UNIVERSITY OF TEHRAN

Electrical and Computer Engineering Department

Digital Logic Design, ECE 367, ECE 894, Spring 1399-1400

Homework 1

Number representation and CMOS gate structures

Name:	**Date:**
Username:	

1. How many bits are needed to represent the decimal number 6539 as an unsigned binary number? How many bits are needed to represent the same number is BCD? Show the representation of this number in both systems.

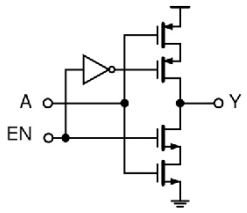
2. What relation can you find between bits of a 4-bit binary number and a 4-bit Gray code? Write a sentence describing your answer. A) Show how XOR gates can be used to convert 4-bit binary numbers to Gray code. B) Show how XOR gates can be used to convert 4-bit gray code to binary numbers.

3. Show switch level CMOS for a 2-input NAND gate. Using #(3,5,7) for NMOS and #(4,6,8) for PMOS transistors, analyze the timing of this gate and find its worst case delay for making a transition to 1 and to 0. Worst case delay is when an output stabilizes after transitional X and Z values. For the worst-case delays show your answer is a waveform.

4. Using NAND gates only generate a 2-to-1 Mux with a select input, s, and two data inputs a and b. Start with a simple expression for the multiplexer. Remember that NAND gate can be regarded as an OR gate with active low inputs or an AND gate with an active low output. Use a NAND gate with two inputs tied together for making a NOT gate.

5. Given the worst-case delay of the NAND gate as in Problem 3, calculate the worst-case delay of the MUX or Problem 4. Show your results in a waveform.

6. Shown here is a tri-state CMOS structure. Given transistor delays of Problem 3, find the three delay values for this structure. In SystemVerilog this is a BIFIF1 structure that uses three delay values (To1, To0, T0Z). Note the difference in using transistor symbols in this diagram and what we use in class.



7. In an exponential function $V_0\, e^{-t/RC}$, what is the time in terms of RC for the function going from $0.9V_0$ to $0.1V_0$? Repeat this question for finding a time that the function has reached its final value considering a reasonable approximation. Repeat this question for the function starting from its V_0 value at time 0 and reaching $0.5V_0$.