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Calculators may be used in this examination but must not be used to store text. Calculators with the ability to store text should have their memories deleted prior to the start of the examination.

THE UNIVERSITY OF BIRMINGHAM

MSc in Computer Science

06 06995

(SEM 520)
Fundamentals of Computer Science

Wednesday 17th May 2000 1400 - 1700

[Answer ALL Questions]

[Use a Separate Answer Book for EACH Section]

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[Answer ALL Questions]

[Use a Separate Answer Book for THIS Section]

SECTION 1

1. (a) Evaluate and write down the three decimal numbers which are equivalent to the following binary expressions (given in twos complement form):

(i) "00111010"
(ii) "11011001"
(iii) "01100110 + 01011001"

[3%]

(b) Explain what are meant by the terms **mantissa** and **exponent** when used to describe floating-point number representation. Give one possible interpretation of the following four bytes, as a decimal number. State clearly any assumptions that you make concerning the interpretation that you give:

"001100000 00000000 00000000 00000111"

[4%]

2 (a) What is an interrupt and why are interrupts important for the efficient operation of all computer systems? Give one example of each of four **dissimilar** uses of interrupt that are implemented by most CPU's. [4%]

(b) Describe the sequence of actions that an interrupt handler has to carry out in order to service an interrupt request. In your answer you must clearly distinguish between the hardware and software actions. [6%]

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3 (a) Give brief definitions of the following:

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

[3%]

(b) In a multi-tasking (multi-processing) environment a particular task (process) may be in any one of several different states. Draw a state diagram to show the main states that a task (process) may be in and also highlight the principal reasons for transitions between these different states. [5%]

(c) What is the relationship between a process and a thread? [2%]

4 (a) What is the Church-Turing thesis and what is meant by the property of algorithms known as universality? [3%]

(b) Outline briefly the basic principles of the Divide and Conquer method of devising efficient algorithms. [3%]

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[Answer ALL Questions]

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SECTION 2

5. (a) Explain what it is meant by the term Software Engineering. [3%]

   (b) Identify the most important differences between Software Engineering and classical Engineering disciplines (like, for instance, Civil Engineering). [3%]

6. (a) What is prototyping? [5%]

   (b) When is prototyping useful in Software Engineering? [2%]

   (c) Why is it NOT advisable to deliver a prototype as the final product? [1%]

7. (a) What are the main differences between the verification and validation sub-phases in the testing phase of software development? [2%]

   (b) What is the difference between white-box and black-box testing? [2%]

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8. A customer commissions your software team to design and implement a software system to efficiently represent and use a library.

   (a) List three questions you think are useful to ask the customer, in order to get a preliminary list of requirements. [3%]

   (b) Assume you have already produced your specification document.
      (i) Choose a suitable HIGH-LEVEL design approach (functional, object-oriented, etc.) for the OVERALL library software system and explain why you find it suitable; [4%]
      (ii) Divide your library software system in some subsystems (at least 2), and for each of them choose a suitable HIGH-LEVEL design approach (functional, object-oriented, etc.) and explain why you find it suitable; [5%]

   You do not have to design the system, only point out which methodology you would prefer.

   Important note to this question: there is no correct answer "by definition". Any answer that is sensible enough and consistent will be evaluated positively.

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9. Below there are two Java methods which are meant to calculate the factorial of an integer number. One of them is correct; the other is incorrect. Identify the incorrect one and explain why it does not work. [4%]

```
(A)  public int fact_a(int N)
     {  if (N == 0)
           return 1;
        else
           return N * fact(N-1);
     }

(B)  public int fact_b(int N)
     {  if (N == 0)
           return 1;
        else
           return fact(N+1)/N+1;
     }
```

NB
fact(0)=1;
fact(n+1)=(n+1)*fact(n);

example: fact(3)=3*fact(2)=3*2*fact(1)=3*2*1*fact(0)=3*2*1*1=6.

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[Answer ALL Questions]

[Use a Separate Answer Book for THIS Section]

SECTION 3

10. (a) Give a one sentence description for each of the four fundamental abstract data types:

SETS, LISTS, TREES and GRAPHS

[4%]

(b) More complex abstract data types may be constructed from combinations of the four fundamental data types given in (a) above, e.g. a set of sets. Give one example of an application of each of the following:

(i) A set with components which are sets.
(ii) A set with components which are lists.
(iii) A list with components which are trees.
(iv) A graph with components which are lists.

For each example add a brief explanation to support your choice of abstract data type.

[4%]

(c) Outline briefly two ways in which the abstract data type *list* may be represented in a language such as Java.

[2%]

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11. In many programming languages, hashing is a common technique for implementing a set abstract data type.

(a) Using diagrams as appropriate, describe briefly the hash technique called hashing with external chaining.

[2%]

(b) In a particular experiment a hash table with external chaining has been chosen to store the frequency of key words identified in a series of research papers. The hash table index address is computed from the position of the first letter of the keyword in the alphabetic ordering, i.e. A's address is 1, B's address is 2, etc. Using diagrams and explanations show the resulting hash structure after inserting the following strict sequence of key words:

access, field, last-in, buffer, random, stack, linear, floating, heap, first-in, relational, relocation, sparse, block, reference, garbage, lambda, link, binary, list.

[6%]

(c) Show the resulting hash changes to the structure after adding the key word 'recognition' to the hash structure you have shown in (b) above.

[2%]

(d) Show the changes to the same hash structure after deleting the key words 'random' and 'buffer'.

[2%]

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12. (a) Define the following two abstract data types: linearly ordered sequential list, and binary search tree. [2%]

(b) In what way are the abstract data types named in (a) above related? [1%]

(c) Construct a binary search tree from the following strict sequence of words:

Integer, real, char, structure, boolean, begin, procedure, if, then, link, else, for, do, string

[4%]

(d) Redraw your binary search tree after deleting the word ‘string’. [2%]

(e) Redraw your binary search tree shown in (d) above after deleting the word ‘char’. [2%]

(f) Briefly outline your deleting algorithm used above. [1%]