Homework 11 (Assigned: 4/24/2020; Due: 5/6/2020, 11:59pm)

1. Plot the loop gain Bode plot for the feedback systems with the following open-loop gain $H_{OL}(s)$ and feedback factor f. Determine loop-gain phase margin for all parts.

   (a) $H_{OL}(s) = \dfrac{100}{1+\frac{s}{10^5}}$; $f = 1$

   (b) $H_{OL}(s) = \dfrac{200}{(1+\frac{s}{10^4})(1+\frac{s}{10^6})}$; $f = 1$

   (c) $H_{OL}(s)$ same as (b); but with $f = 1/2$

   (d) $H_{OL}(s)$ same as (b); but with $f = 1/4$

   (e) $H_{OL}(s) = \dfrac{1000}{s(1+\frac{s}{100})}$; $f = 1/10$

   (f) $H_{OL}(s)$ same as (e); but with $f = 1/2$

   (g) $H_{OL}(s)$ same as (e); but with $f = 1$

2. Design the CMOS realization of the boolean expressions shown below.

   (a) $Y = \overline{A \cdot (B + C)}$

   (b) $Y = \overline{(A + (B \cdot C))}$

   (c) $Y = A \cdot B$

   (d) $Y = A \cdot \overline{B + C}$

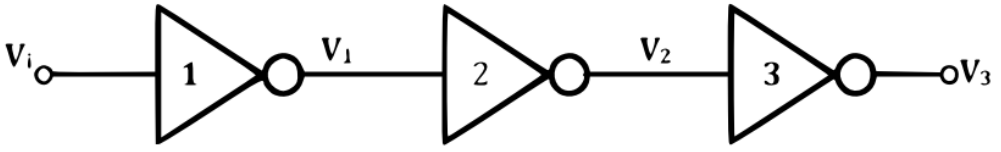
   (e) $Y = \overline{A \cdot B + B \cdot C + C \cdot A}$

   (f) $Y = \overline{((A \cdot B) + C) \cdot (D + E)}$

   (g) $Y = \overline{((A + B) \cdot C + D \cdot E)}$

   (h) $Y = \overline{A + B + C}$

3. Consider the Inverter chain below:



Each inverter is identical to the others with $V_{OH} = 1V$, $V_{OL} = 0V$, $NM_L = 0.3V$, $NM_H = 0.5V$.

(a) Sketch a piecewise linear plot of the VTC(Voltage Transfer Function).

(b) True of False: if $V_i = V_{OL} + v_n$ with $|v_n| < NM_L$, then output $V_3 = V_{OH}$.

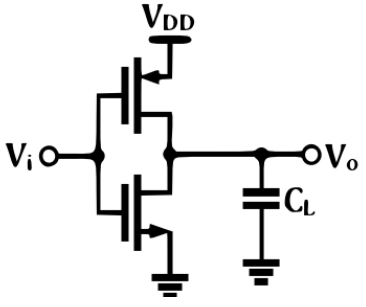
(c) Determine V_3 if $V_i = V_{OL} + 0.4V$. Is the output V_3 correct? Does $V_3 \in \{V_{OH}, V_{OL}\}$?

(d) Determine V_3 if $V_i = V_{OL} + 0.45V$. Is the output V_3 correct? Does $V_3 \in \{V_{OH}, V_{OL}\}$?

(e) Which of the parts (b), (c), (d) demonstrate the noise-immunity property of the digital gates?

(f) Which of the parts (b), (c), (d) demonstrate the restorative property of the digital gates?

4. Consider the CMOS inverter below:



Assume $V_{DD} = 5V$, $k'_n = 150\mu A/V^2$, $k'_p = 75\mu A/V^2$, $(W/L)n = 1$, $V_{THp} = -0.5V$, $V_{THn} = 0.7V$, $C_L = 0.5pF$.

(a) Determine the values of $(W/L)p$ such that V_M is 2.5V, 1.5V and 3.5V.

(b) If $(W/L)p = 2$, determine V_M, t_{PLH}, t_{PHL}, and the dynamic power dissipation P_D when operating at maximum switching frequency(P_{Dmax}).

(c) If $(W/L)p = 4$ and $(W/L)n = 2$, then relative to your answer in part (b), how will V_M, t_{PLH}, t_{PHL} and P_{Dmax} change?