There are two parts to this paper. Attempt both parts.

Part 1 consists of "Algorithmics: data structures and abstract data types" questions. It is worth 34% of the overall examination marks. Part 1 contains four questions, a), b), c) and d), from which you **must** choose any **two**.
Part 2 consists of "Software Engineering" questions. It is worth 66% of the overall examination marks. You **must** do Part 2 Question 1, which is worth 26%. You **must** in addition choose two of Part 2 Questions 2, 3 & 4. Each sub-part of a question is equally weighted unless otherwise specified.

Part 1

Answer any two questions from a), b), c) and d).

a) i) Define the queue Abstract Data Type.

[2 marks]

ii) Describe how a circular linked list can be used to implement a queue. Draw diagrams to show how each operation is performed in the general case, identify all the special cases and indicate how the operations are performed in each special case.

[11 marks]

iii) Is the circular linked list a good choice of data structure for the queue abstract data type? Justify your answer.

[4 marks]

b) Below is a set of {key, value} pairs that are to be stored in a look-up table.

Keys:	"Ten"	"Twenty"	"Thirty"	"Forty"	"Fifty"	"Sixty"	"Seventy"
Values:	10	20	30	40	50	60	70

For each of the following types of look-up table, state the strategy used for insertion of new entries *and* draw the data structure containing the look-up table after all the above {key, value} pairs have been added in the order given above from left to right.

i) Unordered linear look-up table.

ii) Ordered linear look-up table.

Question (b) cont. over pag

iii) Binary search tree.

[7 marks]

List, in order, the set of look-up table entries visited when the entry with key "Seventy" is retrieved in each of the following cases:

iv) From look-up table (i) using linear search.

v) From look-up table (ii) using linear search.

vi) From look-up table (ii) using binary search.

vii) From look-up table (iii) using binary tree search.

[8 marks]

viii) In general, is there any advantage in storing the entries of a linear look-up table in order if linear search is to be used for retrieval?

[2 marks]

c) i) Describe how overflow chaining can be used to implement a hash table. What advantages does this method have over open addressing collision resolution strategies?

[3 marks]

ii) The following hash function is proposed:

```
public int h(String s) {

   //Map the string to all lower case letters.
   s = s.toLowerCase();

   if (s.length() == 0) {
        return 0;
   }

   int maxInd = 0;
   for(int i=0; i<s.length(); i++) {
        if(intVal(s.charAt(i)) > maxInd) {
             maxInd = i;
        }
   }

   return (intVal(s.charAt(maxInd))*maxInd) % M;
}

//intVal maps 'a' to 0, 'b' to 1, … 'z' to 25.
public int intVal(char c) {
   return (int)c - (int)'a';
}
```

Question (c) cont. over page.

M is the size of the hash table. Describe how h works and draw an overflow chaining hash table after the set of {key, value} pairs listed in the table at the beginning of part (b) are added, from left to right in the order given, using h and assuming that M = 13.

[6 marks]

iii) List the properties that a good hash function should possess.

[2 marks]

iv) Discuss how well h meets your criteria for a good hash function.

[2 marks]

v) Suggest an alternative to h, described in words or pseudocode, and explain why we might expect better overall performance from the hash function you propose.

[4 marks]

d) Γ is a directed graph defined as follows:

Γ = <v, E>

v = {A, B, C, D, E, F, G}

E = {{A,B}, {A,D}, {A,G}, {B,C}, {B,E}, {C,G}, {E,F}, {F,E}, {F,F} {G,B}, {G,F}}.

i) Draw Γ.

[4 marks]

ii) Write down the set of simple, proper cycles of Γ.

[2 marks]

iii) Draw the adjacency matrix representation of Γ.

[4 marks]

iv) Outline an algorithm for depth first traversal of a directed graph.

[5 marks]

v) Write down the order in which the vertices of Γ are visited when your depth first traversal algorithm is applied starting with vertex A.

[2 marks]

Part 2

Answer question 1 and two *questions from 2, 3 and 4.*

1.

a) You are building a system to manage rentals for a chain of video stores. Outline the reasons why you need to pay attention to the storage and privacy of personal data. Discuss both the legal constraints and the ethical issues.

b) You have access to the source code of some licensed software produced by an independent organisation. It would be to your commercial advantage to copy some pieces for use in your new product. What stops you? . Discuss both the legal constraints and the ethical issues.

2.

Big Airline is proposing to introduce a new in-flight entertainment system across its fleet of aeroplanes.

a) Do a quick sketch system block diagram of what you imagine such a system might look like.

b) Identify the key actors, sketch a use case diagram.

c) Select one of the principal use cases and provide a use case description for it.

3.

a) You need to devote a lot of effort *up-front* in software development". What does this mean and is it true?

b) It is said that for many systems an incremental approach to development makes most sense. Why?

c) "The waterfall model is not dead - but it should be" What is wrong with it, and under what circumstances might it nevertheless be appropriate to use it?

d) An e-commerce system developer has asked you to advise on their corporate software development process. What are some of the things you would need to know about their projects before giving this advice?

4.

a) What is meant by the terms *upper CASE* and *lower CASE*?

Question 4 cont. over page

b) Fred Brooks coined the term *the mythical man-month.* What did he mean by it?

c) What is a software quality model? Illustrate your answer with an example.

d) What are the principal practical consequences of *Lehman's Laws of Software Evolution*?

END OF PAPER