CS/ECE 252: INTRODUCTION TO COMPUTER ENGINEERING
UNIVERSITY OF WISCONSIN – MADISON

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Midterm Examination 3

Version 1

In Class (50 minutes)

Friday, November 13, 2009

Weight: 15%

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

The exam has **three** two-sided pages and a copy of the *LC-3 Instruction Set Handout* on the final page (Please feel free to detach this final page, but insert it into your exam when you turn it in).

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

NAME:_____

SECTION:_____

ID#:_____

Problem Number	Maximum Points	Actual Points
1	6	
2	4	
3	4	
4	4	
5	8	
6	4	

Problem 1 (6 points)

a)Register R1 contains x00E5 and register R2 contains x0018. What will be the values of the condition codes N, Z, and P after executing the instruction AND R3, R1, R2? Also State contents of R3.

Contents of R3:_____16'b0_____

N=__0 ___

Z=___1__

P=___0__

b) How many times does the LC-3 make a Read Request and Write Request to the memory during the processing of a STI instruction ?.(Do not include Instruction Fetch)

Number of Read requests = 1

Number of Write Requests =1

Problem 2 (4 points)

a)The following table shows a part of LC-3's memory. If the instruction after the conditional branch is fetched from location x3100, what are the initial contents of register R1. Write your answer
in hexadecimal format.

Address	Data
x3100	1110 010 000 001000 ; R2 <- x3109
x3101	1001 001 001 111111 ; R1 <- NOT(R1)
x3102	0001 001 001 1 00001 ; R1 <- R1 + 1
x3103	0001 011 001 0 00 010 ; R3 <- R1 + R2
x3104	0000 010 111111011 ; BRz x3100

***Contents of R1* =____x3109_____ (in hexadecimal format, please)**

b) In any program, what is the range of values that the immediate field of an ADD instruction can take?

-2^4 to($2^4 - 1$)

Problem 3 (4 points)
a) Identify an LC-3 instruction which **does not change the contents of the registers and the memory locations.** Fill in the machine code for the identified in the space below.

15 0

Multiple Answers possible: ADDI /ANDI /BR/JMP

b) Identify an LC-3 instruction which **does not change the contents of the registers, memory, and the condition codes.** Fill in the machine code for the identified in the space below.

0	0	0	0												

15 **0**

Branch condition

Problem 4 (4 points)
The program below checks if bit 2 (the 3rd bit) of R0 is a one. If bit 2 is one, the program adds the contents of R5 and R1 and stores the result in R1. Otherwise, it does nothing. Insert the missing LC-3 machine language instructions. **No credit will be given if you do not comment your instruction**.

Address	ISA Instruction	
x3000	0101 0100 1010 0000	;Clear R2
x3001	0001 0100 1010 0100	;R2 <- R2+4
x3002	**0101 xxx0 0000 0010**	**DR <- R0 and R2**
x3003	0000 0100 0000 0001	;BRz x3005
x3004	**0001 0010 0100 0101**	**R1 <- R1 + R5**
x3005	1111 0000 0010 0101	;HALT

Problem 5 (8 points)
We are about to execute the following program:

Address	ISA Instruction
x3000	0010 0000 0000 0110 ; LD R0, x0006
x3001	0110 0010 1101 1101 ; LDR R1, R3, x001D
x3002	1010 0100 1111 0011 ; LDI R2, x00F3
x3003	1110 0110 0001 1010 ; LEA R3, x001A
x3004	1111 0000 0010 0101 ; HALT

The state of the machine before the program starts is given below:

Address	Memory Contents	**Register**	**Initial contents**
x158E	x0012	R0	x200E
x200E	x3258	R1	x200E
x2257	x0000	R2	x3001
x2FFF	x4567	R3	x3001
x3001	x62C0		
x3006	xABEB		
x3007	xABCD		
x300E	x92FE		
x301C	x3232		
x301D	x2121		
x301E	xDACA		
x30F6	x3111		
x3111	x1252		
xABCD	x1580		
xABDB	x0001		

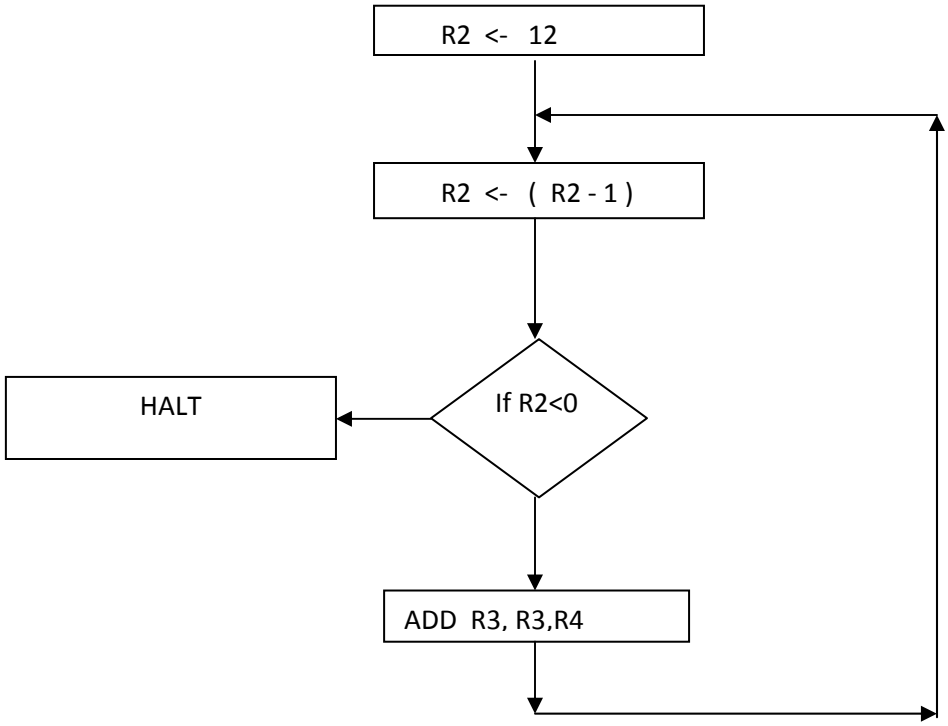
The contents of Registers R0, R1, R2, and R3 after the program completes execution are as follows. **Please write your answer in hexadecimal format**.

Contents of R0 = _____xABCD_____ **Contents of R1 = _____xDACA_____**

Contents of R2 = ___x1252_____ **Contents of R3 = _____x301E_____**

Problem 6(4 points)

A flowchart is drawn below and the memory contents are shown in a table on the next page. Please enter the values of the condition codes and offsets in accordance with the flowchart.



x3100	**R2 <- 12**		
x3101	**R2 <- R2 -1**		
	0000	**a)** 10 0	**b)** 000000010
x3102	**R3 <- R3 +R4**		
x3103			
	0000	**c)** 111	**d)** 111111100
x3104	HALT		
x3105			

LC-3 Instruction Set (Entered by Mark D. Hill on 03/14/2007; last update 03/15/2007)

PC': incremented PC. setcc(): set condition codes N, Z, and P. mem[A]:memory contents at address A.
SEXT(immediate): sign-extend immediate to 16 bits. ZEXT(immediate): zero-extend immediate to 16 bits.
Page 2 has an ASCII character table.