CSE 260M Fall 2024 Exam 1 Due at end of session

This exam is: **closed-book**, **NO electronic devices allowed**, and **closed-notes**. The exception is the "sage page" of the designated size on which you may have notes to consult during the exam.

If anything is unclear or seems to have an error, write down your assumptions.

Be sure you: **Provide legible answers in designated areas (credit will not be given for work that is difficult to read or not where expected)**, **Ensure you clearly fill in circle/square(s) on multiple choice questions**, **Use indentation of your code to show its structure**, **Leave the exam stapled together in its original order**, **Do *NOT* attach any other pages to the exam**. You are welcome to use the blank space on the exam for any scratch work.

If you need to leave the room for any reason prior to turning in your exam, you must leave your exam and any electronic devices with a proctor.

Question:	1	2	3	4	Total
Points:	21	45	10	24	100

You must complete all the identifying information below correctly. Failure to do so is grounds for a zero on this exam:

1. Name (**print clearly**): _____

2. Student ID (**print clearly; 1 digit per underline**): _____ _____ _____ _____ _____ _____

3. You must sign the pledge below for your exam to count. The penalty for cheating will be decided during academic integrity review, but the instructors will recommend an F in this course as the minimum penalty.

   I have read the instructions on this page and I will neither give nor receive any unauthorized aid on this exam.

   _____

   (Sign above)

⟹ Do not proceed until told to do so! ⟸

⟹ Initial the top right corner of each page before starting ⟸

1. Number Representations

(1) (3 points) Convert 73_{16} from hexadecimal to decimal: _____

(2) (3 points) What is the decimal result of adding the following 4-bit two's complement nubmers: 1011_2 added to 0101_2: _____

(3) (3 points) What is the decimal representation of the largest 10-bit two's complement number:

◯ 1023 ◯ 512 ◯ 511 ◯ None of the these options

(4) (3 points) What is result of adding unsigned binary numbers: 00110101_2 and 01001101_2?

◯ 11101101_2 ◯ 10000010_2 ◯ 01110010_2
◯ None of the these options

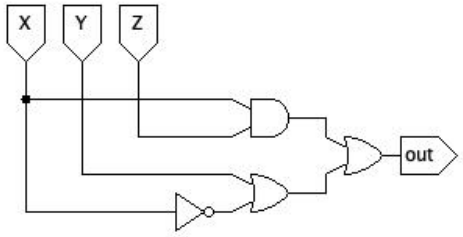
(5) (3 points) Convert 43 to 8-bit unsigned binary: _____

(6) (3 points) 10010010_2 is a 8-bit two's complement number. What is its value in decimal: _____

(7) (3 points) The 8-bit two's complement number, 01110110_2 is multiplied by -1. Show the binary two's complement representation of the result: _____

2. Boolean Algebra & Logic Gates:

(1) (4 points) Given the following circuit:



Provide the equation that most closely represents the circuit. (Do not simplify):

out=_____

(2) (2 points) Which of the variables in the circuit from the previous problem will cause the longest propagation delay:

◯ X ◯ Y ◯ Z ◯ All contribute equally
◯ Not enough information to determine

(3) (4 points) Which of the following is equivalent to: $A\overline{B} + \overline{AB}$:

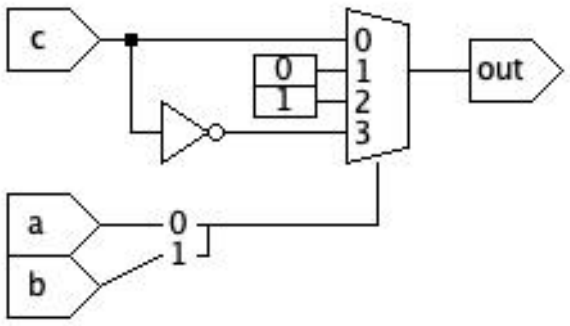
◯ $A\overline{B} + A + B$ ◯ $AB + \overline{AB}$ ◯ $\overline{A} + \overline{B}$ ◯ $A\overline{B} + \overline{A}\ \overline{B}$
◯ None of these options

(4) (4 points) Draw the logic gate implementation of the function: $Y = AB + (B \oplus \overline{C})$

(5) (3 points) If A is false and B is true, what value does C need to be for the previous expression ($Y = AB + (B \oplus \overline{C})$) to be true?

◯ true
◯ false
◯ Cannot be determined from information provided
◯ No value of C will make the expression true

(6) (6 points) Complete the truth table for the circuit below:



a	b	c	out
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(7) (4 points) Determine the canonical sum-of-products expression for the function, Y, given by the truth table:

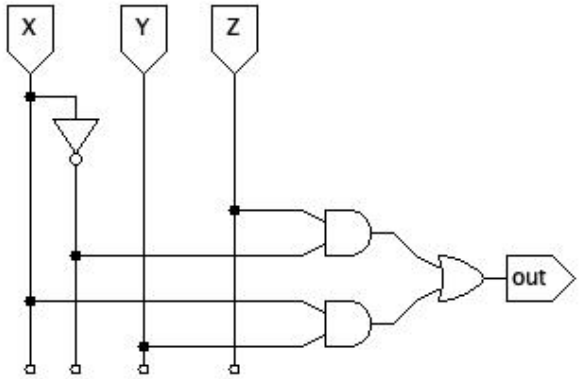
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

$Y =$_____

(8) (4 points) Determine the minimal expression (minimal use of ANDs; Karnaugh map sense) for the previous function:

$Y =$_____

(9) (6 points) Complete the truth table for the circuit below:



X	Y	Z	out
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(10) (6 points) Determine the minimal expression for the function represented in the following Karnaugh map:

CD \ AB	00	01	11	10
00	1	1	1	1
01	0	1	1	0
11	0	1	0	0
10	0	1	0	0

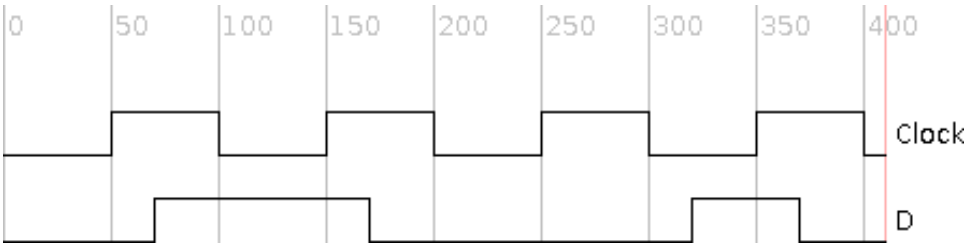
Expression = _____

(11) (2 points) For the function in the previous problem with a 4 variable K-map, assuming the full SOP (sum of products) canonical form was used instead of the minimized equation, how many 4-input AND gates are required and how many inverters are required?

◯ 3 AND, 4 inverters
◯ 4 AND, 4 inverters
◯ 8 AND, 3 inverters
◯ 8 AND, 4 inverters

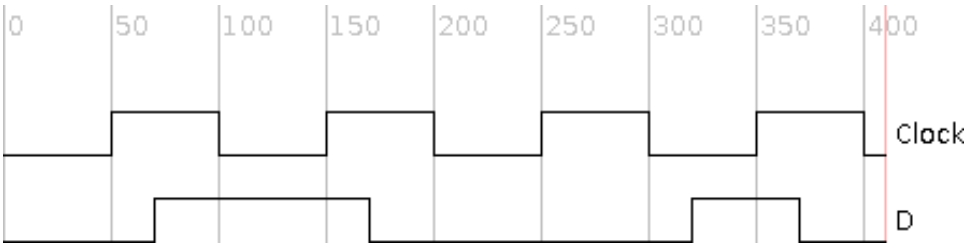
3. Latches and Flip-Flops

(1) (5 points) For a *D latch*, determine which values for the output (Q) are true. Assume delay is less than 10 units for output to change. Fill in all that apply:



☐ time=10, Q=Can't determine ☐ time=120, Q=1 ☐ time=220, Q=1
☐ time=280, Q=0 ☐ time=355, Q=1

(2) (5 points) For a rising-edge *D flip-flop*, determine which values for the output (Q) are true. Assume delay is less than 20 units for output to change. Fill in all that apply:

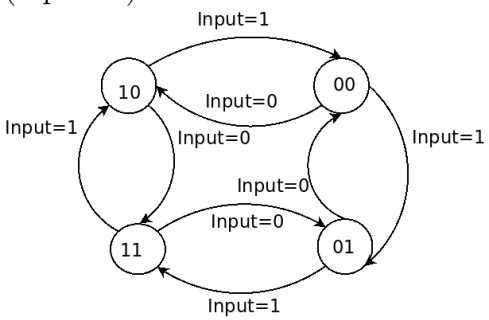


☐ time=10, Q=Can't determine ☐ time=120, Q=1 ☐ time=220, Q=1
☐ time=280, Q=0 ☐ time=360, Q=1

4. State Machines

(1) (8 points) Consider the Soda machine from Homework 3. Assume that it will accept (D)imes and (Q)uarters ONLY and will still dispense a soda once it has collected at least 25 cents. However, it will NOT return any change (excess change is kept). Draw the state transition diagram for this new version of the machine:

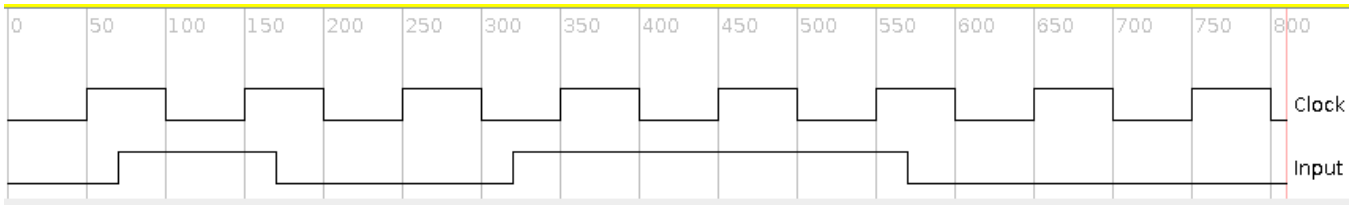
(2) (2 points) For the state transition diagram below:



If one hot encoding was used, how many flip-flops are required?

◯ 2 ◯ 4

(3) (6 points) Using the diagram from above, assume the state machine is built with rising-edge D flip-flops that are initially configured to start at 0, so the initial state is 00. Show all of the transitions that occur for the given Clock and Input signal (use the notation "$A \rightarrow B \rightarrow C \rightarrow \cdots$" to indicate a transition from A to B to C, etc.. The initial state is already provided below):



$00 \rightarrow$ _____

(4) (8 points) Using the diagram from above, complete the output table for the next states assuming 2 flip-flops are used:

Q1	Q0	Input	nQ1	nQ0
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		