University of Glasgow

Friday 4 May 2018
2.00 pm – 3.00 pm
(Duration: 1 hour)

DEGREES of MSci, MEng, BEng, BSc, MA and MA (Social Sciences)

Computing Science 1S

(Answer All Questions)

This examination paper is worth a total of 50 marks

The use of a calculator is not permitted in this examination

INSTRUCTIONS TO INVIGILATORS

Please collect all exam question papers and exam answer scripts and retain for school to collect. Candidates must not remove exam question papers.

1. **(a)** Convert 1010 0010 to a decimal number, assuming binary representation.

[2]

(b) Convert 1010 0010 to a decimal number, assuming two's complement representation.

[3]

(c) Translate the statement `a := b - c*d` into Sigma16 assembly language, assuming that a, b, c, d are signed integer variables. You do not need to write a complete program, and you don't need to write data statements for the variables. Just translate this one statement.

[5]

(d) Translate the following high level language program fragment into low level language. The variables sum, i and n are signed integers, and x is an array of signed integers containing n elements. You do not need to define the variables or array, just translate the program code. (The low level language contains assignment statements, goto statements, and statements of the form if b then goto label, where b is a Boolean expression.)

```
sum := 0
i := 0
while i < n && x[i] > 0 do
   sum := sum + x[i]
   i := i + 1
```

[5]

(e) Translate the program in part (d) into a complete program in Sigma16 assembly language. Use data statements to define the following initial values: n = 4, x[0] = 7, x[1] = 2, x[2] = 0, x[3] = 5. What is the value of sum when the program terminates?

[10]

2. **(a)** Give the truth tables for the following logic gates: and2, or2, xor2.

[3]

(b) Design a circuit that takes two inputs a and b, and produces one output x, which is 1 if the two inputs have the same value, as shown in the truth table. Implement the circuit using any of the standard logic gates (inv, and2, or2, xor2). You may specify the circuit using any of the following notations (just use one): a schematic diagram, Boolean algebra, or Hydra notation.

a	b	x
0	0	1
0	1	0
1	0	0
1	1	1

[3]

(c) Explain the purpose of the clock in a synchronous circuit. Describe how a suitable clock speed for the circuit is determined.

[4]

(d) The following program determines the sum of the elements and the number of elements in a linked list, given a pointer p to the head of the list. Each node is a record consisting of two words: the first word "value" is an integer, and the second word "next" is a pointer to the rest of the list. The last node in the list has nil in the next field (nil is represented by 0). Translate the program to Sigma16 assembly language. You don't need to write out the low level language version, and you don't need to define the variables or the linked list.

```
; given p = pointer to list
length := 0
sum := 0
while p /= nil do
   length := length + 1
   sum := sum + (*p).value
   p := (*p).next
```

[10]

(e) State what the processor does when an interrupt occurs**.** Give two advantages of using interrupts to catch errors (such as overflow or division by zero) rather than using instructions to test explicitly for the error.

[5]