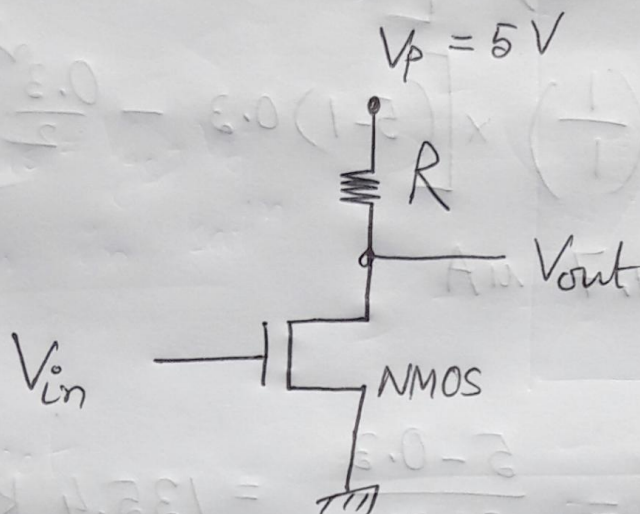
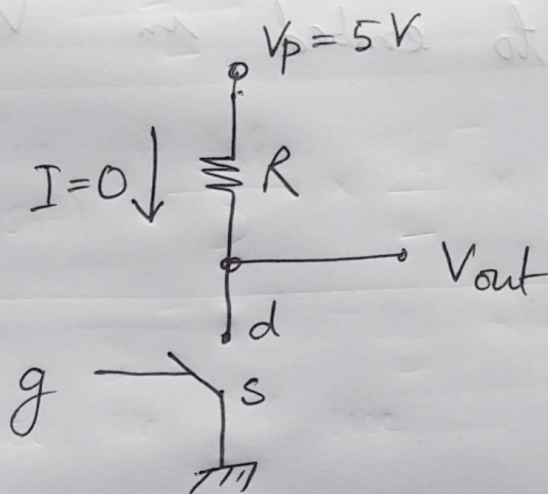


2.7
P-20

NMOS inverter with a Resistive Load



- a) When $V_{in} = 0V$, NMOS is off. So no current flow through resistance R ,



So $V_{out} = 5V$

- b) When $V_{in} = 5V$, NMOS conducts
 $V_{out} = V_{ds} = V_t \times 0.3 = 0.3V$

Here $V_{ds} = 0.3$
 $V_{gs} - V_t = 5 - 1 = 4$

$\therefore \frac{V_{ds}}{0.3} < \frac{V_{gs} - V_t}{4}$, So NMOS is in Resistive mode

$$\begin{aligned}
 \text{So } I_{ds(\text{res})} &= \frac{\epsilon \mu_n}{D} \left(\frac{W}{L} \right) \times \left[(V_{gs} - V_t) V_{ds} - \frac{V_{ds}^2}{2} \right] \\
 &= 30 \times \left(\frac{1}{1} \right) \times \left[(5-1) 0.3 - \frac{0.3^2}{2} \right] \\
 &= 34.7 \mu A
 \end{aligned}$$

$$R = \frac{V_p - V_{out}}{I_{ds}} = \frac{5 - 0.3}{34.7 \mu A} = 135.4 \text{ K}\Omega$$

High resistance

Issue : Difficult to embed in VLSI.