CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING
COMPUTER SCIENCES DEPARTMENT
UNIVERSITY OF WISCONSIN-MADISON

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Midterm Examination 2
In Class (50 minutes)
Monday, March 10, 2008
Weight: 15%

CLOSED BOOK, NOTE, CALCULATOR, PHONE, & COMPUTER.

The exam is two-sided and has 12 pages, including two blank pages at the end.

Plan your time carefully, since some problems are longer than others.

NAME: ____

SECTION: ____

ID# ____

"Pink Version"

Problem Number	**Maximum Points**	**Actual Points**	**Grader**
1	10		SB
2	9		SB
3	12		SW
4	8		SW
5	11		SB
6	15		SW
7	15		SB/PS
8	20		PS
Total	100		

Problem 1 (10 points)

Write the Boolean expression corresponding to the following truth table. You need not simplify the expression.

Inputs			Output
A	**B**	**C**	**Z**
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

$$\overline{A}\,\overline{B}\,\overline{C} + A\overline{B}\,\overline{C} + A\overline{B}C$$

(not A and not B and not C) or (A and not B and not C) or (A and not B and C)

Problem 2 (9 points)

Suppose a 32-bit instruction takes the following format:

OPCODE	DR	SR1	SR2	UNUSED

If there are 256 opcodes and 42 registers:

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

8

b) What is the minimum number of bits required to represent the destination register DR, and source registers SR1 and SR2? (Give the total number of bits.)

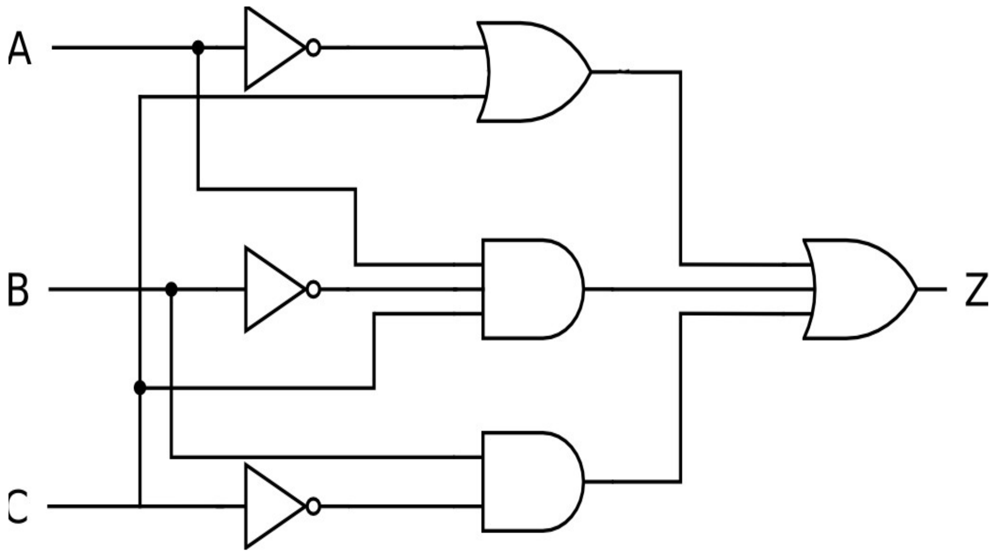
6 * 3 = 18

c) What is the maximum number of UNUSED bits in the instruction encoding?

32 – 18 – 8 = 6

Problem 3 (12 points)

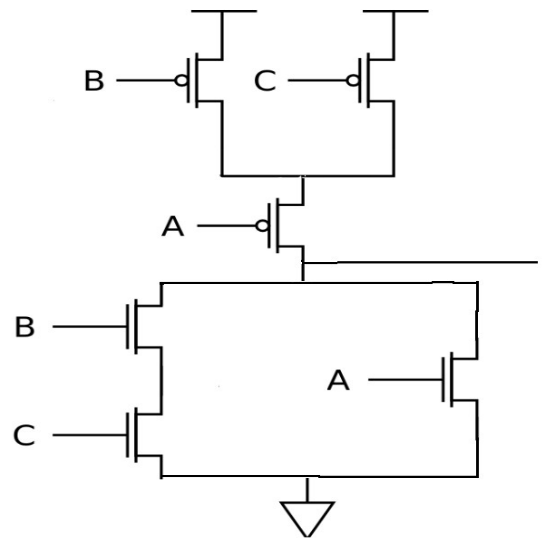
The figure below shows a combinational logic circuit. Complete the truth table corresponding to this circuit.



Inputs			Output
A	**B**	**C**	**Z**
0	0	0	**1**
0	0	1	**1**
0	1	0	**1**
0	1	1	**1**
1	0	0	**0**
1	0	1	**1**
1	1	0	**1**
1	1	1	**1**

Problem 4 (8 points)

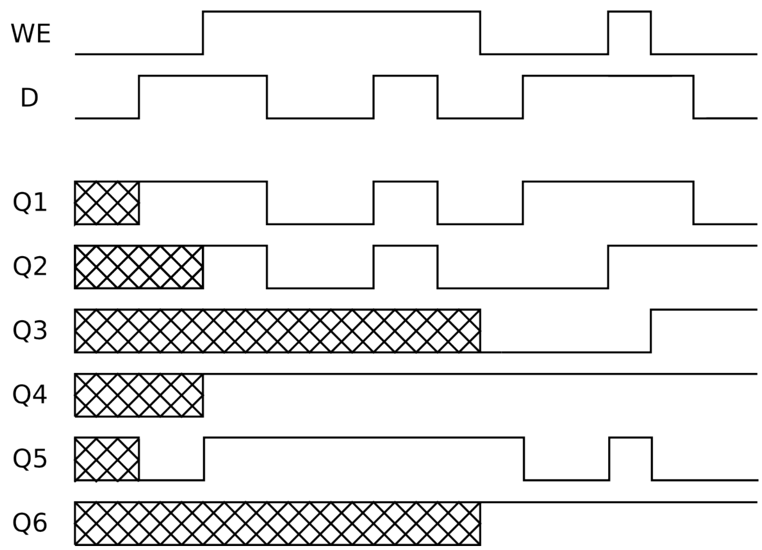
Fill in the truth table for the following transistor level circuit. Note that two wires with the same name are assumed to be connected to each other.



Inputs			Output
A	**B**	**C**	**Z**
0	0	0	**1**
0	0	1	**1**
0	1	0	**1**
0	1	1	**0**
1	0	0	**0**
1	0	1	**0**
1	1	0	**0**
1	1	1	**0**

Problem 5 (11 points)

In the following timing diagram WE and D represent the inputs to a *gated D latch*. Which one of the outputs corresponds to the output of the latch? Circle the correct answer.

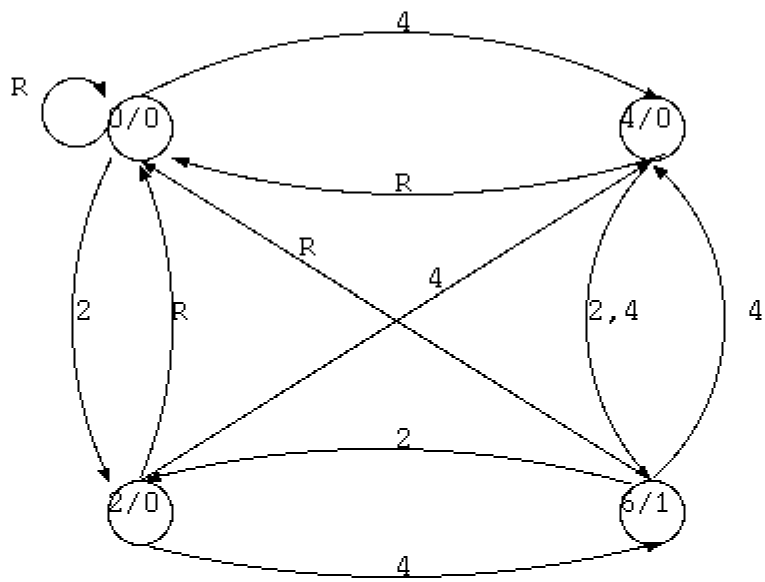


a. Q1
b. Q2 (correct answer)
c. Q3
d. Q4
e. Q5
f. Q6

Problem 6 (15 points)

A Vending machine delivers a package of stamps after 6 dollars are deposited. It has a single bill slot which accepts only \$2 or \$4 bills. (No other types of bills/coins are accepted). The vending machine does not return back changes.

1. Draw the finite state machine diagram for the vending machine. The machine takes one input every clock cycle which can be \$2, \$4 or reset. The machine outputs a 1 when it opens to deliver a stamp package, otherwise it outputs a 0.



2. How many flip-flops (storage elements) will be needed to implement this finite state machine designed in your answer to part I?

Two

Problem 7 (15 points)

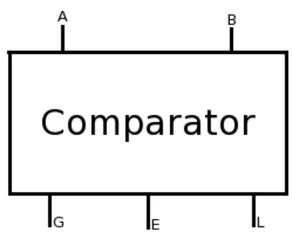
Use the following table to indicate which registers in our von Neumann machine change during different phases of execution. Circle A, L or J if this register is modified during this phase of an add (ADD), load (LDR) or jump (JMP) instruction respectively. Circle all appropriate letters if a register is modified when executing more than one type of instructions.

Instruction	MAR changes	MDR changes	PC changes	IR changes	RegFile is written
Fetch	**A** **L** **J**	**A** **L** **J**	**A** **L** **J**	**A** **L** **J**	A L J
Decode	A L J	A L J	A L J	A L J	A L J
Evaluate Address	A L J	A L J	A L J	A L J	A L J
Fetch Operands	A **L** J	A **L** J	A L J	A L J	A L J
Execute	A L J	A L J	A L **J**	A L J	A L J
Store Result	A L J	A L J	A L J	A L J	**A** **L** J

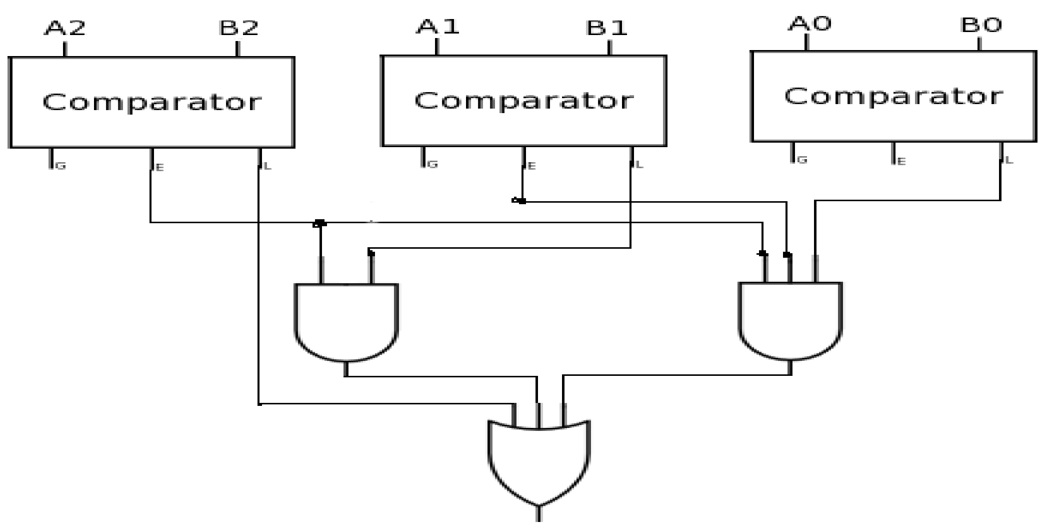
Problem 8 (20 points)

A *1-bit comparator* is a unit which takes two 1-bit inputs A and B and gives three 1-bit outputs G,E,L such that:

a. G is 1 if A is greater than B, 0 otherwise
b. E is 1 if A is equal to B, 0 otherwise
c. L is 1 if A is lesser than B, 0 otherwise



Using any number of such 1-bit comparator as a building block, design a unit which takes two 3-bit numbers A and B, in **unsigned integer** representation and gives an output of 1 if **A is less than B**, 0 otherwise.



A < B if and only if

(A2 < B2) or (A2 = B2 and A1 < B1) or (A2 = B2 and A1 = B1 and A0 < B0)

Scratch Sheet 1 (in case you need additional space for some of your answers)

Scratch Sheet 2 (in case you need additional space for some of your answers)