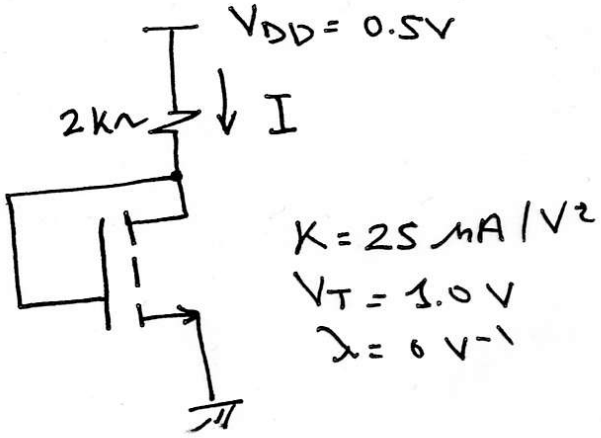
(1)




a) what is the value of I ?

b) Repeat for $V_{DD} = 5.0V$

* ANSWER: For $V_{DD} = 0.5V$, transistor must be off because $V_{DS} = V_{GS} \leq 0.5V$

$\therefore I = 0$

* For $V_{DD} = 5.0V$, transistor must be Saturated

$$\therefore I = \frac{5 - V_{GS}}{2K} = I_{DS} = \frac{K}{2}(V_{GS} - 1)^2$$

$$\therefore \frac{5 - V_{GS}}{2K} = \frac{25 \times 10^{-6}}{2}(V_{GS} - 1)^2$$

$$\therefore 5 - V_{GS} = 25 \times 10^{-3}(V_{GS} - 1)^2$$

$$200 - 40V_{GS} = V_{GS}^2 - 2V_{GS} + 1$$

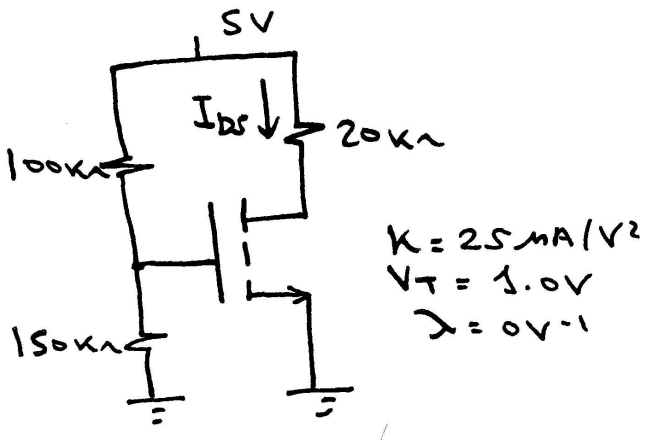
$$\text{or } V_{GS}^2 + 38V_{GS} - 199 = 0$$

$$\therefore V_{GS} = \frac{-38 \pm \sqrt{(38)^2 + 4 \times 199}}{2}$$

$$\therefore V_{GS} = \frac{-38 \pm 47.328}{2}$$

$$\therefore V_{GS} = 4.66\,V$$

(3)




Determine the operating point of the shown transistor.

solution: As $I_G = 0$, $V_G = 5 * \frac{150K}{100K + 150K}$

$\therefore V_G = 3V > 1.0V \Rightarrow$ transistor is on

* Assuming saturation region we have

$$I_{DS} = \frac{K_n}{2}(V_{GS} - V_T)^2 = \frac{25 * 10^{-6}}{2}(3 - 1)^2$$

$I_{DS} = 0.05mA$

* Verification: $V_D = 5 - I_{DS} * 20K$

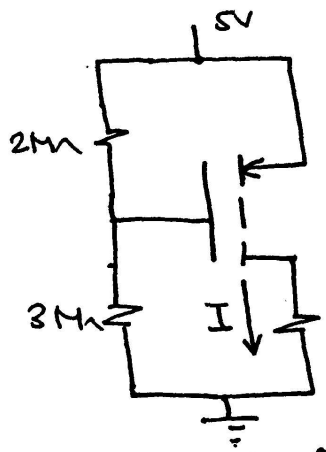
$V_D = 5 - 5 * 10^{-5} * 2 * 10^4$

$V_D = 4V$

$\therefore V_{DS} = 4V > V_{GS} - V_T = 3V$

Assumption of saturation is correct

(4)




Determine the current I for the shown circuit.

Answer: As $I_G = 0$, $V_G = \frac{5 * 3M}{3M + 2M} = 3V$

But $V_S = 5V \Longrightarrow V_{SG} = V_S - V_G = 2V$

It follows that $V_{SG} > -V_{TP} = 1V$ and PMOS transistor is on

* Assuming saturation region we have

$$I_{SD} = \frac{K_P}{2}(V_{SG} + V_{TP})^2$$

$$I_{SD} = \frac{10^{-3}}{2}(2 - 1)^2 = 0.5mA$$

* VERIVICATION: $V_D = I_{SD} * 2k = 1V$

$\therefore V_{SD} = V_S - V_D = 5.0 - 1.0V = 4V$

$\therefore V_{SD} > V_{SG} + V_{TP} = 1.0V \Rightarrow$ Assumption is correct