This question paper consists of 5 printed
pages, each of which is identified
by the Code Number COMP1212

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School of Computing

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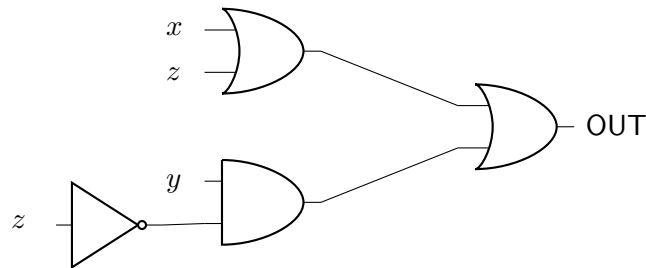
Computer Processors

Time allowed: 2 hours

Answer all THREE questions.

Please note that the questions do not carry equal weight.

　　　　　　　　　　　　　　　　　　　　　Turn over

Question 1 [total 20 marks]

(a) Construct a logical expression that is equivalent to the logic diagram below

[6 marks]

(b) Construct the truth table for the expression from part (a) [4 marks]

(c) Using the truth table from part (b), construct an equivalent logical expression to that in part (a) in conjunctive normal form (CNF) [4 marks]

(d) Using the minimised expression from part (c), write an HDL chip specification. You may assume that the BUILTIN chips AND, OR, NOT are already defined.

[6 marks]

Turn over

Question 2 [total 15 marks]

The assembly code below determines if RAM[0] is divisible by 2. If it is then 1 is placed in RAM[1] and otherwise 0 is placed in RAM[1]. The line numbers are shown at the start of each line.

```
0      @0
1      D=M
2      @1
3      D=D&A
4      @10
5      D;JGT
6      @1
7      M=1
8      @12
9      0;JMP
10     @1
11     M=0
12     @13
13     0;JMP
```

(a) Using a table with the same headings shown below, demonstrate how the hack machine executes the assembly code assuming that RAM[0] contains 7. You need only write in a cell of the table if the value has changed .

A	M	D	PC	RAM[0]	RAM[1]	RAM[2]	RAM[3]	RAM[4]
				7				

[9 marks]

(b) Modify the assembly code from part (a) to determine if the second least significant bit in the value stored in RAM[0] is set to 1. [2 marks]

(c) Translate the following lines of assembly into machine code.

```
D=D&A
@10
D;JGT
D=!A
```

[4 marks]

Question 3 [total 15 marks]

The Hack architecture is a 16-bit Computer. Modern day processors are 32-bit or 64-bit.

(a) Suggest two potential impacts of changing the Hack architecture from 16-bits to 32-bits?
[4 marks]

(b) How would the assembly code for the Hack architecture change if the architecture was changed from 16-bits to 32-bits? [1 mark]

(c) What changes would be required to the Hack architecture in order to develop it into a 32-bit architecture? [10 marks]

Turn over

Question 4 [total 15 marks]

(a) Some virtual machines are implemented using stack machines. Explain the operation of a stack machine, you should illustrate your answer with diagrams or an example. [10 marks]

(b) Explain how function calls are facilitated in a stack based virtual machine. [5 marks]