Assignment 1

ELE-350: Digital Electronics

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1. Given the data in the following table for an NMOS transistor with $k' = 20\ \mu A/V^2$, calculate V_{TO}, λ, γ, $2 \mid \phi_f \mid$, and W/L. Use long-channel transistor models. [1]

	V_{GS} (V)	V_{DS} (V)	V_{BS} (V)	I_D (μA)
1	3	5	0	1210
2	5	5	0	4410
3	5	10	0	5292
4	5	5	-2	3265
5	5	5	-5	2381

[1] Answer:V_{TO} =0.80 V, λ=0.05 1/V, γ=0.7 $V^{0.5}$, $2 \mid \phi_f \mid$=0.6 V, and W/L=20.

2. For the following NMOS inverter circuit, assume V_{DD}=5 V, R=75 kΩ, W/L=3.6/1.2, and C=3 pF. Use the following data for an NMOS transistor: V_{TO}=0.743 V, $k' = 19.6 \times 10^{-6}$ A/V^2, and λ=0.06 V^{-1}. See the answers. [2] [3] [4] [5]

a) Discuss qualitatively why this circuit behaves as an inverter.

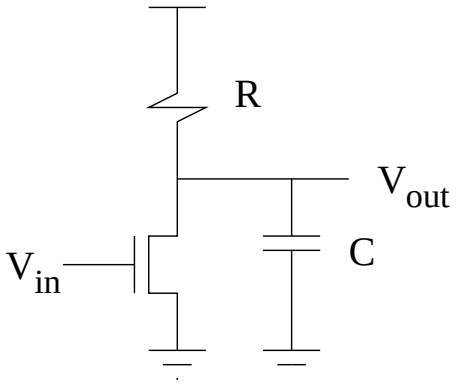
b) Find V_{OH} and V_{OL}.

c) Calculate t_{plh} (falling delay D_f), t_{phl} (rising delay D_r), and t_p (average delay D).

d) Are the rising and falling delays equal? Why?

e) Calculate the static power dissipation for: (i) V_{in}=0 V and (ii) V_{in}=5 V.

f) Calculate the dynamic power dissipation assuming that the gate is clocked as fast as possible.



[2] Answer (b): V_{OH}=5 V and V_{OL}=0.26 V.

[3] Answer (c): D_f=155 ns, D_r=13.6 ns, and D=84.4 ns.

[4] Answer (e): 0 and 0.316 mW.

[5] Answer (f): 0.42 mW.