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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

Monday 14th May 2001 0930 -1230

[Answer ALL Questions]

[Use a Separate Answer Book for EACH Section]

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Section 1: Software Engineering

1. Name the typical phases of a software project. [5%]

2. A university wants to automate the registration of students for courses. Students are presented with a web page where they enter their registration number and a password and choose their courses for the coming academic year. The form is then sent for School Office for checking. The registration information is then entered into a central database.

   (a) Identify possible milestones and draw a Gantt-chart also listing the tasks necessary to achieve the milestones. Ensure that as many tasks as possible can take place in parallel. Do not list tasks or milestones related to analysis and design only. [8%]

   (b) Suggest two prototypes for such a project. [4%]

   (c) Assume the team that should develop the web interface is hired by a competitor a month before the deadline for completion of the project. Suggest one possible way of salvaging the project. [4%]

3. What are some of the differences between white-box and black-box testing? [6%]

4. For the project described in question 2, describe two black-box testing scenarios. [6%]

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Section 2: Introduction to Computer Science

5. (a) Explain what are meant by the terms **mantissa** and **exponent** when used to describe floating-point number representations. Give one possible interpretation of the following four bytes as a floating-point number:

"001100000 00000000 00000000 00000111"

Write down your answer to 3 decimal places. State clearly any assumptions that you make. [3%]

(b) Describe a suitable categorisation for different types of computer instructions and give examples of one instruction in each of the different categories that you are defining. [3%]

(c) Name three different ways in which the order of execution of consecutively stored program instructions might be altered? Give brief details of each of these mechanisms. [3%]

(d) What is an **interrupt signal** and why is such a signal useful for input/output operations? [2%]

(e) How can multiple interrupts be handled if they occur simultaneously? [2%]

(f) Give brief definitions of the following:

(i) real time
(ii) multi-programming
(ii) job scheduling

[4%]

(g) In a **multi-tasking** (multi-processing) environment a particular task (process) may be in any one of several states. Use a **state** diagram to show the main states that a task (process) may be in and also the principal reasons for transitions between these different states. [4%]

(h) Highlight the main differences between the Ethernet and the Token ring network protocols. [4%]

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(i) What is the Church-Turing thesis and what is meant by the property of algorithms known as universality? [4%]

(j) Outline briefly the basic principles of the Divide and Conquer method of devising efficient algorithms. [4%]

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[Use a Separate Answer Book for THIS Section]

Section 3: Data Structures

6. (a) Give a general definition of the abstract data types referred to as a List and an Index List. [2%]

(b) Briefly describe three distinct classes of Index List types and give an example of the use of each class. [3%]

(c) A large university needs to produce its Staff Handbook in order of seniority of staff, i.e. grouped by title in each Department, in the order Head of School, Professors, Readers, Senior Lecturers, Lecturers, Research Fellows, Research Associates, Teaching Assistants and Administrative Staff. In the current computer system, the university already records the title of each member of staff.

Describe, using diagrams and/or a suitable notation, how an Index List may be used to solve the above requirements.

[6%]

7. (a) Present a specification for the abstract data type called a Stack. [2%]

(b) Outline two possible underlying representations for a stack in an Object Oriented Language such as Java. Comment on the relative merits of these representations. [2%]

(c) Two of the many applications for a Stack data type are converting an in-fix expression to a post-fix expression and evaluating post-fix. By use of suitable diagrams, illustrate such an application by showing how the following post-fix expression:

a b + c d - * g /

is evaluated where:

a = 6, b = 3, c = 12, d = 2 and g = 5.

[5%]

(d) Give two other applications for a stack. [2%]

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8. (a) Describe the characteristics of a B-Tree. [1%]

(b) Outline how insertion and deletion of an element from a B-Tree is accomplished. [2%]

(c) In what way do B-Trees grow or contract and what advantages do they have over n-ary trees? [1%]

(d) By a sequence of diagrams and the operation of insertion you described above, show the growth of a B-Tree of order 2 for the following input sequence of data elements:

21; 41, 11, 31, 16, 36, 8, 27, 19, 23;
6; 43, 14, 47, 28, 9, 33, 39, 25, 46, 26;

You should construct a diagram wherever a semi-colon occurs in the above sequence. [4%]

(e) Draw further diagrams to show how the following sequence of elements would be deleted from the B-Tree generated in part d) above:

26; 25;

Again, you should construct a diagram for each semi-colon in the above sequence. [4%]