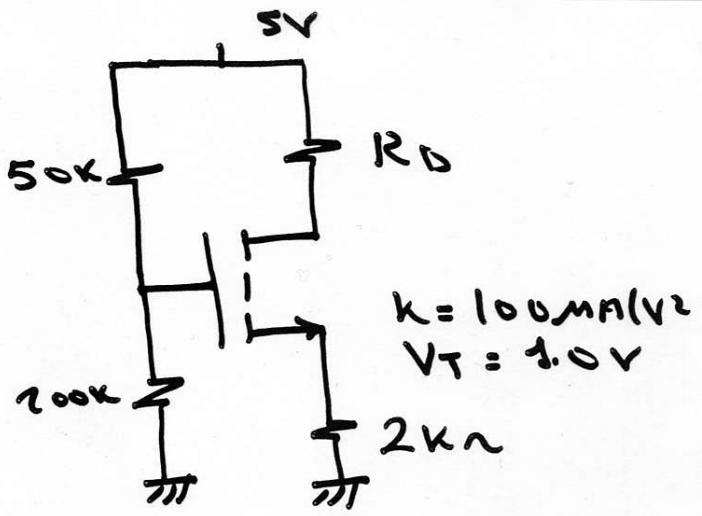
① 

If $I_{DS} = 0.29\,mA$, what is the largest value of R_D to remain in saturation?

$$V_G = 5 * \frac{200}{250} = 4V$$

$$V_S = 0.29 \times 10^{-3} * 2K = 0.58V$$

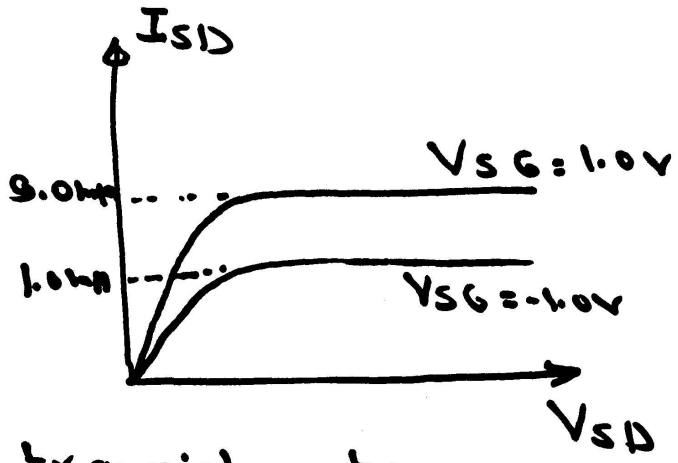
$$\therefore V_{GS} = V_G - V_S = 3.42V$$

$$V_{GS} - V_{TN} = 2.42V$$

$$\therefore V_{DS} \geq 2.42 \Rightarrow 5 - 0.29 K_D \geq 2.42 \quad (-0.58)$$

$$R_D \leq 8.89K\Omega$$

(2)



Determine transistor type and threshold voltage

Answer:

$$1.0\times10^{-3} = \frac{K_p}{2}(V_{SG_1}+V_{TP})^2 \leftarrow (1)$$

$$9.0\times10^{-3} = \frac{K_p}{2}(V_{SG_2}+V_{TP})^2 \leftarrow (2)$$

divide (2) by (1)

$$9 = \frac{(V_{TP}+1)^2}{(V_{TP}+1)^2}$$

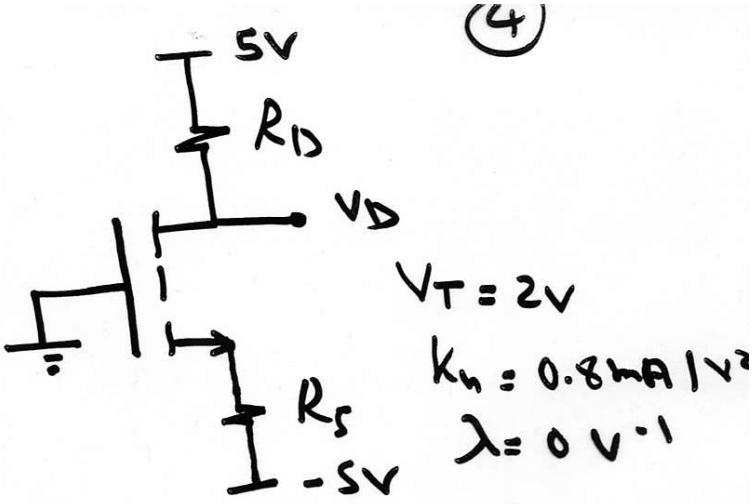
$$\pm 3 = \frac{V_{Tp} + 1}{V_{Tp} - 1}$$

$V_{Tp} = +2\,V$ or $V_{Tp} = +0.5\,V$

$V_{Tp} = 0.5\,V$ is rejected

$\therefore$ transistor is depletion PMOS with $V_{Tp} = 2\,V$

(4)



Determine R_D and R_S such that

$I_{DS} = 0.4mA$, $V_D = 1V$

Answer: transistor must be Saturate

because $V_S < -2V$ for $V_{GS} > V_T$

$$V_{DS} = V_D - V_S = 1 - V_S > 0 - V_S - 2$$

or $-V_S + 1 > -V_S - 2$

$$I_{DS} = \frac{K_n}{2}(V_{GS} - 2)^2$$

$$0.4 \times 10^{-3} = \frac{0.8 \times 10^{-3}}{2}(V_{GS} - 2)^2$$

$$\therefore \pm 1 = V_{GS} - 2 \Longrightarrow V_{GS} = 3V$$

or $V_S = -3V$

$$\therefore R_S = \frac{2.0}{0.4 \times 10^{-3}} = 5k\Omega$$

and $$R_D = \frac{4}{0.4 \times 10^{-3}} = 10k\Omega$$