Homework 5

Max marks: 100

Due on Oct 31, 2022 (Monday), 12:00 noon, before class. Please submit in paper, because it is easier to grade. Also submit a backup copy to brightspace.

1 Problems

Problem 1 *A minority gate produces a TRUE output if and only if fewer than half of its inputs are TRUE. Otherwise it produces a FALSE output. Sketch a transistor-level circuit for a three-input CMOS minority gate. Use a minimum number of transistors. (10 marks)*

Problem 2 *Write a truth table for the function performed by the gate in the figure below. The truth table should have three inputs, A, B, and C. (10 marks)*
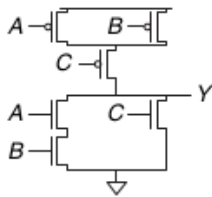

Figure 1.51 Mystery schematic

Problem 3 *Consider the circuit shown in Figure PB.1.*

1. *Write the circuit as a boolean expression for f (5 marks)*

2. *Implement the circuit as a CMOS complex gate, how many transistors are needed? (15 marks)*
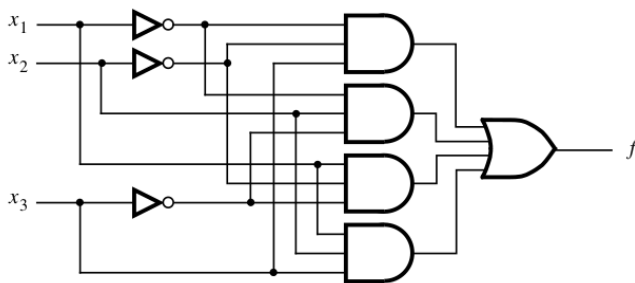

Figure PB.1 A sum-of-products CMOS circuit.

Problem 4 *1. Show that the circuit in Figure PB.2 is functionally equivalent to the circuit in Fig- ure PB.1. (15 marks)*

2. *How many transistors are needed to build this CMOS circuit? Assume that the multiplexers are built using transmission gates (5 marks).*
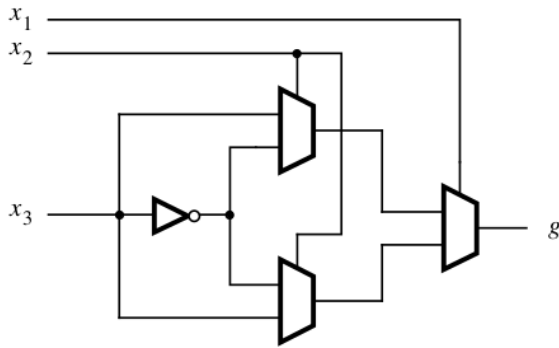
Figure PB.2   A CMOS circuit built with multiplexers.

Problem 5 *Determine the propagation delay and contamination delay of the circuit in Figure 2.84. Use the gate delays given in Table 2.8. (10 marks)*
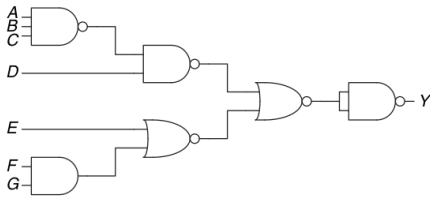
Table 2.8 Gate delays for Exercises 2.43–2.47

Gate	t_{pd} (ps)	t_{cd} (ps)
NOT	15	10
2-input NAND	20	15
3-input NAND	30	25
2-input NOR	30	25
3-input NOR	45	35
2-input AND	30	25
3-input AND	40	30
2-input OR	40	30
3-input OR	55	45
2-input XOR	60	40

Figure 2.84 Circuit schematic

Problem 6 *Find a minimal Boolean equation for the function in Figure 2.85. Remember to take*

A	B	C	D	Y
0	0	0	0	X
0	0	0	1	X
0	0	1	0	X
0	0	1	1	0
0	1	0	0	0
0	1	0	1	X
0	1	1	0	0
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	X
1	1	1	1	1

Figure 2.85 Truth table for Exercise 2.28

advantage of the don't care entries (marked X) (10 marks).

1. *Sketch a circuit for the function (10 marks).*

2. *Does your circuit from have any potential glitches when one of the inputs changes? If not, explain why not. If so, show how to modify the circuit to eliminate the glitches (10 marks).*