ELE209 Lab 4 **Name:** _____
Programming the LC-3

Due: Due beginning of lab the next week. Be sure to email your machine code listings to the TA.

Goal: To learn to program the LC-3 computer in its native machine code.

For all of the following problems, write your machine code in binary, have your program start at memory location x3000, and end with a HALT instruction (b1111000000100101). In the simulator, manually set the source registers to verify your programs work correctly.

1. The LC-3 instruction set includes only the NOT and the AND logical operations. Write four separate programs in the LC-3 machine language that implement the NAND, OR, NOR, and XOR operations. Implement each of these operations as follows.

   (a) R1 ← R2 NAND R3

   (b) R1 ← R2 OR R3

   (c) R1 ← R2 NOR R3

   (d) R1 ← R2 XOR R3

   After thoroughly testing your programs, demonstrate them to your TA using the values
   R2: x0003 which is binary 0011
   R3: x0005 which is binary 0101

   Write the value you expect to see in R1 for each case:

   (a) _____ (b) _____ (c) _____ (d) _____

2. Write an LC-3 program to evaluate the following truth table. You can simplify it as much as you want.

   Use R2 for A, R3 for B, R4 for C, and R1 for Z.

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	0
1	1	1	1

   After thoroughly testing your program, demonstrate it to your TA using the values
   R2 (A): x000F which is binary 00001111
   R3 (B): x0033 which is binary 00110011
   R4 (C): x0055 which is binary 01010101

   Write the value you expect to see in R1 for this test case: _____

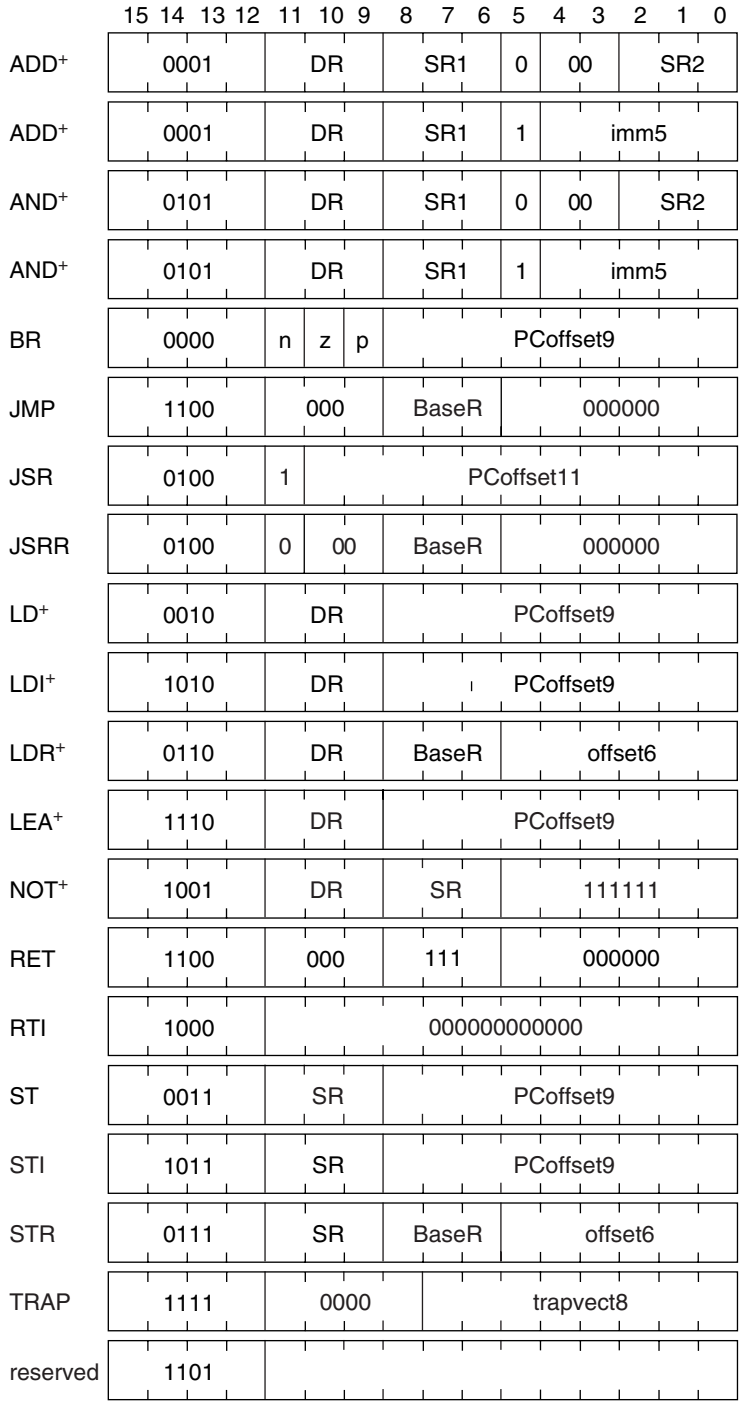
3. Write an LC-3 program to compute the difference between two numbers. Implement the operation as follows:

   R1 ← R2 - R3

   After thoroughly testing your program, demonstrate it using x0F75 in R2 and x07FC in R3.

   Write the value you expect to see in R1 for this test case: _____

LC-3 Instruction Set



Logic properties:

$ABC+DEC = (AB+DE)C$

$AA = A + A = A$

$AB = BA$

$A + B = B + A$

$A + \overline{A} = 1$

$A\overline{A} = 0$

DeMorgan's Law:

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

$AB = \overline{\overline{A} + \overline{B}}$