**University of Regina, Department of Computer Science, CS 301, Assignment 3**

(Please submit one PDF file in UR Courses)

Total: 100 marks

1. (a) [10 marks] Represent the following decimal numbers in twos complement using 16 bits: +512, -29.

(b) [10 marks] Represent the following twos complement values in decimal: 1101011, 0101101.

2. (a) [10 marks] The r's complement of an n-digit number N in base r is defined as $r^n$-N for N≠0 and 0 for N=0. Find the tens complement of the decimal number 13,250.

(b) [10 marks] Calculate (72530-13250) using tens complement arithmetic. Assume that the rules are similar to those for twos complement arithmetic.

3. [20 marks] Use the Booth's algorithm to multiply 23 (multiplicand) by 29 (multiplier), where each number is represented using 6 bits.

4. [20 marks] Consider the following instruction sets of one-address, two-addresses, and three-addresses machines.

One-address machine:

| | |
|---|---|
| LOAD R1 | \\ AC is loaded to R1 |
| STORE R1 | \\ R1 is stored in AC |
| ADD R1 | \\ AC = AC + R1 |
| SUB R1 | \\ AC = AC – R1 |
| MUL R1 | \\ AC = AC × R1 |
| DIV R1 | \\ AC = AC / R1 |

Two-addresses machine:

| | |
|---|---|
| MOVE R1, R2 | \\ R1 = R2 |
| ADD R1, R2 | \\ R1 = R1 + R2 |
| SUB R1, R2 | \\ R1 = R1 - R2 |
| MUL R1, R2 | \\ R1 = R1 × R2 |
| DIV R1, R2 | \\ R1 = R1 / R2 |

Three-addresses machine:

| | |
|---|---|
| ADD R1, R2, R3 | \\ R1 = R2 + R3 |
| SUB R1, R2, R3 | \\ R1 = R2 - R3 |
| MUL R1, R2, R3 | \\ R1 = R2 × R3 |
| DIV R1, R2, R3 | \\ R1 = R2 / R3 |

Using each of the machines independently, write assembly program to compute the following: X=(A+B×C)/(D-E×F), where A, B, C, D, E, F, and X are registers. The content of the registers A, B, C, D, E, and F are never changed. You may consider as many as temporary registers.

5. [20 marks] Consider the following statement. "Both an arithmetic left shift and a logical left shift correspond to a multiplication by 2 when there is no overflow. If overflow occurs, arithmetic and logical left shift operations produce different results, but the arithmetic left shift retains the sign of the number." Demonstrate that the statement is true for 5-bit twos complement integers.