6 \times 10^{-3} A}{(8V - 3V)^2}$$

$$= 0.24 \times 10^{-3} A/V^2$$

From eq. (ii)

$$I_D = 0.24 \times 10^{-3} A/V^2 (V_{GS} - 3V)^2 \quad \dots \text{(iii)}$$

Let, $\cancel{I_D}$ $V_{GS} = 6V$

$$\therefore I_D = 0.24 \times 10^{-3} A/V^2 (6V - 3V)^2$$

$$= 2.16 mA$$

Let, $V_{GS} = 8V$

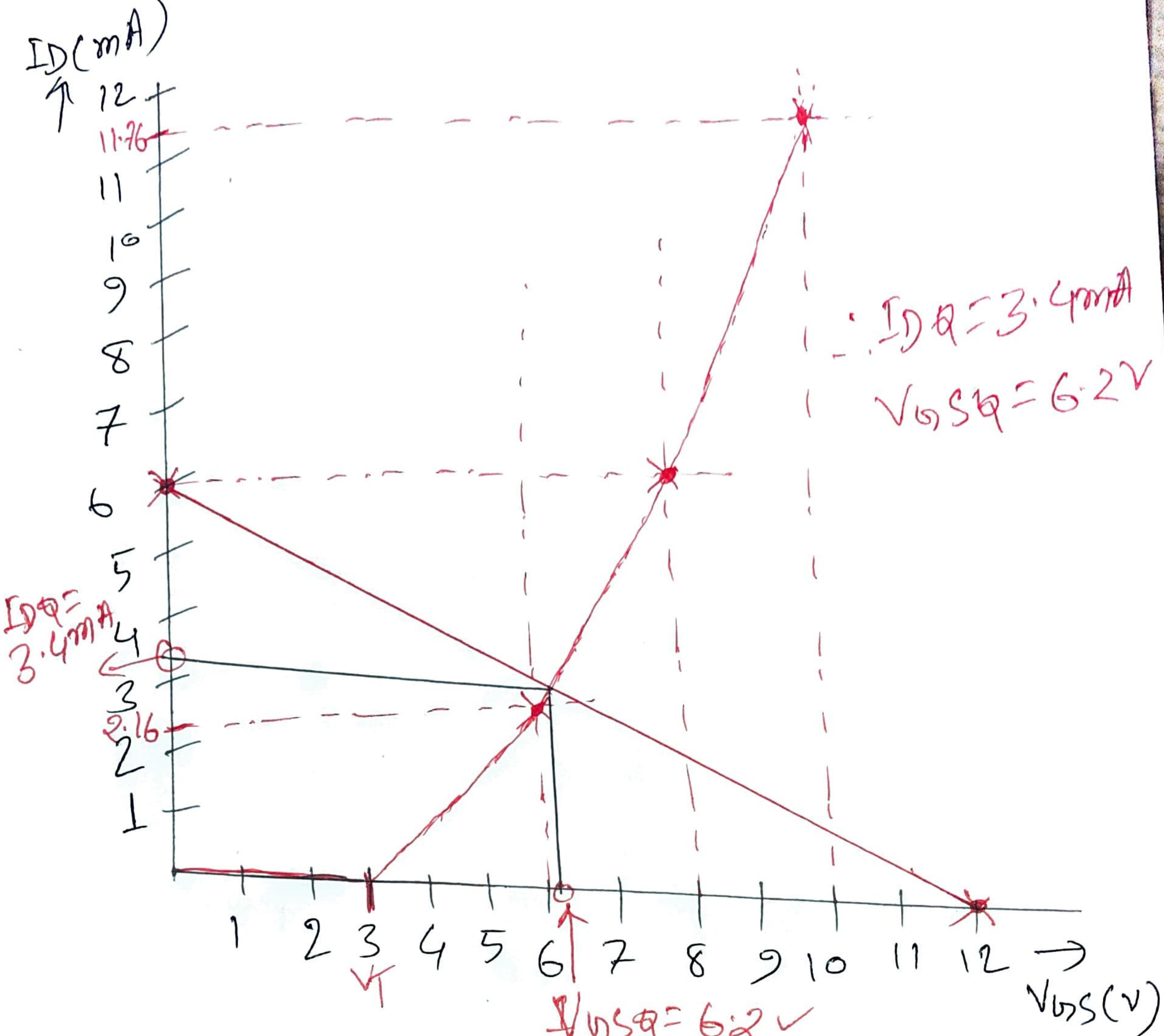
$$I_D = 0.24 \times 10^{-3} A/V^2 (8V - 3V)^2$$

$$= 6 mA$$

Let $V_{GS} = 10V$

$$\therefore I_D = 0.24 \times 10^{-3} A/V^2 (10 - 3V)^2$$

$$= 11.76 mA$$



From eq.(1)

$V_{GS} = V_{DD} - I_D R_D$

Let, $I_D = 0$, $V_{GS} = V_{DD} = 12V$

Let $V_{GS} = 0$, $I_D = \frac{V_{DD}}{R_D} = \frac{12V}{2k\Omega}$

$= 6 mA$

$\boxed{V_{DS} = V_{GS} = 6.2V}$

$\boxed{V_S = 0V}$

$V_{DS} = V_D - V_S$

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

$V_D = 6.2V + 0$

$V_D = 6.2V$