

**6.012 Microelectronic Devices and Circuits
Spring 2007**

April 25, 2007
Quiz #2

	<u>Problem #points</u>
NAME _____	1 _____
RECITATION TIME _____	2 _____
	3 _____
	Total _____

General guidelines (please read carefully before starting):

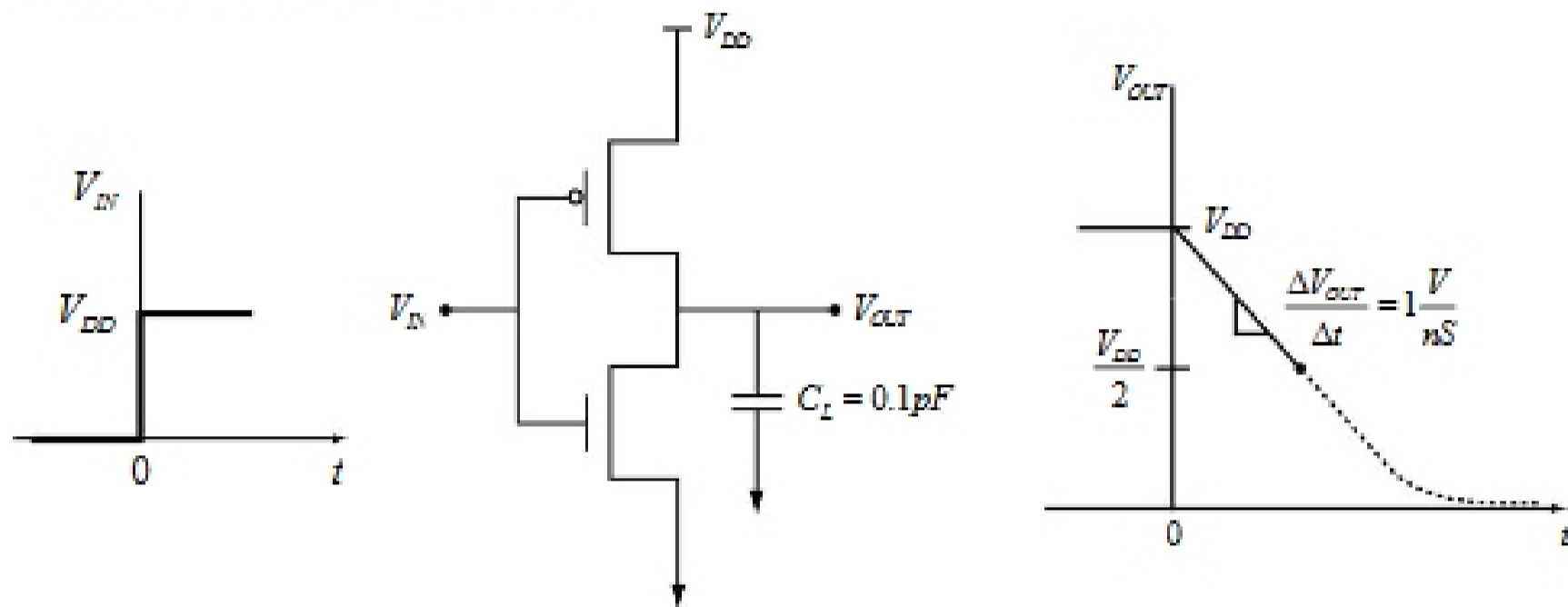
- Make sure to write your name on the space provided above.
- Open book: you can use any material you wish. But no computers.
- All answers should be given in the space provided. Please do not turn in any extra material.
- You have 120 minutes to complete the quiz.
- Make reasonable approximations and *state them*, i.e. low-level injection, extrinsic semiconductor, quasi-neutrality, etc.
- Partial credit will be given for setting up problems without calculations. NO credit will be given for answers without reasons.
- Use the symbols utilized in class for the various physical parameters, i.e. N_a , τ , ϵ , etc.
- Pay attention to problems in which *numerical answers* are expected. An algebraic answer will not accrue full points. Every numerical answer must have the proper *units* next to it. Points will be subtracted for answers without units or with wrong units. In situations with a defined axis, the *sign* of the result is also part of the answer.

Unless otherwise stated, use:

$$\begin{aligned}q &= 1.6 \times 10^{-19} \text{ C} \\kT/q &= 25 \text{ mV at room temperature} \\n_i &= 10^{10} \text{ cm}^{-3} \text{ for silicon at room temperature} \\\epsilon_{\text{Si}} &= 10^{-12} \text{ F/cm} \quad \epsilon_{\text{ox}} = 3.45 \times 10^{-13} \text{ F/cm}\end{aligned}$$

1. (30 points)

You are given a CMOS inverter with a step input voltage from 0 to V_{DD} at $t = 0$, resulting in an output voltage V_{OUT} vs. t shown below. The load capacitance $C_L = 0.1\text{pF}$ accounts for all load capacitance components.



- (a) Given $V_{DD} = 1.5V$ and that the devices are sized such that $V_M = \frac{V_{DD}}{2}$, calculate t_{pHL} .

(b) Calculate the current I_{Dn} at $0 < t < t_{pHL}$.

(c) Given $V_{Tn} = 0.5V$ and $\mu_n C_{ox} = \frac{50 \mu A}{V^2}$, find $\frac{W}{L}$ of the NMOS transistor.