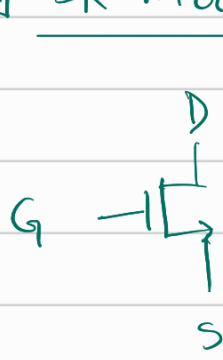
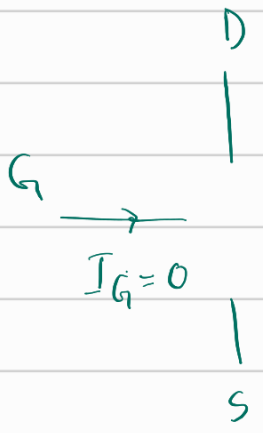
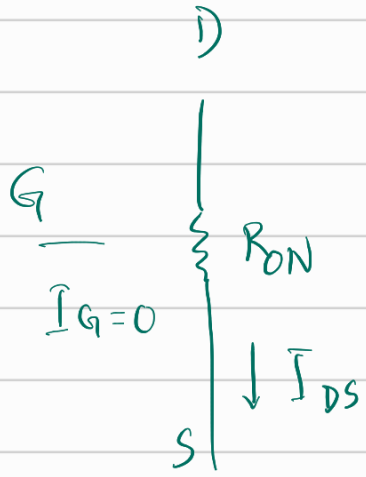
SR model :-

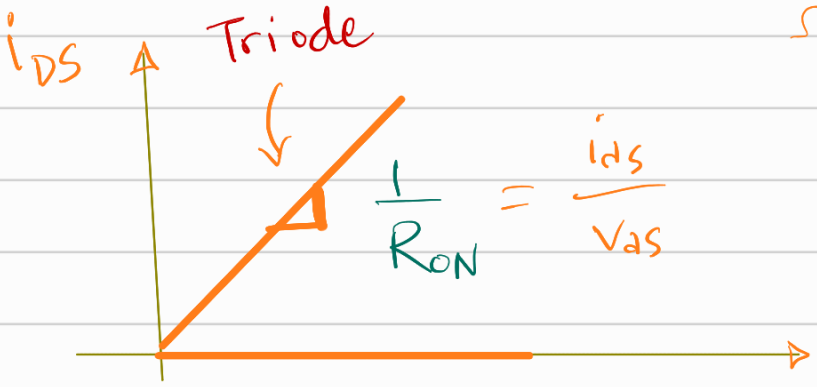




$V_{GS} < V_T$



$V_{GS} \geq V_T$



$$\Omega = \frac{V}{A} = \frac{1}{\frac{A}{V^2} \cdot V}$$

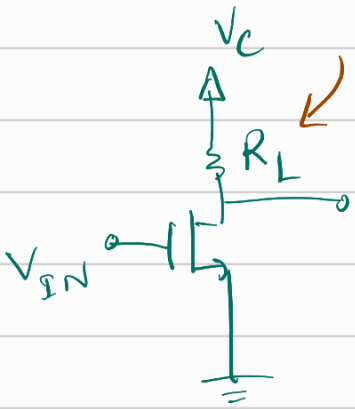
$$R_{ON} = \frac{1}{k_n' \frac{W}{L}(V_{GS} - V_T)}$$

$$R_{ON} = \frac{1}{k V_{OV}}$$

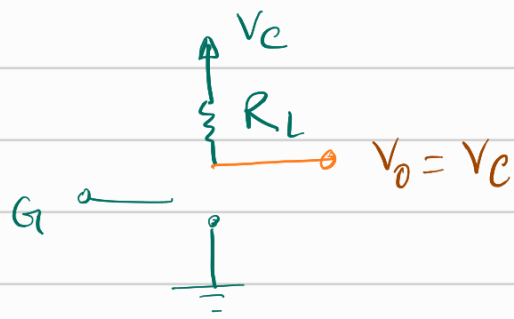
$$k = k_n' \frac{W}{L} \quad ; V_{OV} = V_{GS} - V_T$$

mA/V^2

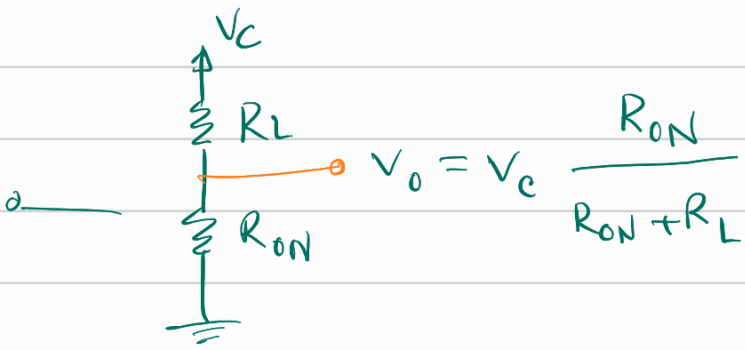
Inverter :-

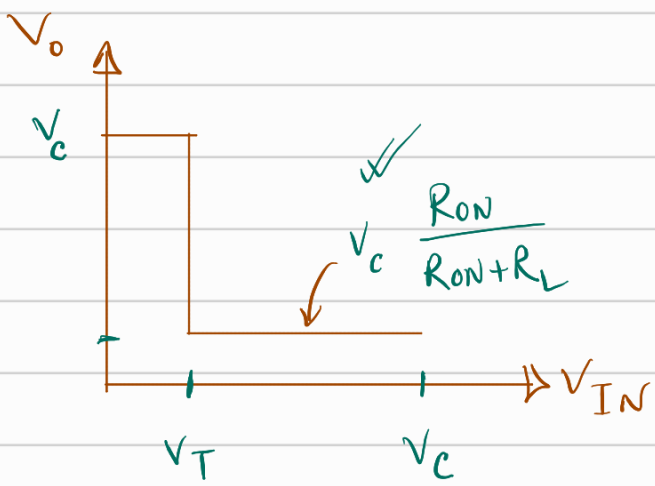


$V_{IN} < V_T$:



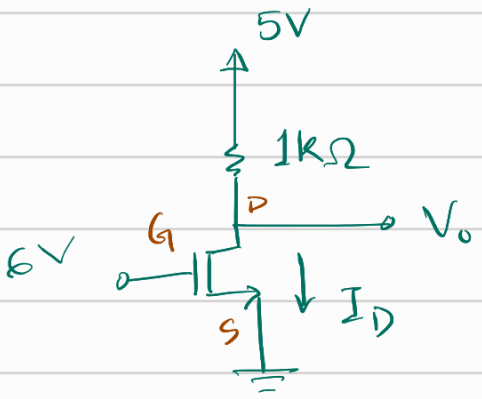
$V_{IN} \geq V_T$:





$\{ R_{ON} \rightarrow \frac{W}{L} \}$ ***

* Example 1 :-



given, $k = 0.5 mA/V^2$

$V_T = 1V$

$P_{1k\Omega} = ?$

Assume, saturation

$\neq \quad I_D = \frac{1}{2} k (V_{GS} - V_T)^2$

$V_{GS} = V_G - V_S = 6 - 0 = 6V$

$\therefore I_D = \frac{1}{2} \times 0.5 (6-1)^2$

$= 9 mA$

$\# \quad$ Saturation : $V_{GS} > V_T$; $V_{DS} > V_{OV}$

$\therefore V_{DS} = V_o = 5 - I_D \times 1k$

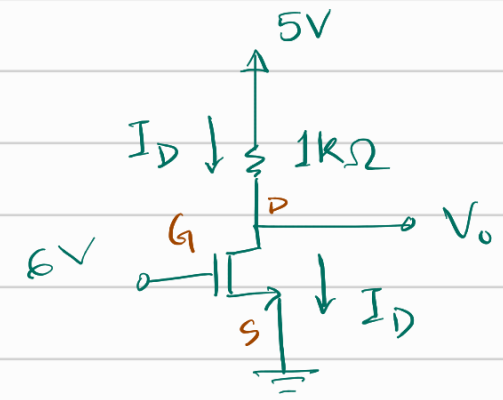
$= 5 - 9 \times 1$

$= -4V$

$\& \; V_{OV} = V_{GS} - V_T = 1V$ $\quad \Rightarrow V_{DS} = -4 \not> 1 = V_{OV}$

Assumption Wrong

Assume, Triode Region



$\# \quad I_D = k\left[(V_{GS} - V_T) V_{DS} - \frac{1}{2} V_{DS}^2\right]$

$\Rightarrow \frac{5-x}{1} = 0.5\left[5x - \frac{1}{2} x^2\right]$

$\Rightarrow 5 - x = 2.5x - 0.25x^2$

$\Rightarrow 0.25x^2 - 3.5x + 5 = 0$

$\Rightarrow x = 12.39, 1.61 = V_D = V_o$

$V_{DS} = V_D - V_S$
$= x - 0$
$= x$

$V_D = 1.61V \longrightarrow I_D = \frac{5 - V_o}{1k} = \frac{5 - 1.61}{1k} = 4.39 mA$

$\#$ Triode : $V_{DS} < V_{OV} \Rightarrow V_{DS} < V_{GS} - V_T$

$\Rightarrow V_{DS} < V_G - V_S - V_T$

$\Rightarrow V_{DS} < 5$

$V_D = 1.61, V_S = 0 \Rightarrow V_{DS} = 1.61 < 5 = V_{OV}$

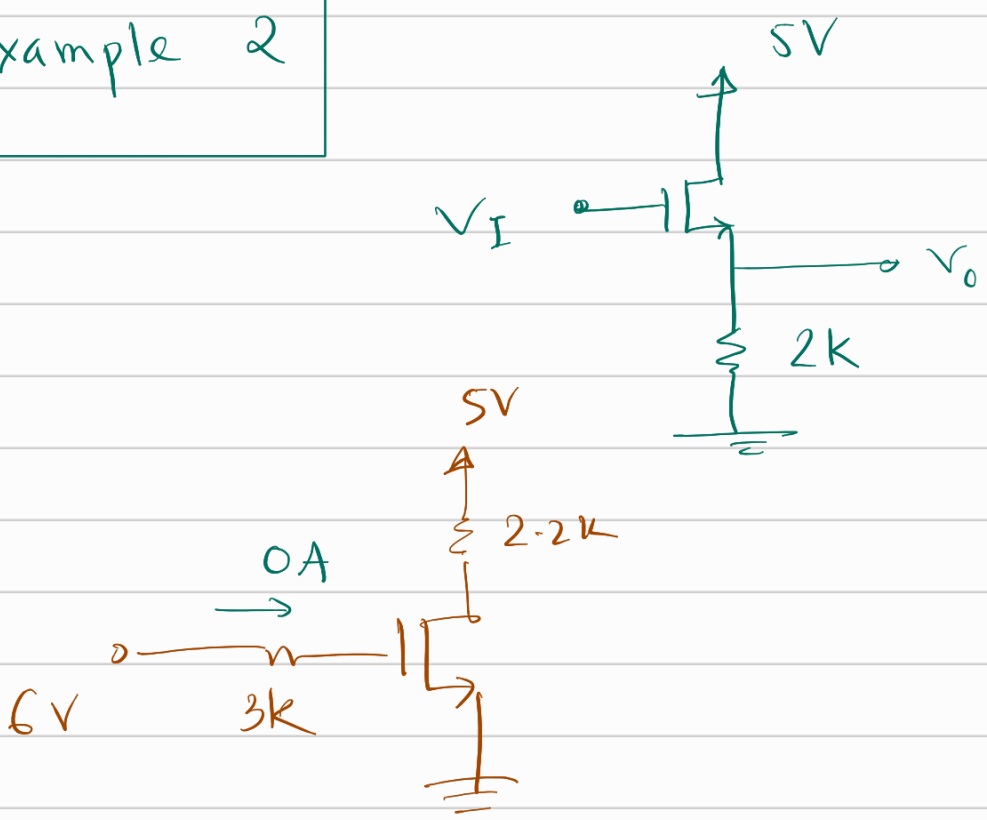
$\therefore$ Assumption Correct

$\mu \cdot k = m$

Therefore, $P_{1k\Omega} = I_D^2 \cdot 1k = 19.27 \underline{mW}$

$(mA)^2 \cdot k\Omega$

Example 2



$P_{3K} = 0\ W$