6.012 Microelectronic Devices and Circuits
Spring 2005

April 20, 2005
Quiz #2

	Problem #points
NAME_____	1_____
RECITATION TIME_____	2_____
	3
	Total_____

General guidelines (please read carefully before starting):

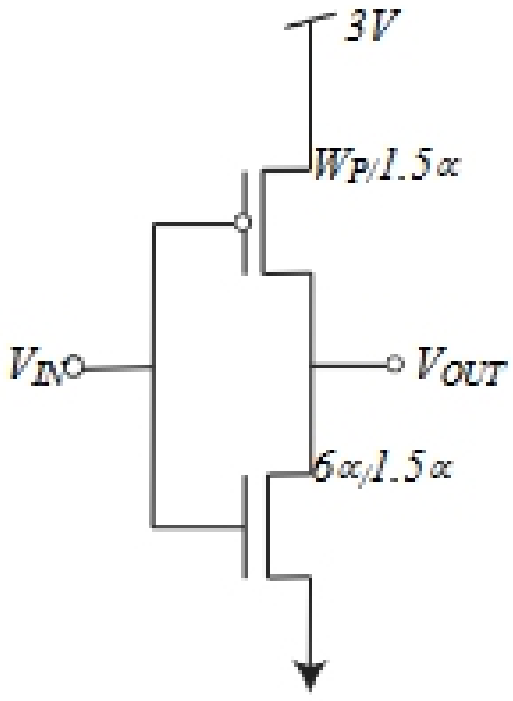
- Make sure to write your name on the space provided above.
- Open book: you can use any material you wish. But no computers.
- All answers should be given in the space provided. Please do not turn in any extra material.
- You have 120 minutes to complete the quiz.
- Make reasonable approximations and *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:

$q = 1.6 \text{ X } 10^{-19}$ C
$kT/q = 25$ mV at room temperature
$n_i = 10^{10}$ cm^{-3} for silicon at room temperature
$\varepsilon_{Si} = 10^{-12}$ F/cm $\varepsilon_{ox} = 3.45\text{X}10^{-13}$ F/cm

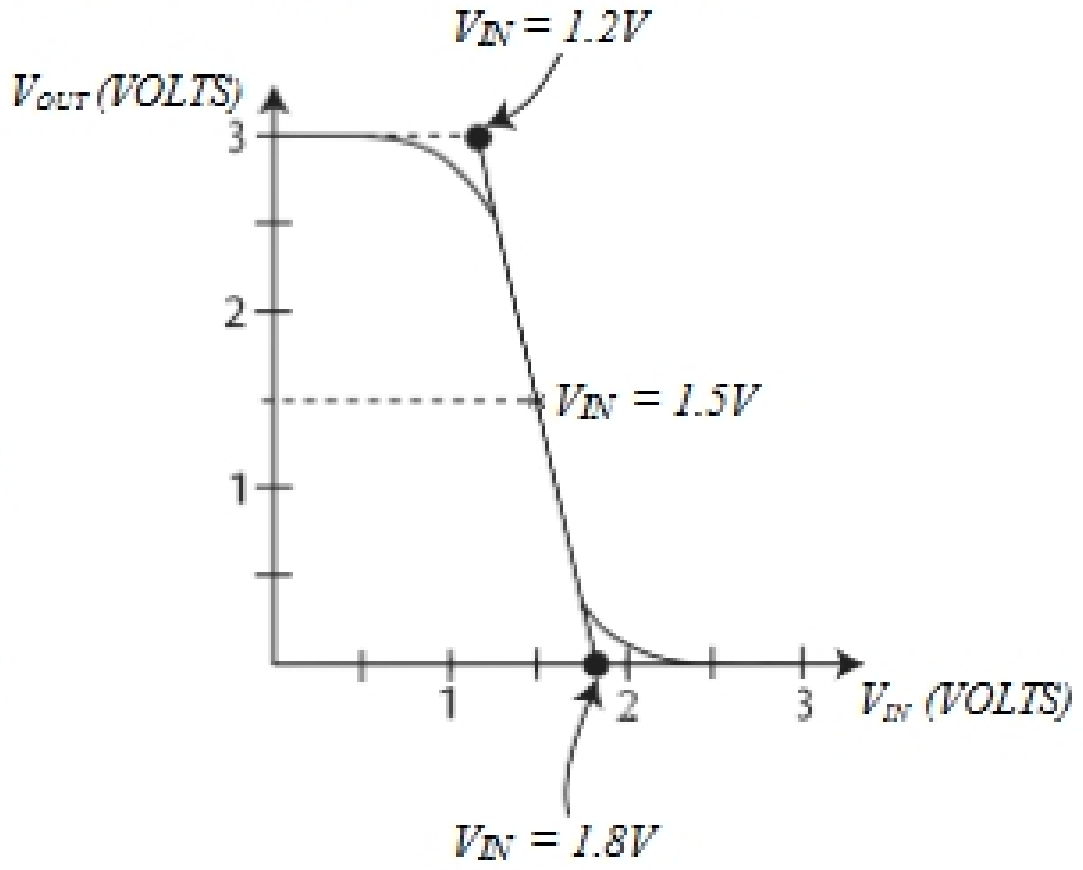
1. (30 points)

A CMOS inverter has the following voltage transfer characteristics and transistor data.



NMOS Data
$\propto_n C_{ox} = 50\ \propto A/V^2$
$V_{Tn} = 0.5V$

PMOS Data
$\propto_p C_{ox} = 25\ \propto A/V^2$
$V_{Tp} = -0.5V$



a) Calculate W_p such that $-I_{Dp} = I_{Dn} = 100\propto A$ at $V_{IN} = V_M$.

b) Calculate the NMOS transconductance, g_{mn}, at $V_{IN} = V_M$.

c) Calculate $(\lambda_n+\lambda_p)$.