Homework 3

BASICS OF COMPUTING
(CSCE 101, SPRING 2007)
URL: `http://my.unl.edu`

Due on 8th March, 2007

20th February, 2007

Name :
Course No : **CSCE101**

Instructions:

- **You may neatly print the answers on a printed version of this assignment!**
- If your answers take more than one page, **staple** your homework. Failure to do so may result in portions of the homework being lost. In addition, there will be an automatic 5% deduction from the homework grade.
- You must **show all steps of your work for full credit**. Do not simply write final answers for a problem if it involves intermediate steps. In most cases, you will show your work in the same manner that you would for a math class. Writing a short essay describing how you solved the problem is unnecessary.
- The only way to submit your homework is in class at the beginning of the class when it is due.
- **Some of these problems require you to hand in an electronic copy of your work using Webhandin. For these problems, you must save the program, naming it with your first initial, followed by your last name, followed by "-X", where X is the problem number. For example, the instructor would name his file for problem 8 "cstrope-8" (without the quotes). After saving the file, print the file and turn in a hard copy with your homework. Finally, submit the program using Webhandin.** *Failure to follow this procedure will be an automatic deduction of 2% from the homework grade.*

http://cse.unl.edu/∼cse101/handin

1. (6 points) The following are instructions written in the machine language described in Appendix C. Translate them into English:

Instruction	Translation in English	Register Transfer Notation
2512		
B0FE		
6FF2		

2. (6 points) Translate the following instructions from English into the machine language described in Appendix C.

Register Transfer Notation	Translation in English	Instruction
$R[1] \leftarrow M[4D]$		
$R[E] \leftarrow R[E]$ OR $R[2]$		
ROTATE(R[4],3)		

3. (6 points) Consider a hypothetical machine with the following specifications:

- A CPU with 23 registers,
- a main memory with 2048 cells, and
- a machine languate with a total of 104 instructions.

Note that the machine language instructions for our virtual machine in class all have instructions of the same length, 16 bits. In this question, instructions can have different lengths.

Answer the following questions:

(a) How many bits are needed for the op-code portion of the instruction in the above machine language?

Answer:

The number of bits needed for the op-code = ______________

(b) What is the length of the register addresses in the above machine?

Answer:

The length of the register addresses = ____________

(c) How many bits are needed to encode the address of a cell in the memory in the above machine?

Answer:

The number of bits needed to encode a cell's memory address = ____________

4. (4 points) Using the results from the previous question: Let R0, R1, and R2 be three registers in the CPU, and let M1 be the address of a cell in the main memory. Compute the instruction length of the following two instructions: **ADD R3 RF R1** (this instruction adds the contents of the register R1 and register RF, and places the result in register R3), **LOAD R1 M5** (This instruction loads the contents of the memory cell whose address is M5 into the register R1).

Answer:

(1) **ADD R3 RF R1:** ____________

(2) LOAD R1 M5: ____________

5. (4 points) If the number of instructions in the above machine language is decreased to 64 instructions instead of 104 instructions, will this change affect the overall instruction length? Answer the same question for the case of increasing the number of instructions to 136 instructions instead of 104 instructions? (Show your work.)

Answer:

- 64 instructions:

- 136 instructions:

6. (10 points) Do problem 15 on page 112. "Run" the program using the notation in the lecture notes. When finished, answer the questions posed at the end of the problem.

Answer:

7. (10 points) Suppose three values, x, y and z are stored in a machine's memory. Describe the sequence of events (loading registers from memory, saving values in memory, and so on) that leads to the computation of $x + y + z$. How about $2x + y$? *(Note: You do not need to know the position in memory; in describing the sequence of events, you may use terminology such as* `LOAD x into register ... from memory`*.)*

Answer:

8. (15 points) *For the following problem, download the Super Machine program* `problem8.smo` *in the Homework 3 folder on Blackboard, and load this program into the Super Machine.*

   Run the program `problem8.smo`.

   (a) *(2 points)* In simple terms, explain what this program does:

   (b) *(10 points)* Although the machine language code works, the end result of this program is not correct. To find the problem, "run" the program as shown in class, also performing each Arithmetic/Logic instruction that the program does. *Show your work!*

   (c) *(3 points)* Again using the Super Machine, change the program so that it performs correctly. Turn in the corrected program as noted on the first page of this homework.

9. (5 points) Problem 22, page 113: "Run" three steps of the program using the notation shown in class, and answer the question at the end of the problem.

10. (15 points) In the Super Machine, write a program (beginning at memory cell M[00]) that will compute the product of 2 positive two's complement numbers located in memory cells M[AC] and M[B0], and stores the result in M[AA].

    (a) *(10 points)* Turn in this program as noted on the first page of the homework.

    (b) *(5 points)* If the Super Machine executes an instruction every microsecond (a millionth of a second), how long does it take to complete your program if the initial values in memory are M[AC] $\leftarrow$ 03 and M[B0] $\leftarrow$ 04?

Answer:

The machine will take ______________ microseconds.

11. (5 points) Identify both the mask and the logical operation needed to accomplish each of the following objectives:

    (a) Put 0s in the middle four bits of an eight-bit pattern without disturbing the other bits.

    (b) Complement a pattern of eight bits.

    (c) Complement the most significant bit of an eight-bit pattern without changing the other bits.

    (d) Put a 1 in the most significant bit of an eight-bit pattern without disturbing the other bits.

    (e) Put 1s in all but the most significant bit of an eight-bit pattern without disturbing the most significant bit.

12. (4 points) Perform the indicated operations: For this last one, choose one of the operations {AND, OR, XOR}, and perform the operation with the following numbers. Circle the appropriate operation.

```
      111000          111000          111000
AND   101001     OR   101001    XOR   101001
___________     ___________     ___________


                    100100
{AND, OR, XOR}      110101
__________________________
```

13. (10 points) In the Super Machine, write a program that reads in an 8-bit Floating Point number from M[AA], and calculates:

    - The mantissa, which it stores in M[B0],
    - The exponent, which it stores in M[B1], and
    - The sign bit, which it stores in M[B2].

    For example, if the bit pattern in M[AA] is 10111011, then M[B0] $\leftarrow$ 0x0B, M[B1] $\leftarrow$ 0x03, and M[B2] $\leftarrow$ 0x01. Turn in this program as noted on the first page of this homework.

14. **Extra Credit** (10 points) Write a program in the machine language of Appendix C that reverses the contents of the memory cell at address 8C. (That is, the final bit pattern at address 8C when read from left to right should agree with the original pattern when read right to left.) Turn in this program as noted in the first page of this homework.