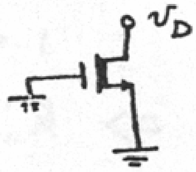
28 $k_n'(W/L) = 2\ mA/V^2$

$V_t = -3\ V$



$v_{GS} = 0 > V_t \Rightarrow$ device is on

$v_{GS} - V_t = 3\ V$

(a) $v_D = 0.1\ V \quad v_{DS} = 0.1\ V < v_{GS} - V_t$

$\Rightarrow$ triode region

$i_D = k_n' \frac{W}{L}\left[(v_{GS} - V_t)V_{DS} - \frac{1}{2}V_{DS}^2\right]$

$= 2\left[3 \times 0.1 - \frac{1}{2} \times 0.1^2\right] = \underline{\underline{0.59\ mA}}$

(b) $v_D = 1\ V \quad v_{DS} = 1\ V < v_{GS} - V_t$

$\Rightarrow$ triode region,

$i_D = 2\left[3 \times 1 - \frac{1}{2} \times 1^2\right] = \underline{\underline{5\ mA}}$

(c) $v_D = 3\ V \quad v_{DS} = 3\ V = v_{GS} - V_t$

$\Rightarrow$ saturation region,

$i_D = \frac{1}{2} k_n' \frac{W}{L}(v_{GS} - V_t)^2$

$= \frac{1}{2} \times 2 \times 9 = \underline{\underline{9\ mA}}$

(d) $v_D = 5\ V \quad v_{DS} = 5\ V > v_{GS} - V_t$

$\Rightarrow$ saturation region,

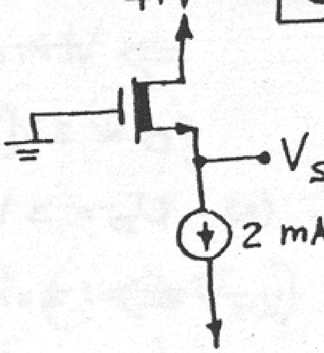
$i_D = \frac{1}{2} \times 2 \times 9 = \underline{\underline{9\ mA}}$

31 $k_n' \frac{W}{L} = 4\ mA/V^2$

$V_t = -2\ V$

Since $v_{DG} < |V_t|$, the MOSFET will be operating in the triode region,

5



$$i_D = k_n' \frac{W}{L} \left[(v_{GS} - V_t) v_{DS} - \frac{1}{2} v_{DS}^2 \right]$$

$$2 = 4 \left[(-V_S + 2)(1 - V_S) - \frac{1}{2} (1 - V_S)^2 \right]$$

$$= -4V_S + 8 - 8V_S + 4V_S^2 - 2 - 2V_S^2 + 4V_S$$

$$2V_S^2 - 8V_S + 4 = 0$$

$$V_S^2 - 4V_S + 2 = 0$$

$$V_S = \frac{4 \pm \sqrt{16 - 8}}{2} = 2 \pm \sqrt{2}$$

$$= 3.414\ V \text{ or } 0.586\ V$$

The first answer is not physically meaningful for it results in the $V_{GS} = -3.414 < V_t$ and thus implies cut-off. Thus

$$V_S = \underline{\underline{+0.586\ V}}$$

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$$i_D = \frac{1}{2} k_n' \frac{W}{L} (v_{GS} - V_t)^2$$

$$1 = \frac{1}{2} k_n' \frac{W}{L} (-1 - V_t)^2 \quad (1)$$

$$9 = \frac{1}{2} k_n' \frac{W}{L} (1 - V_t)^2 \quad (2)$$

$$\frac{(2)}{(1)} \Rightarrow 9 = \frac{(1-V_t)^2}{(-1-V_t)^2} \Rightarrow 3 = \frac{1-V_t}{-1-V_t}$$

$$V_t = \underline{\underline{-2\ V}}$$

5

Substitute in (1)

$$1 = \frac{1}{2} k_n' \frac{W}{L} \times 1$$

$$k_n' \frac{W}{L} = 2 \ mA/V^2$$

$$I_{DSS} = \frac{1}{2} k_n' \frac{W}{L} V_t^2 = \frac{1}{2} \times 2 \times 4 = \underline{\underline{4\ mA}}$$