

NCSU ECE 109 Sections 602 and 603 and UNCA CSCI 255.001

Exam 4 Spring 2009

5 May, 2009

This is a closed book exam. No notes are allowed other than the “handy table” distributed with the exam. Calculators, PDA's, cell phones, and other electronic or communication devices may not be used during this exam.

The exam is to be turned in by 3:00 pm.

Please read and sign the following statement:

I have neither given nor received unauthorized assistance on this test.

Name: _____

If you want partial credit for imperfect answers, explain the reason for your answer!

Problem 1 (14 points) Hand assembled

Use the symbol table shown below in this question.

DURHAM	x3401
ORANGE	x3481
WAKE	x3501

Write the appropriate 16-bit LC-3 machine language word, in binary or hex, for each assembly language statement shown in the left column of the table below. Assume that the instruction is located at address x3400 in all cases. If the assembly language statement is illegal, state the reason why.

ADD R1, R2, x10	
ADD R3, R4, WAKE	
BR DURHAM	
BRz ORANGE	
LD R5, WAKE	
JSRR DURHAM	
STI R3, ORANGE	

Problem 2 (10 points) Addressing modes

Assume that the eight LC/3 registers have the values shown on the left below and that the eight words of memory starting at memory location $\times 3040$ have the values shown on the right.

<i>Register</i>	<i>Value</i>
R0	$\times 0000$
R1	$\times 0000$
R2	$\times 2222$
R3	$\times 3333$
R4	$\times 0000$
R5	$\times 5555$
R6	$\times 0000$
R7	$\times 0000$

<i>Address</i>	<i>Value</i>
$\times 3040$	$\times 0000$
$\times 3041$	$\times 0000$
$\times 3042$	$\times 4444$
$\times 3043$	$\times 6666$
$\times 3044$	$\times 0000$
$\times 3045$	$\times \text{AAAA}$
$\times 3046$	$\times 0000$
$\times 3047$	$\times 0000$

For the five addresses shown below, write a single LC/3 instruction to load the value **stored in** the specified memory location into register 4. Assume that each instruction is located at memory address $\times 3001$.

If this location cannot be loaded in one instruction, state why this is not possible.

$\times 3042$	
$\times 3101$	
$\times 4455$	
$\times 5535$	
$\times \text{AAAA}$	

Problem 3 (6 points) Memory

A computer memory has 16-bit words stored in 4 M locations. What is the size of this memory in bits?

How many address bits are needed to address the 4 M words of this memory?

The programming problems

Your answers to the remaining nine problems should be written on pieces of lined paper, which you should attach to this exam when turning in. Be sure to write your name (or at least your initials) on these pages. Points may be deducted from convoluted answers.

Problem 4 (5 points)

Write a piece of LC-3 assembly code that copies the value stored in R4 into R5.

R5 ← R4

Problem 5 (5 points)

Write a piece of LC-3 assembly code that subtracts 32 from R5.

R5 ← R5-32

Problem 6 (5 points)

Write a piece of LC-3 assembly code that sets R5 to 10-R3.

R5 ← 10-R3

Problem 7 (5 points)

Write a piece of LC-3 assembly code that triples the value stored in R4.

R4 ← 3*R4

Problem 8 (5 points)

Write a piece of LC-3 assembly code that prints the letter 'T' (ASCII x4A) on the display.

Problem 9 (5 points)

Write a piece of LC-3 assembly code that adds the contents of memory locations x4444 and x5555 and stores the result in memory location x9999.

Problem 10 (10 points)

Write a piece of LC-3 assembly code that sets R4 to be equal to bits 0 to 4 of R3 sign-extended to a full 16-bit value. For example, if R3 is x000F, R4 should be set to x000F; and, if R3 is x0010, R4 should be set to xFFF0. (This is the same extension that occurs with the five-bit immediate operand fields of the ADD and AND instructions.)

Problem 11 (15 points)

Write a piece of LC-3 assembly code that sets R4 depending on the value stored in R3.

- 1) If R3 is positive or zero, set R4 to 0.
- 2) If R3 is xBEEF, set R4 to 1.
- 3) If R3 is not xBEEF and is neither positive nor zero, set R4 to 2.

Problem 12 (15 points)

Write an LC-3 subroutine that receives in register R0 the starting address of an eight-word "packet" of values. The LC-3 subroutine should add those eight words and return the result of that addition in register R1.