M08/5/COMSC/HP2/ENG/TZ0/XX

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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

Friday 23 May 2008 (morning)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.

*Answer **all** the questions.*

1. The following code allows data items to be added to a list structure.

```
public class Node
{ int d;
  Node next;
  public Node(int d)
  { this.d = d;
  }
}
public class List
{ Node head;
  public List()
  { head = null;
  }
  Node getHead()
  { return head;
  }
  void add(Node n)
  { n.next = head;
    head = n;
  }
  int count()
  { return countUp(head);
  }
  private int countUp(Node n)
  { if (n == null) return 0;
    else return 1+countUp(n.next);
  }
}
```

The following statements are used to add some elements to the list.

```
List list = new List();
list.add(new Node(21));
list.add(new Node(1));
list.add(new Node(3));
list.add(new Node(221));
```

(This question continues on the following page)

(Question 1 continued)

(a) Draw a diagram of the state of the list, showing clearly the head, nodes, data values and links between the nodes. *[3 marks]*

(b) State the BigO efficiency of adding nodes to the list. *[1 mark]*

(c) State the BigO efficiency of searching through the list for a particular node. *[1 mark]*

(d) Explain why a data element in the list cannot be accessed directly. *[2 marks]*

(e) State the name of the programming technique used in the `countUp` method used in the `List` class. *[1 mark]*

To use this method the following statement is used.

```
output(list.count());
```

(f) State the sequence of steps that flow from executing the above statement and state clearly how the count method stops executing. *[4 marks]*

A method is required to search the list.

(g) Construct a method, to be included in the `List` class, to return true if the value is found or false if the value is not found. (Assume that no repeated values are in the list.) *[4 marks]*

Assume the list is stored as a binary tree.

(h) State the efficiency of searching a binary tree. *[1 mark]*

(i) Briefly explain how a binary tree could be searched to check if a particular value is stored in the tree. *[3 marks]*

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2. Numeric data is stored in a computer in binary format.

(a) Using a 7-bit two's complement binary format show how the following integer values would be represented.

(i) 37_{10} *[1 mark]*

(ii) -37_{10} *[2 marks]*

(b) Given a 7-bit two's complement binary format, and showing all working, calculate

(i) the largest integer that can be stored; *[1 mark]*

(ii) the smallest integer that can be stored. *[2 marks]*

(c) Explain what would occur if an attempt was made to store an integer that exceeded the largest value allowed. *[3 marks]*

(d) Convert 4.5_{10} to binary, including the binary fraction part. *[2 marks]*

The number 234.45_{10} can be represented in the form 0.23445×10^{3}. The *mantissa* is 23445 (*i.e.* the figures after the point) and the *exponent* is 3 (as the point has been moved 3 places to the left). The "10" represents base 10.

Now consider the number $3.75_{10} = 11.11_{2}$.

The number 11.11_{2} would be represented as 0.1111×2^{10}. The *mantissa* is 1111_{2} (*i.e.* the figures after the point) and the *exponent* is 10_{2} (as the point has moved 10_{2} places to the left). The "2" represents base 2.

(e) State the mantissa and the exponent for the binary equivalent of the number 4.5_{10} calculated in part (d) above. *[2 marks]*

(f) Calculate the value of the number represented by a mantissa of 1101_{2} and an exponent of 11_{2}, and then convert it to **base 10**. *[2 marks]*

(g) State the name of the error and explain why this error would occur when attempting to store the number 1234.34 using a 5-bit mantissa. *[2 marks]*

(h) Outline an example of a computer application that would need to store floating point values rather than integer values. Clearly state why errors in representation would cause problems. *[3 marks]*

3. The account names and telephone numbers of individuals are stored in a sequential file. It is important the data can be displayed alphabetically according to account name.

(a) Define the term *sequential file organization*. *[2 marks]*

(b) Suggest a suitable sequential file organization for this set of data. *[2 marks]*

(c) Outline how a telephone number can be retrieved from the file if the account name is known (assume non-repeated account names). *[2 marks]*

A new telephone number and account name are to be added to the middle of the file.

(d) Given the organization you suggested in part (b), explain the steps that would need to be undertaken to enable this new data to be added to the file. *[3 marks]*

Over time, the file becomes very large and there are a lot of additions and deletions as new telephone numbers and account names are added to the file, and old ones are deleted.

(e) Outline why sequential organization would not be an appropriate file organization method in this case. *[3 marks]*

(f) Suggest an alternative file organization method, stating **two** reasons for your choice. *[4 marks]*

(g) Suggest **two** ways that data would be accessed given the file organization method you suggested in part (f). *[4 marks]*

4. *This question requires the use of the Case Study*.

A common method of inputting data or instructing a computer is to use a keyboard.

(a) Explain **two** reasons why a person with poor eye-sight may experience difficulty operating a computer device using a keyboard. *[4 marks]*

Graphic designers and web page creators need to design visual displays carefully.

(b) Outline **two** reasons why visual displays on a computer screen can create difficulties for people with certain disabilities. *[4 marks]*

One method to speed up data input into a word processor is to associate collections of letters with longer phases that can be individually customised.

For example, a person with limited finger movement could link their full name with an abbreviation *e.g.* whenever "myn" is entered the word processor displays "Mrs Mary Chong".

(c) Outline a suitable data structure or data structures that could be used to store the abbreviation and the longer phrase. *[4 marks]*

(d) Suggest an efficient method of accessing the abbreviation in your chosen data structure(s). *[2 marks]*

(e) Outline how the longer phrase would be retrieved once the abbreviation has been located. *[2 marks]*

Section 4.2.5 "Speech output systems", on page 9 of the Case Study, outlines the basic operation of a particular output method that can be used to assist people with visual impairment.

(f) Construct a diagram to show the key components of this output system. *[4 marks]*

(g) Explain what process needs to occur to translate the text into sound. *[4 marks]*

(h) Explain **three** social implications related to the increased dependency of society on computer networks and the potential lack of access to these networks for people with disabilities. *[6 marks]*