

CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN—MADISON

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Midterm Examination 2

In Class (50 minutes)

Wednesday, March 12, 2014

Weight: 17.5%

NO: BOOK(S), NOTE(S), OR CALCULATORS OF ANY SORT.

The exam has **eleven** pages. **Circle your final answers.** Plan your time carefully since some problems are longer than others. You **must turn in the pages 1-11**. Use the blank sides of the exam for scratch work.

LAST NAME: _____

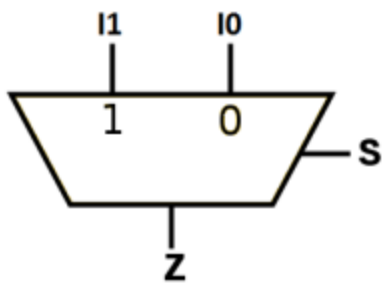
FIRST NAME: _____

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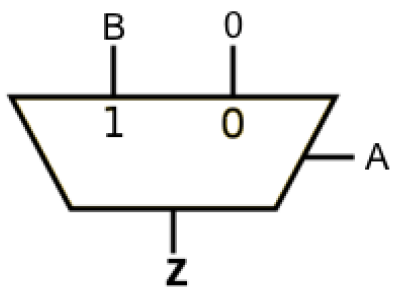
Problem 1 (4 points)

Implement the following truth table using a 2:1 MUX block.

A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1



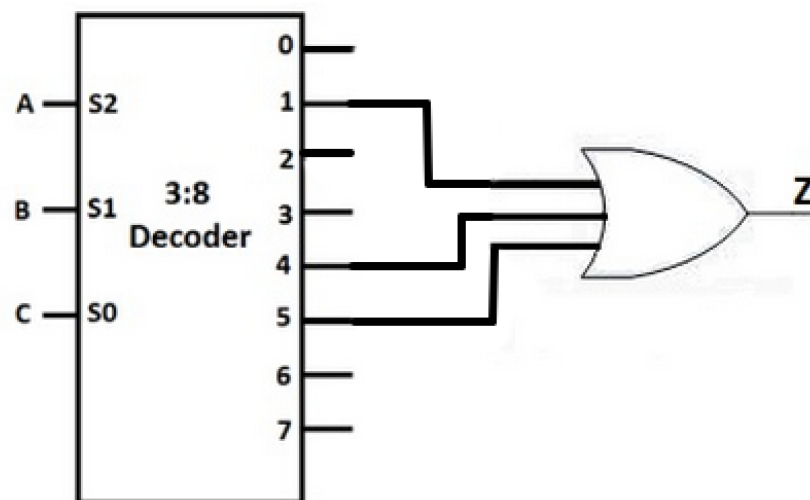
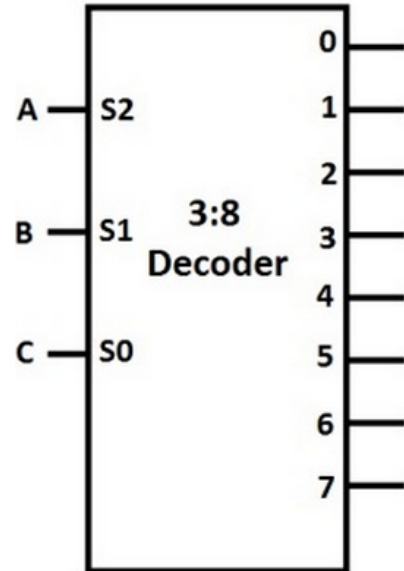
2:1 MUX BLOCK



Problem 2 (3 points)

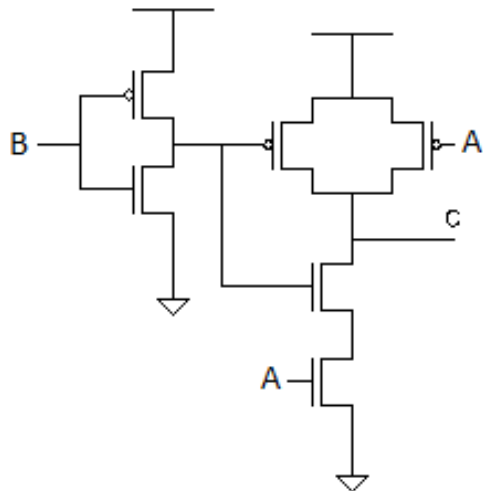
Implement the truth table below, with inputs A, B, and C and output Z, using a 3:8 decoder (as pictured below) and a 3-input OR gate.

A	B	C	Z
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0



Problem 3 (3 points)

Complete the truth table for the following transistor level circuit:

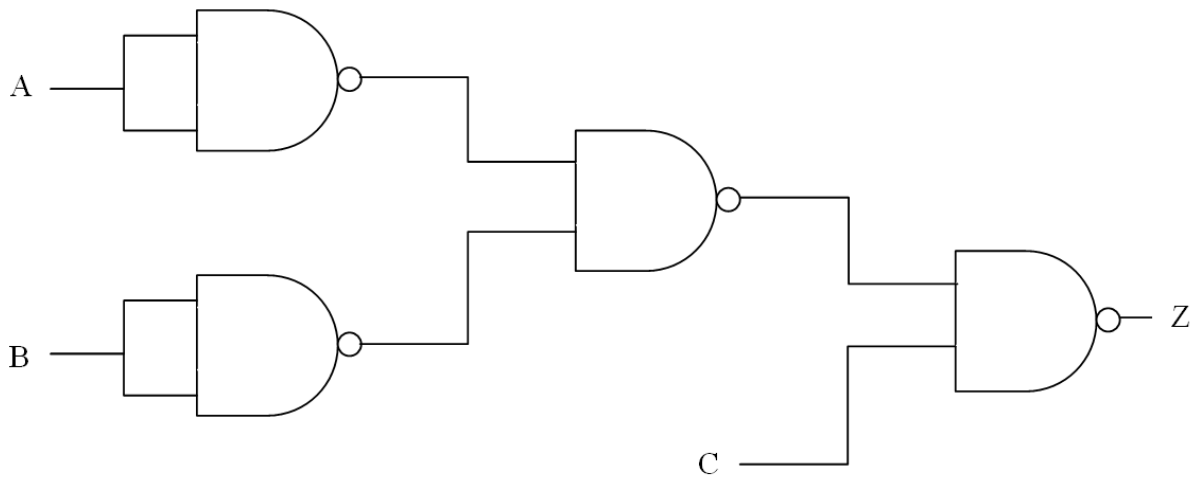


A	B	C
0	0	1
0	1	1
1	0	0
1	1	1

Problem 4 (3 points)

Given the logic equation $Z = (\text{NOT}(A \text{ OR } B)) \text{ OR } (\text{NOT } C)$

Draw the gate-level circuit for Z using only 2-input NAND gates (Hint: DeMorgan's Law).



Problem 5 (4 points)

Suppose a 64-bit instruction takes the following format:

OPCODE	SR	DR	IMM
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If there are 201 opcodes and 64 registers,

a) What is the minimum number of bits required to represent the OPCODE?

201 Opcodes $< 256 = 2^8$

8 bits opcode

b) What is the minimum number of bits required to represent the SR register?

64 registers $= 2^6$

6 bits SR register

c) What is the maximum number of bits that can be used to represent the immediate field (IMM)?

$64 - 8 - 6 - 6 = 44$

44 bits IMM

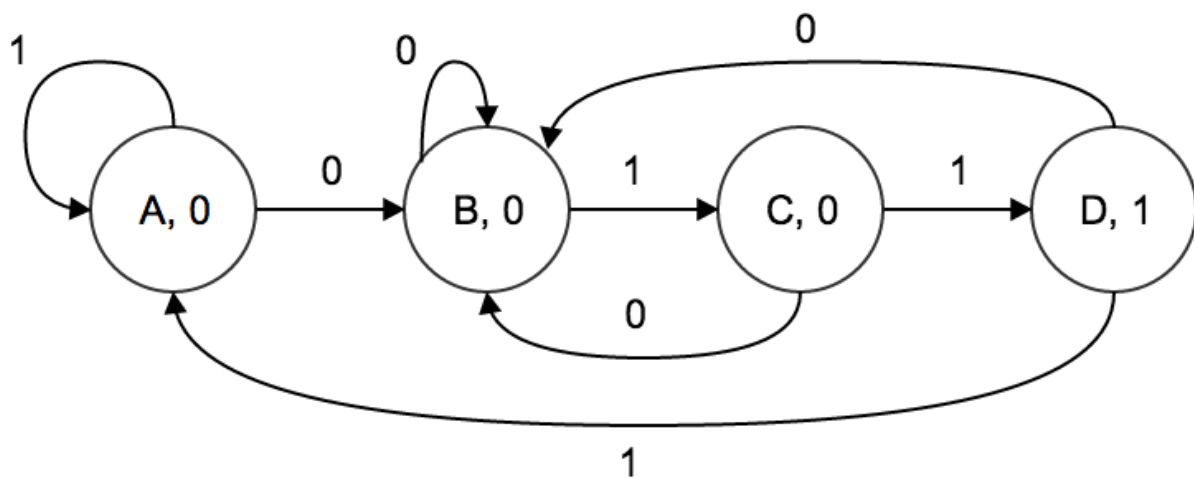
d. If the immediate (IMM) uses one's complement representation, what is the smallest number that can be represented in the IMM field?

$-(2^{43} - 1)$

Problem 6 (4 points)

Draw a finite state machine for recognizing the bit sequence "011". The machine takes one input every clock cycle which can be 1 or 0. The machine outputs a '1' when the sequence 011 is recognized; otherwise it outputs a '0'.

Sample Input	0 1 1 1 1 0 1 0 1 1
Sample Output	0 0 1 0 0 0 0 0 0 1



Problem 7 (4 points)

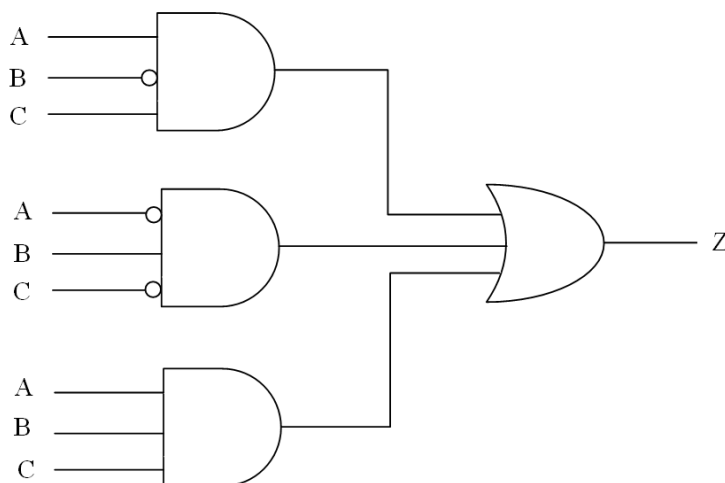
Use the truth table to answer the following questions.

A	B	C	Z
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

a. (2 points) Write the Boolean expression for Z (in terms of A, B, and C) corresponding to the truth table. You don't need to reduce the expression.

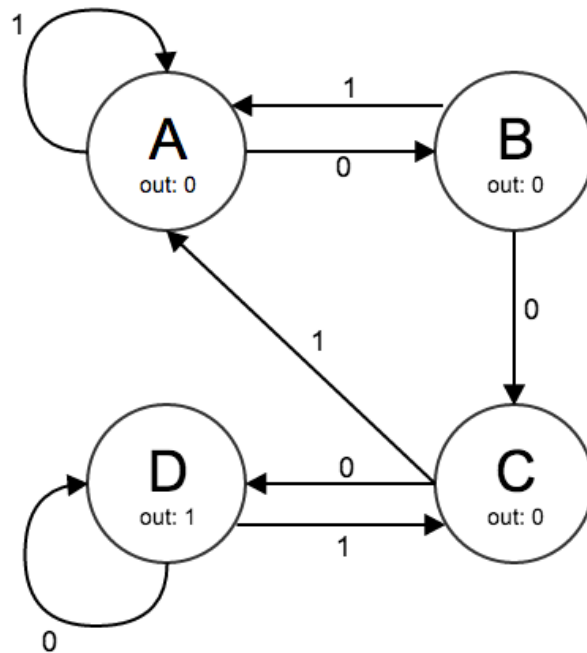
$Z = (A \text{ AND } (\text{NOT}(B)) \text{ AND } C) \text{ OR } ((\text{NOT}(A)) \text{ AND } B \text{ AND } (\text{NOT}(C))) \text{ OR } (A \text{ AND } B \text{ AND } C)$

b. (2 points) Draw the logic gate-level circuit which corresponds to the truth table. Do not simplify the expression



Problem 8 (2 points)

Consider the finite state machine drawn below. State A has output 0, state B has output 0, state C has output 0, and state D has output 1.



Fill out the next state column in the table below for this state machine.

Current State	Input	Next State
A	0	B
A	1	A
B	0	C
B	1	A
C	0	D
C	1	A
D	0	D
D	1	C

Problem 9 (3 points)

1. Which of the following consists of all of the structures needed to manage the processing that is carried out by the computer?
 - a. the control unit
 - b. the processing unit
 - c. memory
 - d. input/output
2. How many registers does the processing unit of the LC-3 have?
 - a. 4
 - b. 6
 - c. 8
 - d. 16
3. In the instruction cycle, what does the "evaluate address" phase do?
 - a. obtains the source operands needed to process the instruction.
 - b. carries out the execution of the instruction.
 - c. examines the instruction in order to figure out what the microarchitecture is being asked to do.
 - d. computes the address of the memory location that is needed to process the instruction.