UNIVERSITY OF TEXAS AT AUSTIN
ELECTRICAL ENGINEERING DEPARTMENT

EE 306, Introduction to Computing, Fall 2018
Exam 1
Oct, 2018

Directions There are 7 problems worth a total of 100 points. The number of points for each question is indicated. Make sure that you show all work since partial credit will be given. This exam is closed book, closed notes, and **no calculators are allowed**. You may not communicate in any way with anyone other than exam proctors during the exam time. Don't forget to put your name and UTEID on ALL pages. You may use the back of the sheets if you need extra space to do scratch work.

You have **75+5 mins** to finish the exam

Name: _____

	Points possible	Score
Problem 1	16	
Problem 2	12	
Problem 3	16	
Problem 4	12	
Problem 5	10	
Problem 6	18	
Problem 7	18	
Total	100	

1. (16 points) Answer the following

    (a) (4 points) Express the unsigned 8-bit decimal value 209 in base-8 and base-16.

    (b) (4 points) Given the following number in hexadecimal: xB6

        i. What unsigned number does it represent?

        ii. What signed number does it represent in 2's complement form?

    (c) (4 points) Show how a computer performs the following operation using 2's complement representation for signed numbers?

$$(35)-(12)$$

    (d) (4 points) Assuming the result must fit in 8-bits, compute the result and state if there is either overflow, underflow, or neither in the following operation performed on signed 2's complement numbers.

$$101+1101011$$

2. (12 points) Given a 16-bit floating-point representation, with 10 bits for the fraction. Answer the following:

(a) (5 points) What does 1100001100000000 represent (you can leave the answer as a fraction or reduce it to decimal and fractional part)?

(b) (5 points) Using the same format, what is the floating point representation for the real number -16.125?

(c) (2 points) What is the binary representation of the largest positive normalized number one can represent in this format? (You are not required to compute its value)

3. (16 points) Answer the following circuit questions:

(a) (12 points) A 8-to-1 MUX can be implemented using two 4-to-1 MUXes and one 2-to-1 MUX. The 8-to-1 MUX to be implemented is connected as shown below. For example, when $S_2S_1S_0$ is 000 then A is selected, when $S_2S_1S_0$ is 001 then B is selected and so on.

A   B   C   D   E   F   G   H

000   001   010   011   100   101   110   111 S_2 S_1 S_0

Out
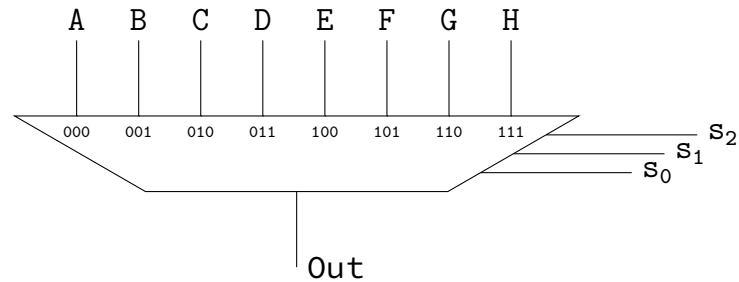
A fellow student wired the two 4-to-1 MUXes and one 2-to-1 MUX as follows. He insists that two of his inputs be as labeled (you cannot move them). Your job is to **label** the select lines and the missing inputs so the equivalent behavior of the 8-to-1 MUX is realized:

00   01   10   11   S S⁻

B   D

00   01   10   11   S S⁻

0   1   S⁻

Out
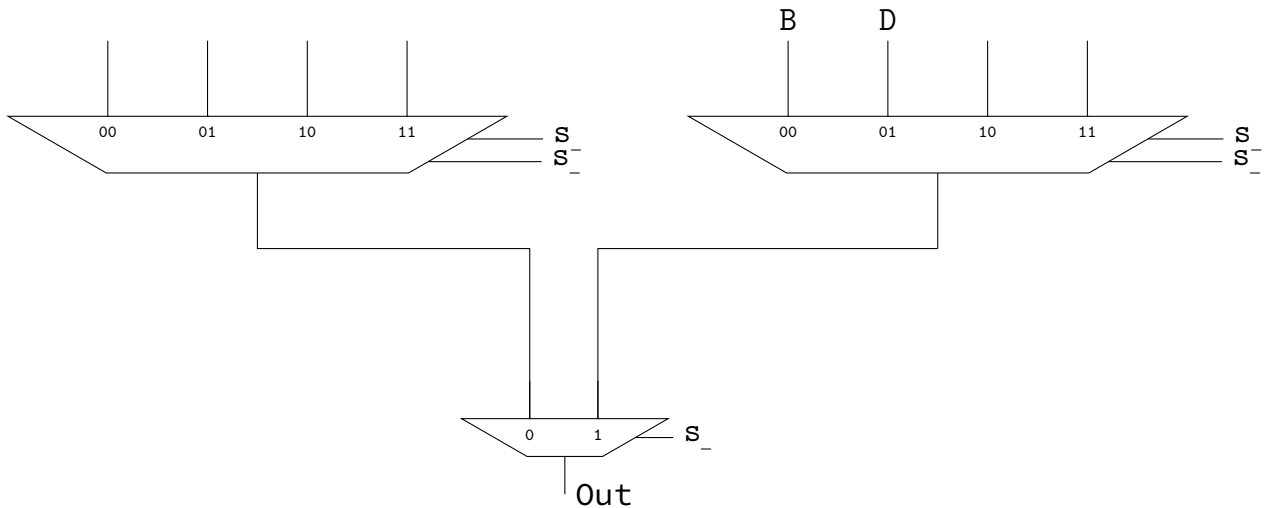
(b) (4 points) What value (Q) does a D-Latch store if both its D input and WE are connected to a clock of period 1sec?

D Q
WE
clk

4. (12 points) A series of read and write operations are performed on the memory. You have been given the initial state of the memory, the final state of the memory after all operations have been performed, and, a table with the read/write memory operations. However, some of the entries are missing.

   (a) (10 points) Fill in the missing entries.

Initial State	
Memory Address	Contents
00	1 0 1
01	1 0 0
10	0 1 0
11	0 0 1

Final State	
Memory Address	Contents
00	1 1 0
01	1 0 0
10	1 1 1
11	0 0 1

Read/Write Operations		
MAR	R/W	MDR
00	0	_ _ _
_ _	_	0 0 0
_ _	1	1 1 0
_ _	0	0 0 0
_ _	_	_ _ _
_ _	0	0 0 1
11	1	_ _ _

   (b) (2 points) What is the *address space* and *addressability* of this memory?

5. (10 points) Every morning Bevo has to choose whether he will walk to class or rent a scooter. You are tasked with building an app for Bevo which helps him decide. The app's suggestion S, tells Bevo whether he should walk or he should rent a scooter. Here are the scenarios the App considers: Bevo must walk when it might rain and if he worked out yesterday. If he is feeling lazy and he did not workout yesterday, he must walk. If he has at least 30 minutes till class starts and he did not workout yesterday, he must walk. All other cases he can take the scooter.

    (a) (6 points) Identify the inputs and outputs and give the truth table:

    (b) (2 points) Write an boolean expression for the output(s) as function(s) of the input(s).

    (c) (2 points) Draw a combinational logic circuit for the Suggestion S.

6. (18 points) Shown below is the truth-table for an FSM.

```
   CS   Input      NS   Output
   ----------------------------
   S1 S0 I1 I0 | N1 N0   O
   ----------------------------
   0  0  0  0  | 0  0    1
   0  0  0  1  | 0  0    1
   0  0  1  0  | 1  0    1
   0  0  1  1  | 1  1    1
   0  1  0  0  | 0  1    0
   0  1  0  1  | 0  1    0
   0  1  1  0  | 0  1    0
   0  1  1  1  | 1  1    0
   1  0  0  0  | 0  0    0
   1  0  0  1  | 1  0    0
   1  0  1  0  | 1  0    0
   1  0  1  1  | 1  0    0
   1  1  0  0  | 0  0    1
   1  1  0  1  | 0  1    1
   1  1  1  0  | 1  1    1
   1  1  1  1  | 1  1    1
```

(a) (12 points) Give the State Transition Graph for the FSM.

(b) (4 points) What size decoder is needed to implement a PLA-based circuit for the FSM ?

(c) (2 points) Write a simplified boolean expression for the Output (O)

7. (16 points) Answer the following:

(a) (4 points) Given a memory module with a total storage of 128 bytes and an addressability of 16 bits, what is the address space of the memory module? How many address bits are needed?

(b) (4 points) Write a truth-table for the circuit below. Is it well defined, that is, does it work for all possible

input combinations of A and B?


```
          3.3V
A
B
          Out
          0V
```
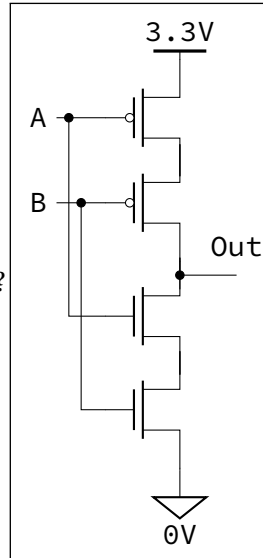
(c) (2 points) With 8-bit signed 2's complement, we can represent numbers in the range of -128 to 128. [True/False]

(d) (2 points) Putting an inverter on both inputs and the output of an OR gate makes it logically equivalent to?

   i. a XOR gate
   ii. a NAND gate
   iii. a NOR gate
   iv. an AND gate
   v. None of the above

(e) (2 points) `11001010 (XOR) _____ = 00111010`?

(f) (2 points) A demultiplexer (DEMUX) is quite like the opposite of a multiplexer - it takes in only one input, and passes it, through only one of the n output lines based on the select lines, and the other $n-1$ output lines get no output. How many select lines do you need for an n-output DEMUX? Express your answer in terms of n?