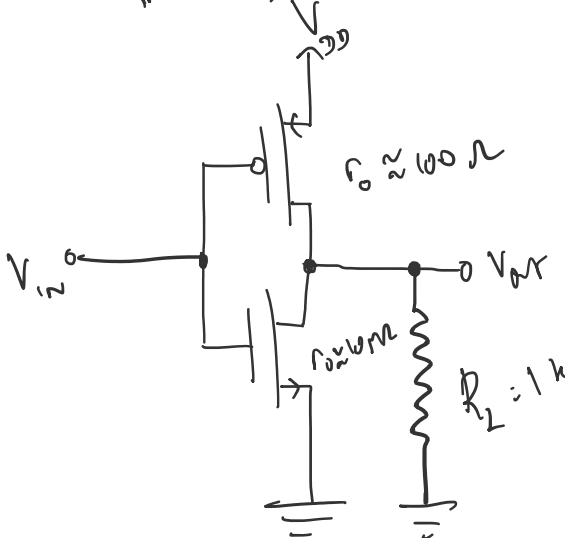
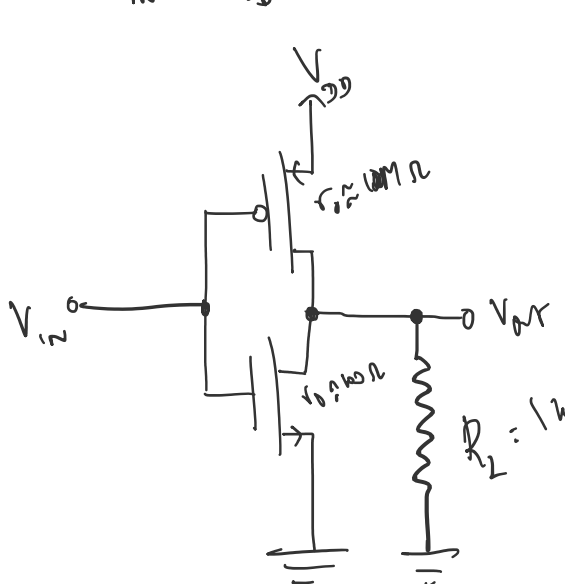


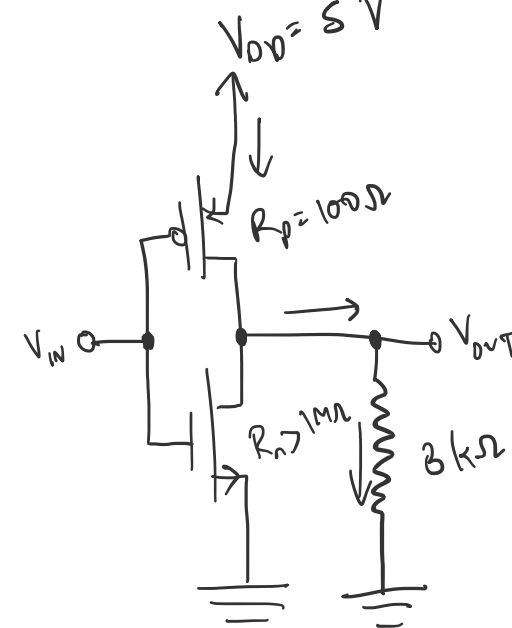
Homework 6

Sunday, February 20, 2022

7:01 PM

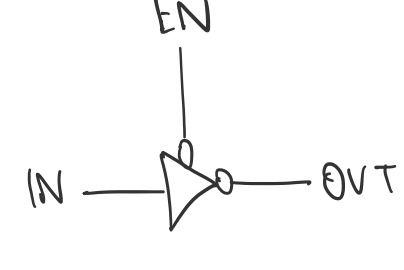
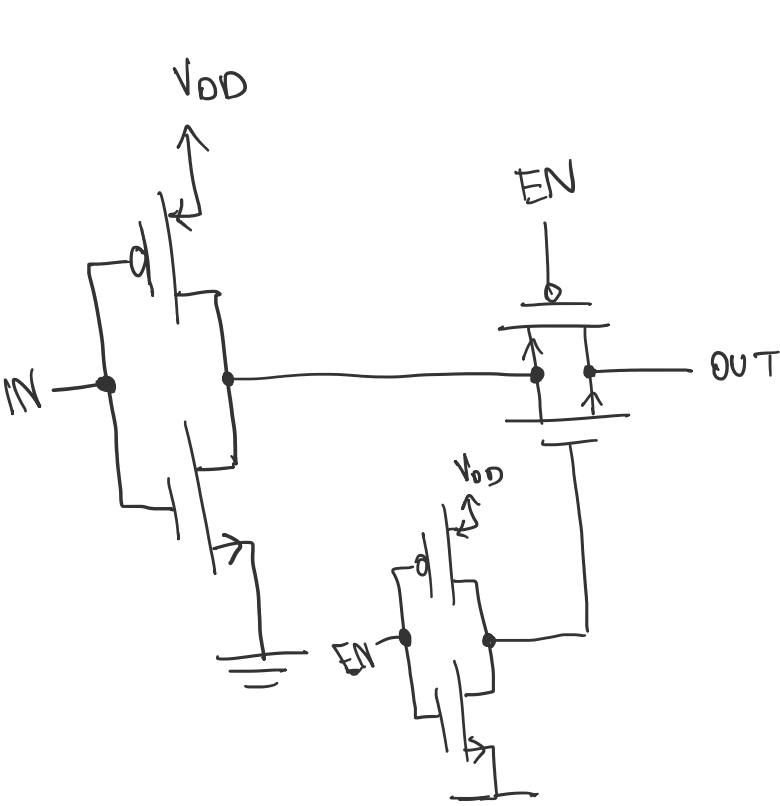
① When $V_{in} = 0V$,  The n-MOSFET turns off while p-MOSFET turns on, leading to a voltage divider for V_{out} . Thus, $V_{out} \approx 0.9 V_{DD}$ which is close to expected value of V_{DD} but not exact.

when $V_{in} = V_{DD}$,  The pMOSFET turns off while n-MOSFET turns on. This leads to a small amount of current through r_{ds} & R_L which leads to voltage at V_{out} slightly higher than the expected value of 0V.

②  $I_{onmax} = \frac{5}{3100} = 1.613 \text{ mA}$
 $V_{out} = I_{onmax} R_L = 4.84 \text{ V}$

③ $V_{out} : V_{DD} e^{-t/R_n C_L}$; $R_n = 100\Omega$, $C_L = 150 \text{ pF}$
 $V_{out} : 5 e^{-(t/67 \times 10^{-7})}$
 $0.8 \times 5 = 5 e^{-(t_{0.8}/67 \times 10^{-7})}$
 $t_{0.8} = 3 \text{ ns}$
 $0.2 \times 5 = 5 e^{-(t_{0.2}/67 \times 10^{-7})}$
 $t_{0.2} = 24 \text{ ns}$
 $t_{HL} = 21 \text{ ns}$

- ④ CMOS circuits' dynamic power has two components:
- ① switching power \rightarrow the power consumed due to switching current that flows from supply voltage through the output capacitance to ground
 - ② short circuit power \rightarrow the power consumed when current flows from power supply straight to ground when both the PMOS & NMOS are simultaneously on

⑤  We can use two inverters and a transition gate as shown below 

- ⑥ We can use a multiplexer with an enable and select inputs
when enable is HIGH, the signal corresponding to the binary form of select inputs is sent to the output

EN	SEL	D0	D1	D2	... D _{n-1}	OUT
0	x	x	x	x	x	0
1	0	d0	x	x	x	d0
1	1 (b01)	x	d1	x	x	d1
1	2 (b10)	x	x	d2	x	d2
1
1	n-1	x	x	x	d(n-1)	d(n-1)

⑦ module $V_{multiplex}$ (
input D0,D1,E,
output Z
);
assign Z = (E?D1:D0);
endmodule;

⑧ $Y: 5'b0x011$

⑨ reg [15:0] A;
reg [2:0] B;
 $Y = \{3\{B\}, A[13:8], 4'b0\}$

number of bits in Y = 12+6+4 = 22

⑩ reg [31:0] A [0:127];
assign B = A[4];