



Electrical and Computer Systems Engineering Department

ENCS333

Homework 2

Due October 11th

- 1- If a designer wants a perfectly balanced rise time and fall time for a CMOS inverter driving a capacitive load, what should the ratio of NMOSFET to PMOSFET transistor widths be?
- 2- In the context of digital integrated circuits, what are holes? Use three or fewer sentences.
- 3- List three advantages of CMOS over NMOS, and one advantage of NMOS over CMOS.
- 4- Delay depends on the input patterns. Consider Figure 1.
 - In input pattern P, inputs A and B are each low for a long time, then input B transitions instantly to V_{DD} .
 - In input pattern Q, inputs A and B are each low for a long time, then both transition to V_{DD} simultaneously and instantly. Which input pattern results in more delay? Explain why

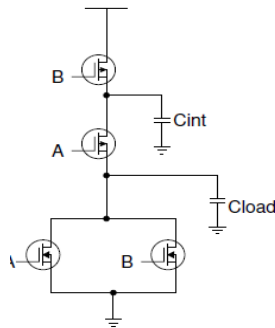
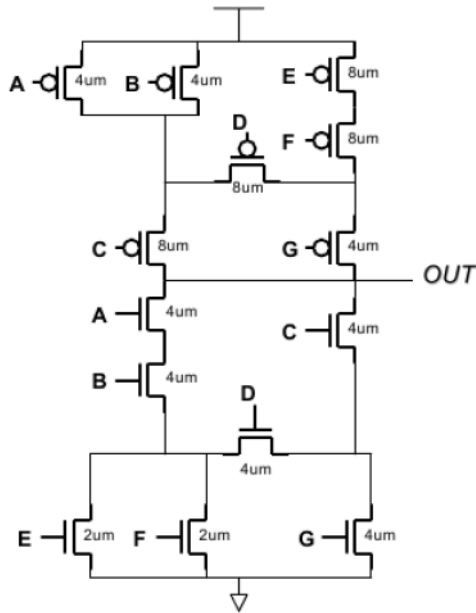


Figure 1: Logic gate.

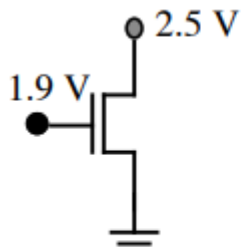
- 5- Show the circuit diagram for the function below using pass gate with output buffer or inverter.

$$f(a, b, c) = ab + \bar{a}\bar{b}\bar{c}$$

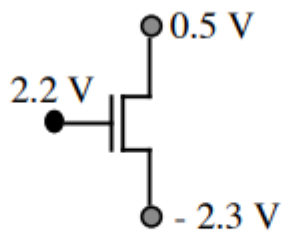
- 6- Use default parameters unless alternate values are given. Write a logic equation for this complex gate.



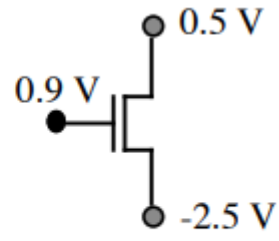
7- Determine the bias state (Region of operation) for the three circuit conditions if $V_{tn} = 0.4$ V. The source voltage is always lower than the drain voltage in an nMOS transistor. First identify the correct terminals.



(a)

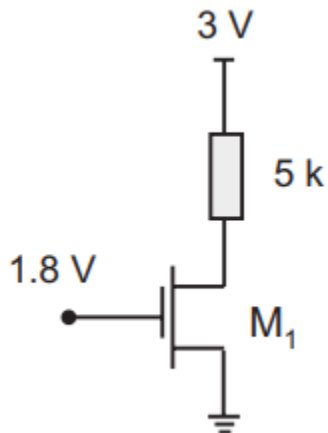


(b)



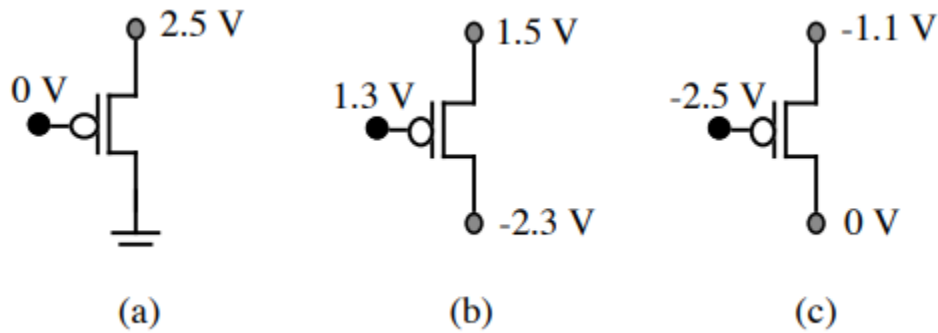
(c)

8- Calculate I_D and V_{DS} if $K_n = 100 \mu\text{A}/\text{V}^2$, $V_{tn} = 0.6$ V, and $W/L = 3$ for transistor M_1 .



9- Repeat Q8 above finding I_D and V_{DS} if $V_G = 1.8 \text{ V}$

10- Determine the bias state for the pMOS transistors where $V_{tp} = -0.4 \text{ V}$. It is helpful with pMOS transistors to first identify and label the source and drain terminals. The source terminal in a pMOS transistor has a higher voltage than the drain terminal.



11- Calculate I_D and V_{DS} for $V_{tp} = -1.0 \text{ V}$, $K_p = 100 \mu\text{A}/\text{V}^2$, and $W/L = 4$

