Discussion 1C

Su22 EECS16B

Notes made by
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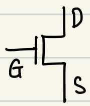
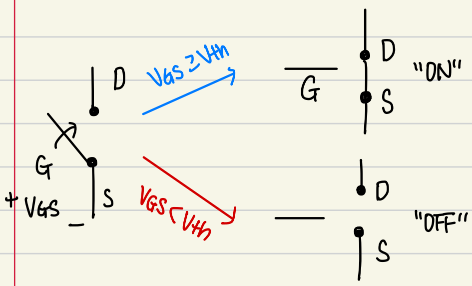
Q1

Transistor Review

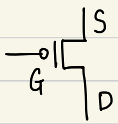
NMOS

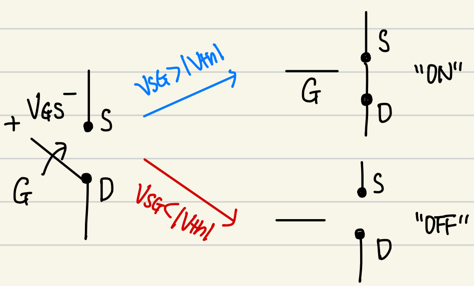




Simple model
: think of transistor as a <u>switch</u>

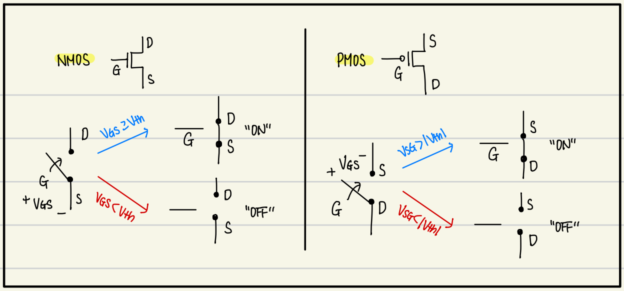
PMOS



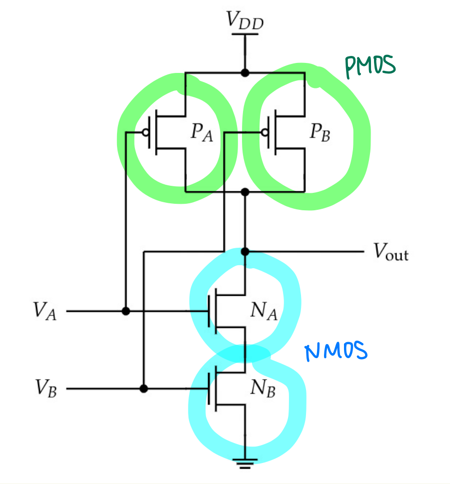


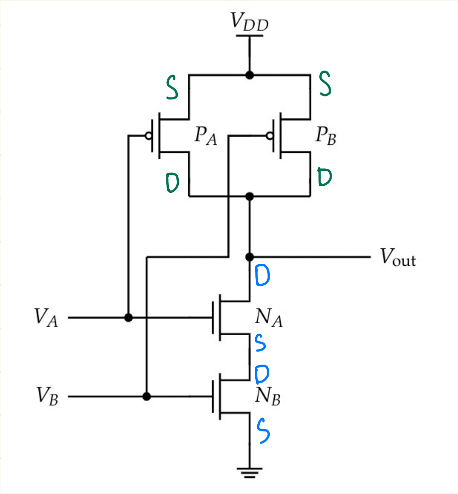
Note: $0 < V_{th} < V_{DD}$

cheatsheet

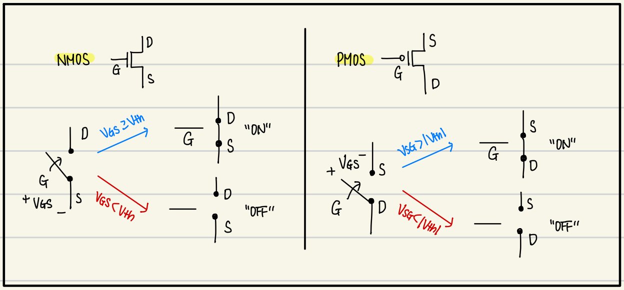


a) (a) **Label the gate, source, and drain nodes for the NMOS and PMOS transistors above.**



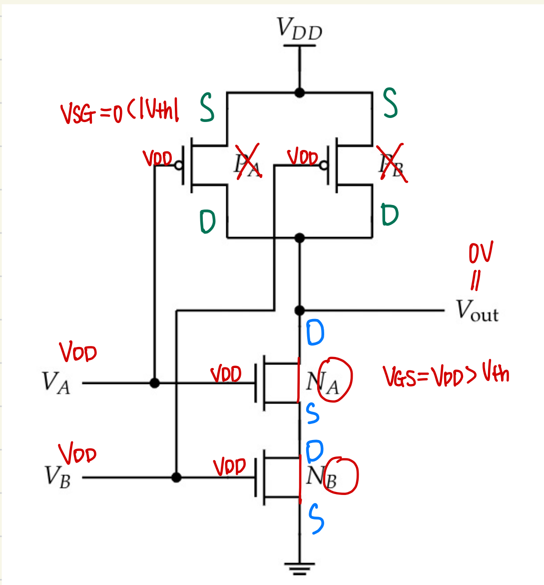


cheatsheet



Note: $0 < V_{th} < V_{DD}$

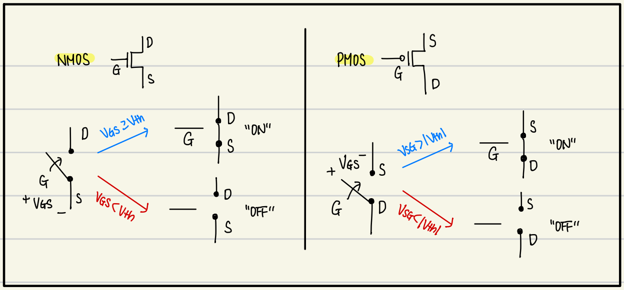
b) $V_A = V_{DD}$, $V_B = V_{DD}$ $\quad$ $V_{out} = 0V$



→ Note: V_A is connected to P_A, N_A

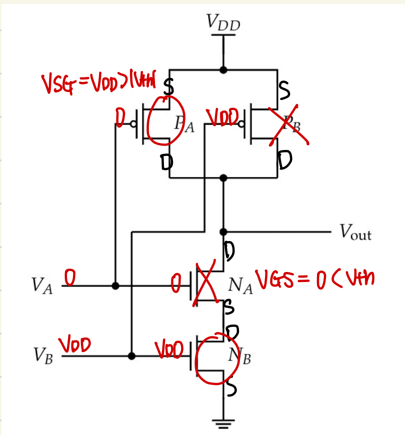
V_B " " P_B, N_B

cheatsheet



Note: $0 < V_{th} < V_{DD}$

c) $V_A = 0V$, $V_B = V_{DD}$ $V_{out} = V_{DD}$ (Since P_A is closed connecting V_{out} to V_{DD} and it's not connected to ground as N_A is turned off)



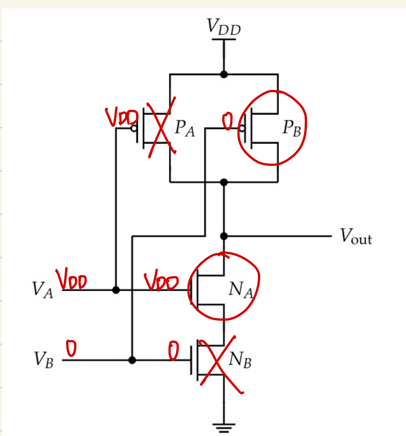
So far we saw:

N_A, N_B { ON $V_G = V_{DD}$; OFF $V_G = 0$ }

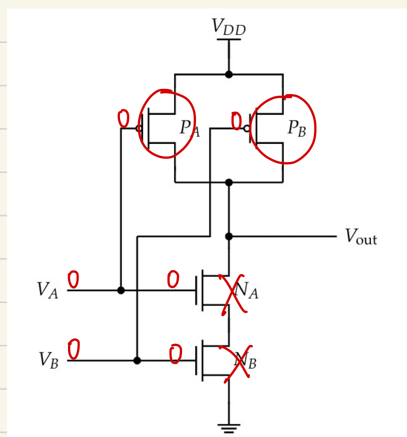
P_A, P_B { ON $V_G = 0$; OFF $V_G = V_{DD}$ }

Knowing this, we can solve (d), (e) a lot faster!

d) $V_A = V_{DD}$, $V_B = 0V$ $V_{out} = V_{DD}$



d) $V_A = 0V$, $V_B = 0V$ $V_{out} = V_{DD}$

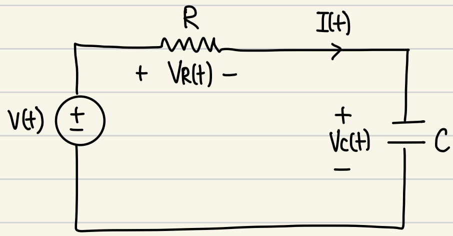


f) Summarizing results from (b),(c),(d),(e) we get the truth table below:

V_A	V_B	V_{out}	
0	0	V_{DD}	– (d)
0	V_{DD}	V_{DD}	– (b)
V_{DD}	0	V_{DD}	– (c)
V_{DD}	V_{DD}	0	– (a)

Q2.

a) (a) Starting from the given charge-voltage relation for a capacitor, **find an equation that relates the current across the capacitor $I(t)$ with the voltage across the capacitor $V_C(t)$.**



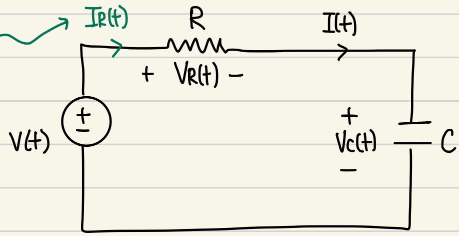
Start with capacitor equation : $Q(t) = CV_C(t)$

$$\frac{dQ(t)}{dt} = I(t) = C\frac{dV_C(t)}{dt}$$

$$\Rightarrow \frac{dV_C(t)}{dt} = \frac{I(t)}{C}$$

b) (b) Analyzing the circuit, **write an equation that relates the functions $I(t)$, $V_C(t)$, and $V(t)$.**

current flowing into resistor



① KCL $\quad I_R(t) = I(t)$

② Convert KCL into V-R relationship

$$I_R(t) = \frac{V_R(t)}{R} = \frac{V(t) - V_C(t)}{R}$$

$$\frac{V(t) - V_C(t)}{R} - I(t) = 0 \Rightarrow V(t) = RI(t) + V_C(t)$$

c)

(c) So far, we have an equation that involves both $I(t)$ and $V_C(t)$. To solve this equation, we can remove $I(t)$ (one of the unknowns) using what we found in part 2.a. **Rewrite the previous equation in part 2.b in the form of a differential equation.** You will pick up with this in the next discussion.

From a) $\frac{dV_C(t)}{dt} = I(t) \cdot \frac{1}{C} \longrightarrow I(t) = C \cdot \frac{dV_C(t)}{dt}$

From b) $RI(t) + V_C(t) = V(t)$

substitute

$\Rightarrow RC\frac{dV_C(t)}{dt} + V_C(t) = V(t)$