CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING
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Midterm Examination 2
In Class (50 minutes)
Friday, October 26, 2007
Weight: 15%

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

The exam is two-sided and has 11 pages, including two blank pages at the end.

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

NAME: _____

SECTION: _____

ID# _____

Problem Number	Maximum Points	Graded by
1	3	SR
2	4	SR
3	3	SJ
4	2	SJ
5	3	GJ
6	4	EH
7	3	EH
8	4	NEJ
9	4	GJ
Total	30	

Problem 1 (3 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	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

Z = ((NOT(A)) AND B AND C) OR (A AND (NOT(B)) AND C) OR (A AND B AND (NOT(C)))

Problem 2 (4 points)

Suppose a 16-bit instruction takes the following format:

OPCODE	DR	SR1	SR2	UNUSED

If there are 30 opcodes and 7 registers:

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

5 bits

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.)

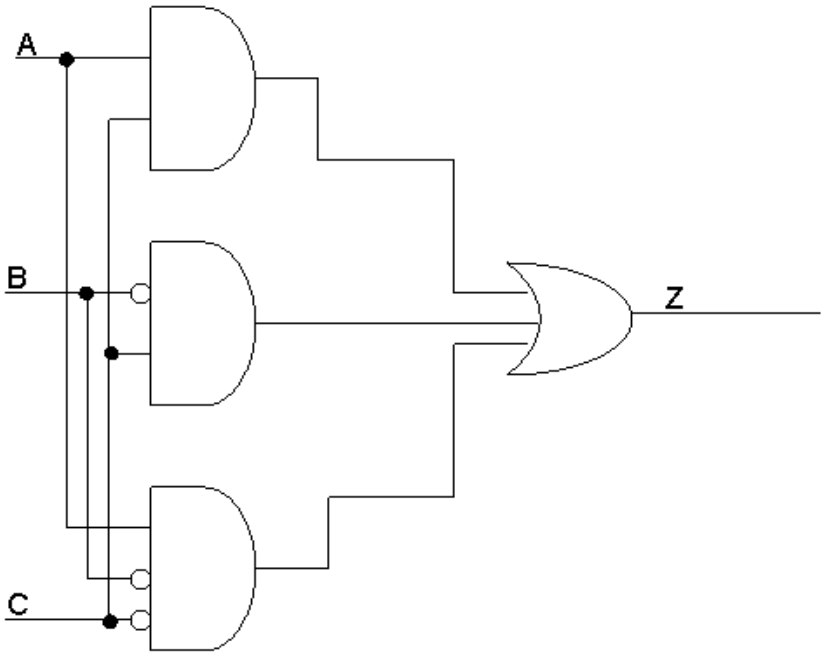
3 * 3 = 9 bits

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

16 – 5 – 9 = 2 bits

Problem 3 (3 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	**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	**1**

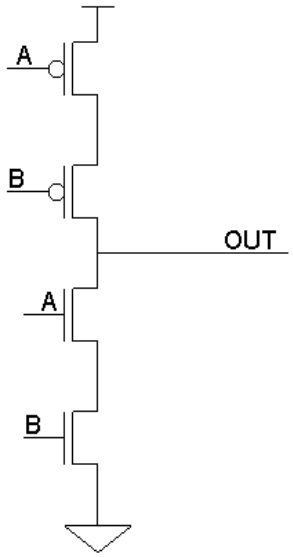
Problem 4 (2 points)

You know a byte is 8 bits. A 4-bit quantity is called a *nibble*. If a byte-addressable memory has a 32-bit address, how many nibbles of storage are in this memory?

2^{32} * 8/4 = 2^{33} nibbles

Problem 5 (3 points)

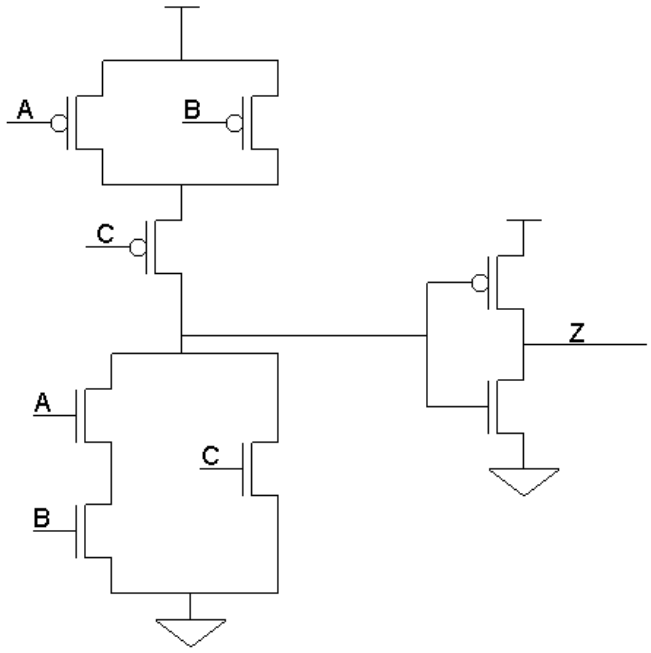
The circuit below has a major flaw. Can you identify it? *Hint*: Evaluate the circuit for all sets of inputs.



The output OUT is neither connected to Power not Ground when either A = 1 and B = 0 or A = 0 and B = 1, thereby creating an open circuit.

Problem 6 (4 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.

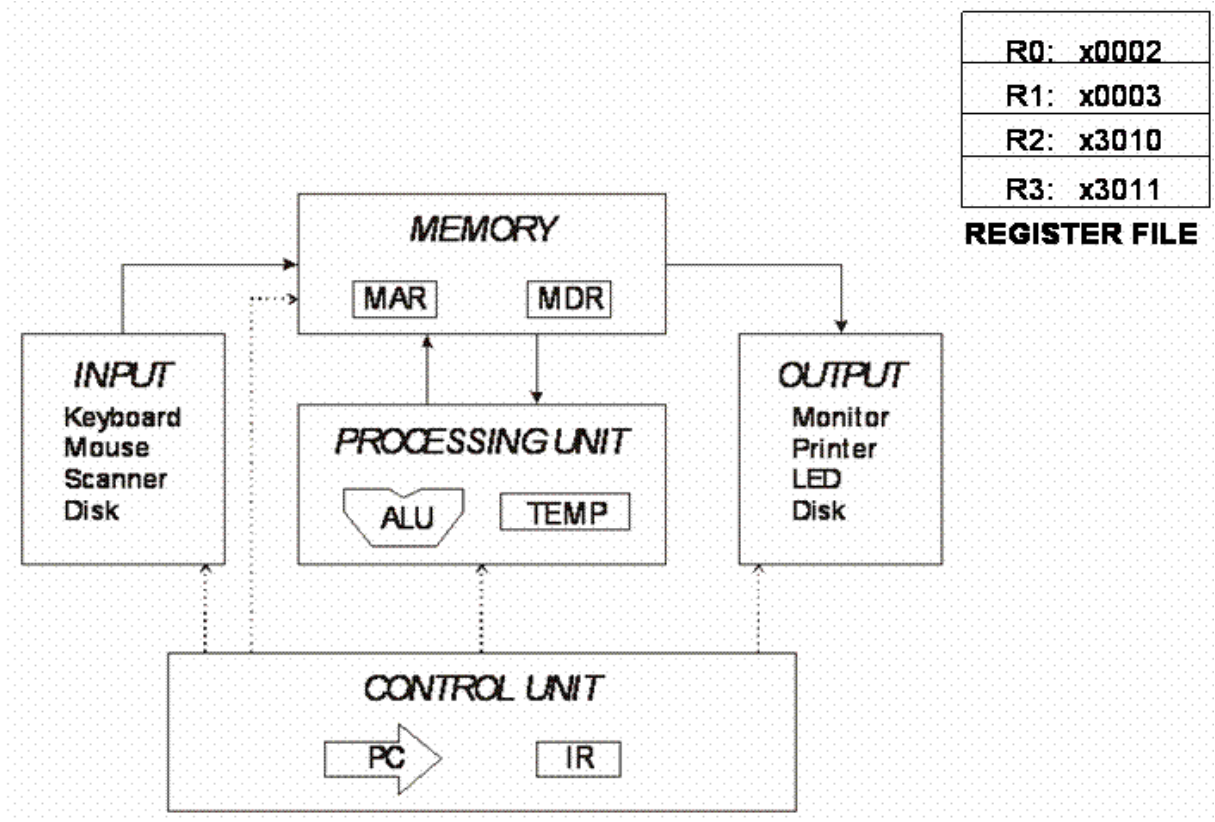


Inputs			Output
A	**B**	**C**	**Z**
0	0	0	**0**
0	0	1	**1**
0	1	0	**0**
0	1	1	**1**
1	0	0	**0**
1	0	1	**1**
1	1	0	**1**

1	1	1	**1**

Problem 7 (3 points)

The figure below shows a block diagram of the Von Neumann model.



List the steps in writing a value x0003 to a location x3011 in the memory. Your steps should mention the MAR and MDR where applicable.

1) ___Write the data x0003 to MDR_____

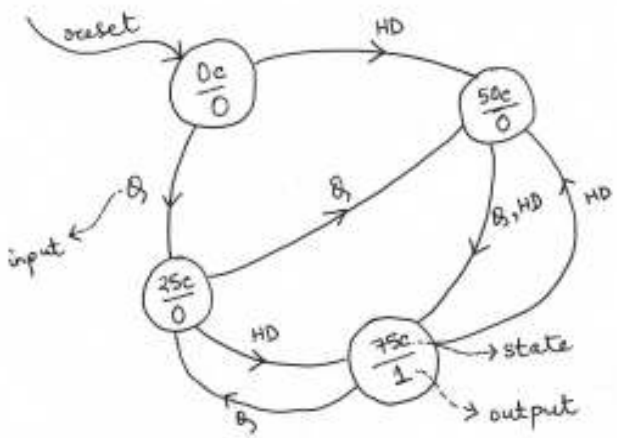
2) ___Write the address x3011 into the MAR_____

3) ___Send a "write" signal to the memory_____

Problem 8 (4 points)

A Vending machine delivers a package of gum after 75 cents are deposited. It has a single coin slot which accepts only quarters (25 cents) or half dollars (50 cents). (No other types of coins are accepted). The vending machine does not return back changes.

I. Draw the finite state machine diagram for the vending machine. The machine takes one input every clock cycle which can be Q, HD or reset. The machine outputs a 1 when it opens to deliver a gum package, otherwise it outputs a 0.



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

2 flip-flops.

Problem 9 (4 points)

Circle the correct answer for the following questions:

I. Circuit A is a 1-bit adder calculating the sum only and no carry; circuit B is a 1 bit multiplier. Both the circuits are implemented using AND, OR and NOT gates only.

   a. Circuit A has the same number of gates as circuit B
   b. Circuit B has more gates than circuit A
   c. **Circuit A has more gates than circuit B**

(Hint: Construct the truth table for the adder and the multiplier)

II. If the number of address bits in a memory is reduced by 2 and the addressability is doubled, the size of the memory (i.e., the number of bits stored in the memory)

   a. Doubles
   b. **Halves**
   c. Remains unchanged
   d. Increases by 2^(address bits)/addressability

III. The minimum number of transistors required to implement a CMOS 3 input OR gate is

   a. 10
   b. **8**
   c. 6
   d. 4

IV. The Decode phase of the Instruction Cycle always examines which part of the instruction?

   a. Immediate (literal) value
   b. Register
   c. Offset
   d. **Opcode**