

50 minutes (maximum)
Closed Book

- Have your ID out on your desk.
- You may use one side of one sheet (8.5x11) of paper with any notes you like.
- This exam has XX pages, including this cover page and a blank page at the end. Do all your work on these exam sheets, use the backs of the pages if needed.
- Be specific and clear in your answers. If there is any question about what is being asked, then indicate the assumptions you need to make to answer the question.
- Show all your work if you wish to be considered for partial credit.
- If you use the back pages for scratch space, cross out your scratch work before you submit the exam.

During the midterm you will be provided with the following information as it is relevant:

IEEE floating point format:

1 sign bit, 8 stored exponents, 23 mantissa/fraction bits

LC3 semantics

(e.g. STR SR, BaseR, offset6

mem[BaseR + SEXT(offset6)] = SR

)

LC3 machine code formats (the chart on the inside of the back cover)

NOTE: The below is just an example point breakdown.

Question	Points	Score
1	15	
2	20	
3	15	
4	10	
5	5	
6	5	
7	10	
8	20	

Name: _____

Email: _____

DO NOT TURN TO NEXT PAGE TILL YOU GET PERMISSION

1. [XX points] gdb

What is the sequence of commands for loading an executable (a.out) into the debugger, setting up a breakpoint upon entry into the main function, starting execution of the program, and executing the next line within gdb?

\%

(gdb)

(gdb)

(gdb)

2. [XX points] gdb

Assume that the following session is underway using gdb:

```
41     int num_bits = sizeof(Instruction)*BITS_IN_BYTE;
(gdb) next
47     instr = instr << ((num_bits - 1) - start);
(gdb) next
52     Instruction mask = 1;
(gdb)
```

a) What command will print the decimal value of the variable num_bits?

b) What command will print the hexadecimal value of the variable instr?

3. [XX points] gdb

Assume that the following session is underway using gdb:

```
176          bit5 = bit_field_to_unsigned(m->IR, 5, 5);  
(gdb)
```

What command will make gdb follow the execution into the `bit_field_to_unsigned` function?

4. [XX points] Number Representation

Here are the slightly modified example problems that can be found as some of the sample exercises for quiz 1 at <http://ieng9.ucsd.edu/cs30x/quizzes.html>. They were put together by Rick Ord and he has posted their solutions on the same web page.

How does one decorate a 31-year-old's birthday cake with only five candles?

Perform the following number system conversions:

$$1101011_2 = ?_{10}$$

$$F3A5_{16} = ?_{10}$$

$$174003_8 = ?_{10}$$

$$AB3D_{16} = ?_{10}$$

$$10110111_2 = ?_{10}$$

$$7156_8 = ?_{10}$$

Perform the following number system conversions:

$$1101011_2 = ?_{16}$$

$$174003_8 = ?_2$$

$$10110111_2 = ?_{16}$$

$$F3A5_{16} = ?_2$$

$$11011001_2 = ?_8$$

$$AB3D_{16} = ?_2$$

Perform the following number system conversions:

$$125_{10} = ?_2$$

$$3489_{10} = ?_8$$

$$209_{10} = ?_2$$

$$9714_{10} = ?_8$$

$$132_{10} = ?_2$$

$$23851_{10} = ?_{16}$$

$$57190_{10} = ?_{16}$$

$$1435_{10} = ?_8$$

$$65113_{10} = ?_{16}$$

Add the following pairs of binary numbers, showing all carries:

110101	101110	11011101	1110010
+11001	+100101	+1100011	+1101101
-----	-----	-----	-----

Give the 8-bit signed-magnitude, one's-complement, and two's-complement (however many bits) representation for each of the following decimal numbers:

18 115 79 -49 -3 -100

What do each of the Condition Code bits mean?

What does it mean if the bit is a 0?

What does it mean if the bit is a 1?

Why do HFC, IBM, and TWA come before Haag, Iacocca, and Taaffe, respectively, in the phone book?

5. [XX points] Manipulating Bits with C

Using the C operators `<<`, `>>`, and/or `&`, write a sequence of C code that determines if bit 8 in the variable `x` is one or zero. To indicate that bit 8 is a 1 do a `'printf("1\n")'`. If bit 8 is a 0 then do a `'printf("0\n")'`.

6. [XX points] Limitations of Offsets

a) What is the range of values that an LEA instruction can load into a register?

b) Given that your base register (BaseR) contains the value 0x1234, what is the range of memory locations that an LDR can access?

c) What is the range of values that can be added to a register if using the immediate addressing mode with the ADD instruction?

d) Assume that a branch instruction is at address 0x3000. What is the range of possible memory addresses to which control may go to next?

7. [XX points] LC3 programs

a) Fill in the LC3 assembly and machine instruction sequence show below so that at the end of the sequence register R7 contains the value R3-R5.

LC3 machine code	LC3 assembly
0101 0010 0110 0000	AND R1, R1, #0 ; R1 ← 0

b) What sequence of LC3 ADD and AND instructions can be used to set R7 to -42? Write the LC3 assembly and machine code for the sequence.

LC3 machine code	LC3 assembly
	AND R7, R7, #0

c) The following LC3 sequence should result in R5 containing the value 4, but instead it appears to contain the value 5. (a) First write the LC3 assembly for the given LC3 machine code in the space provided. (b) Then, find the bug and explain it with one or two sentences. Fix the code by modifying the instructions as necessary. (Hint: see example 1 in Section 6.2.2 of the book. Note that during the midterms such a hint is not possible so make sure you understand all of the bugs discussed in Chapter 6.)

```

x3000    0101 101 101 1 00000 ; R5 = 0
x3001    0101 110 110 1 00000 ; R6 = 0
x3002    0001 110 110 1 00100 ; R6 <- 4
x3003    0001 101 101 1 00001 ; R5 <- R5 + 1
x3004    0001 110 110 1 11111 ; R6 <- R6 - 1
x3005    0000 011 111111101   ; BRzp x3003
x3006    1111 0000 00100101   ; HALT

```

8. [XX points] Given the following components: IR, Reg (both on board) and SEXT, 2-to-1 mux, ALU, draw the parts of the data path relevant to the ADD instruction.

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