

**A27228**

No calculator

# **UNIVERSITY OF BIRMINGHAM**

School of Computer Science

Degree of MSc

Computer Science

**06 21933**

Fundamentals: Introduction to Computer Science

Summer Examinations 2011

Time allowed: 1 ½ hours

[Answer THREE out of FOUR Questions]

[Marks indicated on this paper add up to 102%  
The final mark will be capped to 100%]

[Answer THREE out of FOUR Questions]

1. (a) Explain briefly, the difference between an algorithm and a program. [6%]
- (b) Briefly explain what is meant by Interpretation and Compilation. [6%]
- (c) *Lexical Analysis* and *Syntax Analysis* are two phases of the process of compilation. Briefly explain what Lexical Analysis and Syntax Analysis mean. [7%]
- (d) Explain why the following algorithm terminates, where  $x$  and  $y$  are integers:
 

```

while y is nonzero {
    calculate remainder of y/x
    replace x by y
    replace y by remainder
}
write down x
      
```

 [7%]
- (e) For each integer  $n$  which is more than 1, **factorial**( $n$ ) is defined to be product of numbers  $1, 2, \dots, n$ . If  $n = 1$ , **factorial**( $n$ ) = 1. Write a **recursive** algorithm which calculate **factorial**( $n$ ) . [8%]

2. (a) Briefly explain what is meant by a *noncomputable* problem [8%]
- (b) Briefly describe the *halting* problem. [8%]
- (c) Explain what is meant by polynomial time complexity [8%]
- (d) Consider the merge sort algorithm, in which  $a$  is an array of Strings,  $n$  is a positive integer and  $\lfloor n/2 \rfloor$  is the integer part of  $n$  divided by 2.

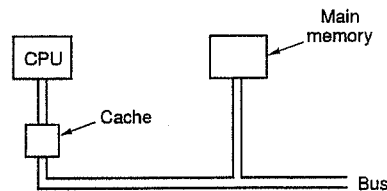
```

module sort (a , n)
    if n > 1
        then merge(sort(left(a), [n/2]), sort(right(a), n- [n/2]))
    endif
endmodule
  
```

Briefly explain the algorithm. If  $T(n)$  denotes the time taken by the algorithm to sort  $n$  names, then briefly explain why  $T(n) = 2T(n/2) + cn$ , where  $c$  is a constant number.

[10%]

3. (a) The following picture depicts hardware components CPU, Cache and Main Memory connected via a Bus.



Explain what is the use of caching in order for the CPU to access any item. [7%]

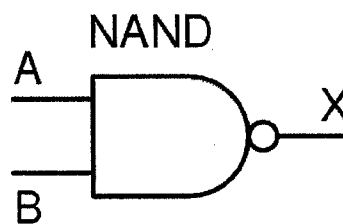
- (b) Derive the formula for the *mean access time* in terms of the following three parameters:

$c$  := cache access time  
 $m$  := main memory access time  
 $h$  := hit ratio.

Explain your answer.

[14%]

- (c) NAND and NOR gates can generate all logic gates. Write the truth table for the NAND gate depicted below. Explain how a NOR gate can be created from four NAND gates. Show the correctness of your answer via a truth table. [13%]



NAND gate

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4. (a) Three addressing mode are *immediate*, *direct* and *registered* addressing. Briefly explain two of them. [8%]

- (b) The following program calculates how many seconds there are in week and store the value in 503. Complete the program by including correct values on the dotted lines and briefly explain your answer. The final outcome of the execution is supposed to be stored in the address 503.

```
209: LOAD ...
201: MULT ...
211: MULT ...
212: MULT ...
213: STORE ...
500: 24
501: ...
502: 60
503:
```

[15%]

- (c) Write  $(8 + 2 \times 5) / (1 + 3 \times 2 - 4)$  in Reverse Polish Notation and evaluate it by completing the following table.

[11%]

step	Remaining String	Instruction	Stack
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13	/	IDIV	6