CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN—MADISON

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Midterm Examination 3

In Class (50 minutes)

Wednesday, April 15, 2015

Weight: 17.5%

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

The exam has **ten** pages. **Circle your final answers**. Plan your time carefully since some problems are longer than others. You **must turn in the pages 1-8**. Use the blank sides of the exam for scratch work.

Note: LC-3 instruction set is provided on Page 9

LAST NAME: _____

FIRST NAME: _____

ID#: _____

Problem	Maximum Points	Points Earned
1	3	
2	2	
3	2	
4	6	
5	5	
6	6	
7	6	
Total	30	

Problem 1 **(3 points)**

a. **(1 point)** Which of the following LC-3 instructions performs R3 = R3 + R2?

i. `0001 010 011 0 00 011`
ii. `0001 011 010 0 00 010`
iii. `0001 011 010 0 00 011`
iv. `0001 010 010 0 00 011`

b. **(1 point)** The LC-3 branch instruction `0000 101 000011110` is located at memory address `0x4000`. If the branch is taken, what does that imply about the values of the condition codes before the instruction is executed?

i. Both N = 1 and P = 1, and Z = 0.
ii. Either N = 1 or P = 1, and Z = 0.
iii. Both N = 1 and Z = 1, and P = 0.
iv. Either N = 1 or Z = 1, and P = 0.

c. **(1 point)** Which of the following instructions loads the data at address `0x300A` into R2? Assume that R1 contains `0x3005`. Also, assume that each instruction below is located at address `0x3000`.

i. `0010 010 000001001`
ii. `0110 010 001 000101`
iii. `1110 010 000001001`
iv. Both ii and iii, and not i
v. Both i and ii, and not iii
vi. All three of them,ie, i, ii and iii.

Problem 2 **(2 points)**

Assume that the following instructions are a part of a program and that the second instruction (which is a branch) is taken:

```
0001 000 000 1 11001
0000 010 000000111
```

What was the value of R0 just before executing these two instructions?

R0 = 7

Problem 3 **(2 points)**

An LDR instruction, located at `0x3000`, uses R1 as its base register. The value currently in R1 is `0x2000`.

a. **(1 point)** What is the largest address this instruction can load from?

Largest address = 0x2000 + 0x1F

b. **(1 point)** What is the smallest address this instruction can load from?

Smallest address = 0x2000 - 0x20

Problem 4 **(6 points)**

Given below are six instructions that writes some value into register R2. Assuming that initial values of R0 =`0x0101` and R1 = 3 before executing each of these instructions, specify which value is getting stored in R2 after executing each instruction. You can assume that each of these instructions is located at `0x3000`.

a. **(1 point)** `0001 010 001 0 00 000`

R2 = `0x0104`

b. **(1 point)** `0001 010 001 1 00000`

R2 = R1+0 = 0x3

c. **(1 point)** `0101 010 001 0 00 000`

R2 = R1 AND 0x3 = 0x1

d. **(1 point)** `0101 010 000 1 10000`

R2 = `0x0100`

e. **(1 point)** `1001 010 001 111111`

R2 = 1111 1111 1111 1100 = `0xFFFC`

f. **(1 point)** `1110 010 000000001`

R2 = 0x3002

Problem 5 **(5 points)**

Assume that the initial value of R0 = 6 and that the initial value of R2 = 0.

a. **(3 points)** Fill in the three missing comments for the program below.

Instruction address	**Instruction**	**Comments**
0x3000	0001 010 010 1 00010	ADD R2, R2, #2
0x3001	0001 000 000 1 11111	ADD R0, R0, #-1
0x3002	0000 101 111111101	BRnp 0x3000
0x3003	1111 0000 0010 0101	HALT

b. **(2 points)** What is the value of R2 upon reaching the HALT instruction?

Loop repeats 5 times since R0 = 5
=> R2 = 2*6 = 12 = 0xC

Problem 6 **(3 points)**

Assume that the initial contents of R0 = 0x3010 and R1 = 0x3011. Also, assume that the initial values of memory locations from 0x300F to 0x3012 are all zeros.

For each of the instructions below, starting at 0x3000, specify what the values of memory locations 0x300F to 0x3012 are after executing each instruction.

Instruction address	**Instruction**	**Values at memory locations after executing the instruction**
0x3000	0011 000 000001111	Value at 0x300F:0x0 Value at 0x3010:0x3010 Value at 0x3011:0x0 Value at 0x3012:0x0
0x3001	0111 001 000 000010	Value at 0x300F:0x0 Value at 0x3010:0x3010 Value at 0x3011:0x0 Value at 0x3012:0x3011
0x3002	1011 001 00001111	Value at 0x300F:0x0 Value at 0x3010:0x3010 Value at 0x3011:0x3011 Value at 0x3012:0x3011

Problem 7 **(6 points)**

We are about to execute the program below. Assume that the condition codes before execution are N = 1, Z = 0, P = 0.

Address	Instruction	Comments
0x3000	0011 001 000001011	Store R1 into location 0x300C
0x3001	0000 100 000000011	If N flag is set, branch to 0x3005
0x3002	0001 000 000 1 11011	R0 <- R0 - 5
0x3003	0101 010 010 0 00 000	R2 <- R2 AND R0
0x3004	1111 0000 0010 0101	HALT
0x3005	1010 010 000000100	LDI R2, 0x300A
0x3006	1111 0000 0010 0101	HALT

a. **(3 points)** Fill in the four missing instructions in the program above.

b. **(3 points)** Suppose a section in memory **before** execution of the program is as follows:

Address	Value
0x300A	0x300C
0x300B	0x300F
0x300C	0xACED
0x300D	0x300B

Given the initial values of the below registers, fill in the values after the program has completed execution (reached a HALT). Give your answers in **hex**.

Register	Initial Value	Final Value
R0	0xFACE	0xFACE
R1	0x1234	0x1234
R2	0x300A	0x1234