A08014

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No calculator permitted in this examination

THE UNIVERSITY OF BIRMINGHAM

Degree of MSc in Computer Science

06 06995

Fundamentals of Computer Science

Saturday 11th May 2002 1400 - 1700

[Answer ALL Questions]

[Use a Separate Answer Book for EACH Section]

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Section 1: Introduction to Computer Science (i)

1. Questions on the design and theory of algorithms.

   (a) What is the difference between algorithm and program? [3%]

   (b) Briefly explain the concepts of syntax and semantics. [4%]

   (c) Give examples of
   (i) syntactically incorrect constructions and
   (ii) syntactically correct, but semantically incorrect, constructions. [4%]

   (d) Briefly explain three control mechanisms. [5%]

   (e) Briefly explain the main aims of the theories of computability and complexity. [3%]

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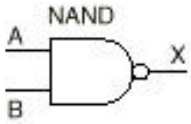
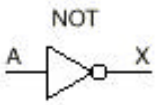
Section 2: Introduction to Computer Science (ii)

2. Recall the tables for the NAND and NOT gates given below.



A	B	X
0	0	1
0	1	1
1	0	1
1	1	0



A	X
0	1
1	0

(a) Represent a NOT gate using *only* NAND gates. [3%]

(b) What are the advantages of NAND-only circuits? [2%]

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3. (a) Explain the action of each instruction of the machine code fragment below. [4%]

```
100:  LOAD 200
101:  SUBTRACT 201
102:  JUMPZERO 105
103:  LOAD 202
104:  ADD 200
105:  STORE 200
…
200:  5
201:  1
202:  7
```

(b) Write a pseudo-code instruction that corresponds to the above fragment. You should assume that X is at address 200, Y at 201 and Z at 202. [2%]

4. Describe the typical structure of an operating system. What is CPU sharing? [4%]

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Section 3: Software Engineering

5. (a) What is the waterfall model of software development? [6%]

   (b) What is its main disadvantage? Propose an alternative model which solves this problem. [5%]

6. A Computer Store wants to sell its goods via the internet. To achieve this, the store intends to set up a website where the goods are described and availability and price are listed. The customers then select the goods they want, give their address and credit card details. After a check of the credit card details the goods are sent to the address specified. A database is used to store details of available goods and customer information.

   (a) Identify possible milestones for this project and draw an activity network containing these milestones. Ensure that as many tasks as possible can take place in parallel. [8%]

   (b) Which parts of the system must use encryption? Justify your answer. [8%]

7. For the project in the previous question, describe one way of testing the user interface. [6%]

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Section 4: Data Structures

8. (a) Composite data types may be constructed from combinations of the four fundamentals data types: **sets, lists, trees and graphs.** e.g. set of sets. Describe briefly one example for each of the following:

(i) A set with components which are sets.
(ii) A list with components which are a set.
(iii) A list with components which are a tree.
(iv) A tree with components which are lists.
(v) A list with components which are graphs.

[7%]

(b) A **list** data type may be represented and implemented in Java using an **array** or using **references** to create a linked structure. State **one advantage** and **one disadvantage** for each of these mechanisms for implementing a list data type. [4%]

9. (a) Give ONE reason why supporting a Set Data Type is difficult in programming languages. [2%]

(b) A **Hash table with internal chaining** has been chosen to store the following list of words -

image, pixel, pattern, graph, resolution,
palette, reflective, recognition,
position, feature, font, texture

Using the alphabetic position of the first letter of each word as its Hashed address i.e. a Hashes to 1, b Hashes to 2 etc., construct diagrams with explanation where necessary, to show the Hash table after inserting the above words, in the order they are listed. [5%]

(c) Suppose the words ‘recognition’ and ‘pattern’ are deleted from the Hash table you constructed in part (c) above. Use a diagram to show the resulting table. [3%]

(d) How may the efficiency of access to an internally chained Hash table be improved? [1%]

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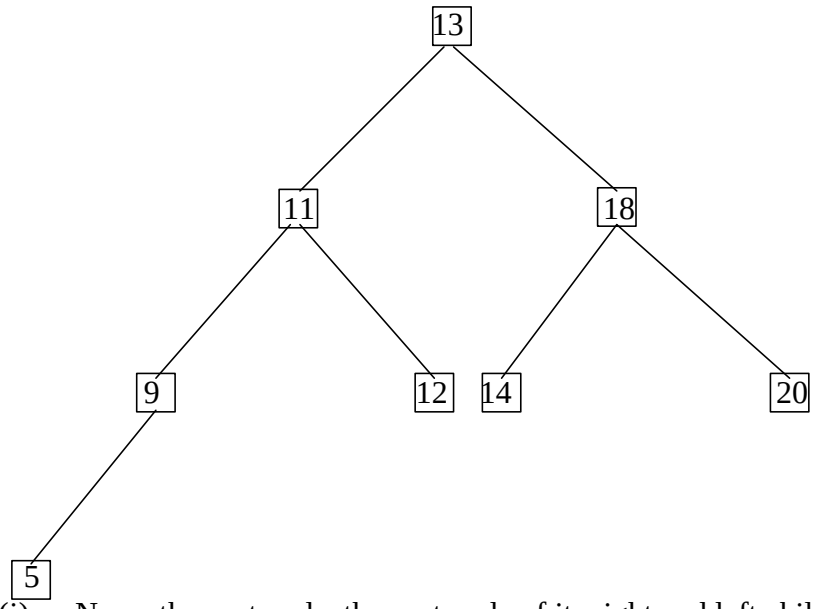
10. (a) What is the difference between a binary tree and an AVL tree? [2%]

(b) Consider the following binary tree:



(i) Name the root node, the root node of its right and left children and list the leaf elements. [1%]

(ii) What is the size of the tree? What is its height? [1%]

(iii) List the nodes of the tree using the postorder traversal. [2%]

(iv) Is the tree an AVL Tree? [1%]

(c) A preorder traversal of the binary tree shown in part (b) above creates the list:

5, 9, 12, 11, 14, 20, 18, 13

Show step-by-step the effect of inserting this list of elements into an initially empty AVL tree. [4%]