University of Regina, Department of Computer Science, CS 301, Assignment 4

(Please submit one PDF file in UR Courses)

Total: 100 marks

1. (i) [10 marks] You are given an one-address machine with an accumulator and the following memory values:

Word 20 contains 40.

Word 30 contains 50.

Word 40 contains 60.

Word 50 contains 70.

What values do the following instructions load into the accumulator?

(a) LOAD IMMEDIATE 20

(b) LOAD DIRECT 20

(c) LOAD INDIRECT 20

(d) LOAD IMMEDIATE 30

(e) LOAD DIRECT 30

(ii) [10 marks] An address field in an instruction contains a decimal value 14. Where is the corresponding operand located for:

(a) immediate addressing?

(b) direct addressing?

(c) indirect addressing?

(d) register addressing?

(e) register indirect addressing?

2. [20 marks] Let the address stored in the program counter (PC) be designated by the symbol X1. The instruction stored in X1 has an address part (operand reference) X2. The operand needed to execute the instruction is stored in the memory word with address X3. An index register contains the value X4. What is the relationship between these various quantities if the addressing mode of the instruction is (a) direct; (b) indirect; (c) PC relative; (d) indexed?

3. (i) [10 marks] A PC-relative mode branch instruction is 3 bytes long. The address of the instruction, in decimal, is 256028. Determine the branch target address if the signed displacement in the instruction is -31.

(ii) [10 marks] A PC-relative mode branch instruction is stored in memory at address 620_{10}. The branch is made to location 530_{10}. The address field in the instruction is 10 bits long. What is the binary value in the instruction? Note that $(x)_{10}$ indicates that x is a decimal number.

4. (i) [4 marks] If the last operation performed on a computer with an 8-bit word was an addition in which the two operands were 00000010 and 00000011, what would be the value of the following flags?

Overflow
Sign

(ii) [6 marks] If the last operation performed on a computer with an 8-bit word was a subtraction in which the two operands were 11110000 and 0010100 (i.e., 11110000 – 00010100 was performed), what would be the value of the following flags?

Carry
Zero
Overflow

(iii) [10 marks] A pipelined processor has a clock rate of 2.5 GHz and executes a program with 1.5 million instructions. The pipeline has five stages, and instructions are issued at a rate of one per clock cycle. Ignore penalties due to branch instructions and out-of-sequence executions. What is the speedup of this processor for this program compared to a nonpipelined processor? You can assume that (a) each instruction goes through all five stages of the pipeline; (b) the five stages are of equal duration; (c) all of the stages can be performed in parallel; and (d) there are no conditional branch instructions.

5. [20 marks] Write a summary of what you have learned in this course in about 1000 words.