

# CS447 Lab #4 (Week 5)

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## Introduction

In this lab, you will complete some pen-and-paper problems that are intended to review some material that is relevant for the midterm. This handout will be distributed as hardcopy during recitation.

*Note: At the end of recitation, you should turn in the handout, with any work that you have completed. Please write your name on the first page.*

*Any reasonable attempt will be considered sufficient in order to earn full credit for this lab. More details are provided in the Submission section on the final page.*

This lab will focus on a subset of the midterm review topics:

- Converting between binary and hexadecimal formats
- Logical and shifting operations, and their use to extract values from bitfields
- Branching, with a focus on conditions that include short-circuit Boolean operators (&&, ||)

## Part a: Conversion between binary and hexadecimal formats

For all problems in this section, assume unsigned representations (no two's complement).

As a warm up, try the following simple conversions from decimal format:

- 1. Decimal value 37 as binary?**
- 2. Decimal value 37 as hexadecimal?**

The following problems involve conversions from binary to hexadecimal (or vice versa):

- 3. Binary value 0110 1011<sub>2</sub> as hexadecimal?**
- 4. Hexadecimal value 0x7f as binary?**
- 5. Binary value 0000 0001 0010 1010 0100 0000 0010 0000<sub>2</sub> as hexadecimal?**
- 6. Hexadecimal value 0x3230000f as binary?**

Part b: Operations for extracting bitfields

The following problems ask you to predict the results of logical and shifting operations.

7. Assume that some nonzero value is stored in register \$t0. The instruction

```
sll $t0, $t0, 3
```

is equivalent to the multiplication of the contents of \$t0 by what number?

8. For the following problems, assume that  $x = 0100\ 1000_2$  and  $y = 0111\ 0100_2$ .

a. What is the binary result of  $and(x,y)$ ? (This can also be represented as  $x\&y$ ).

b. What is the binary result of  $or(x,y)$ ? (This can also be represented as  $x\vee y$ ).

c. What is the binary result of  $not(x)$ ? (This can also be represented as  $\sim x$ ).

9. Assume that  $x = 15$ , and  $y = 65$  (both in decimal format). What is the result (in a base of your choice) of  $and(x,y)$ ?

10. Assume that \$t0 contains the decimal value 48, and \$t1 contains the decimal value 16.

The following MIPS instructions are run:

```
and $t2, $t0, $t1
```

```
srl $t3, $t2, 2
```

In other words, we perform  $\$t2 = and(\$t0, \$t1)$ , shift two places to the right the contents of \$t2, and store the final result in \$t3. What is the value (in any base) stored in \$t3?

11. Assume that we have decided to store the day of the year (for example, "September 30<sup>th</sup>") as a binary representation in the 32-bit MIPS register \$s0. We will not make use of the two most significant bytes of the register. In the least significant bytes (bit positions 15.....0), we will store the month and day in binary, according to the following format:

position	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
contents	binary representation of month								binary representation of day							

For example, if we wished to store the date "September 30<sup>th</sup>" (9/30), the binary representation of positions 15...0 in \$s0 would be:

```
0000 1001 0001 11102
```

Assume we wanted to extract the day (e.g., the 30<sup>th</sup>) from \$s0 and store the result in register \$s1. Write one or more MIPS instructions that can accomplish this goal. Multiple solutions could work.

### Part c: Branching

12. Consider the following MIPS instructions. Assume that \$v0 holds the value of some positive integer in the range of 1-99.

```

9  addi $t0, $zero, 15
10 addi $t1, $zero, 80
11 slt $t2, $t0, $v0
12 beq $t2, $zero, blockB
13 slt $t3, $v0, $t1
14 beq $t3, $zero, blockB
15 # print message A
16 blockA:
17 la $a0, msgA
18 li $v0, 4
19 syscall
20 j end
21 blockB:
22 # print message B
23 la $a0, msgB
24 li $v0, 4
25 syscall
26
27 end:
28 li $v0, 10
29 syscall

```

In another language (for example, C/C++, Java, Python), lines 9-25 could be represented with a single if...else statement, with a Boolean operator (for example, && or ||) in the condition, and print statements in the *if* and *else* blocks. Try writing this if....else statement in the language of your choice. You can use whatever variable name you prefer to represent \$v0.

Submission:

**Please hand in your work when recitation ends** (or earlier, if you complete the entire handout early). Make sure you have **written your name** on the first page! If you are in attendance at recitation, then any reasonable attempt on some or all of these problems will be considered sufficient to receive full credit for this lab.

This lab will not be graded for accuracy; however, the solutions will be made available on Github within 24 hours after recitation has ended.