N10/5/COMSC/HP2/ENG/TZ0/XX

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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

Wednesday 17 November 2010 (morning)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

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

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*Answer **all** the questions.*

1. (a) In the context of *data structures*, explain what is meant by a

(i) *queue*; *[2 marks]*

(ii) *stack*. *[2 marks]*

(b) State **one** computer application for which a queue is a suitable data structure. *[1 mark]*

Consider the following class.

```
class Node
{
  public int item;
  public Node next;

  public Node(int d)
  {
    item = d;
    next = null;
  }

  public void displayNode()
  {
    output(item + " ");
  }
}
```

(c) Statement `Node x = new Node(5);` creates an object of class type `Node`. State the output produced by the call `x.displayNode();`. *[1 mark]*

(This question continues on the following page)

(Question 1 continued)

Examine the following linked list implementation of a queue.

```
class MyQueue
{ private Node first;
  private Node last;
  public MyQueue() { first = null;  last = null; }
  public boolean isEmpty() { return first == null; }

  public void enqueue(int x)
  { Node newNode = new Node(x);
    if (isEmpty())
    { first = newNode; }
    else
    { last.next = newNode; }
    last = newNode;
  }

  public int dequeue()
  {
    // Code missing that will remove a node from the queue
  }

  public void displayQueue()
  { if (first == null)
    { output("The queue is empty!"); }
    else
    { Node temp = first;
      while (temp != null)
      { temp.displayNode();
        temp = temp.next;
      }
    }
  }
}
```

(d) The statement `MyQueue x = new MyQueue();` creates an empty queue.

(i) State the output that will be produced after execution of the following statement.

```
x.displayQueue();
```

[1 mark]

(ii) Construct the code for the method `dequeue()`. The method should remove one item from `x` and return the value of the removed item. *[4 marks]*

(iii) State the output that will be produced after execution of the following statements.

```
x.enqueue(2);
x.enqueue(4);
int y = x.dequeue();
output("Deleted item: " + y);
x.enqueue(1);
x.enqueue(7);
output("Items in the queue: ");
x.displayQueue();
```

[3 marks]

(e) Explain how the elements in a non-empty queue could be reversed using a stack. *[6 marks]*

2. A car company sells five different models of cars and employs four salesmen. A record of sales for each month can be represented by a table. The first row of the table contains the number of sales of each model by Salesman 1; the second row contains the number of sales of each model by Salesman 2, and so on.

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Salesman 1	12	0	0	5	6
Salesman 2	11	1	3	1	3
Salesman 3	10	11	5	3	0
Salesman 4	9	8	5	4	5

(a) (i) Calculate the total number of sales for Salesman 2. *[1 mark]*

(ii) Calculate the total number of sales of Model 3. *[1 mark]*

The sales data as given above is input into a two-dimensional array named `Sales`, declared as `int[][] Sales = new int[4][5];` that can be logically represented as follows.

Sales	[0]	[1]	[2]	[3]	[4]
[0]	12	0	0	5	6
[1]	11	1	3	1	3
[2]	10	11	5	3	0
[3]	9	8	5	4	5

Examine the following code.

```
public void mystery(int[][] Sales)
{
  for (int n = 0; n < 4; n = n + 1)
  {
    int total = 0;
    for (int m = 0; m < 5; m = m + 1)
    {
      total = total + Sales[n][m];
    }
    output("Total number of sales for Salesman " + (n + 1) + " is " + total);
  }
}
```

(b) State the output of the method call `mystery(Sales)`. *[4 marks]*

(This question continues on the following page)

(Question 2 continued)

(c) Construct the method that will output the total number of sales for each of the five car models. *[6 marks]*

Assume that the prices of cars are given in the following one-dimensional array.

```
double[] ModelPrice = {10288.00, 12999.99, 18456.00, 20345.00, 45799.00}
```

For example:
`ModelPrice[1]` holds value `12999.99`.
This means that the price of Model 2 is 12999.99.

(d) Construct a method that will accept a one-dimensional array `ModelPrice` and a two-dimensional array `Sales`. The method should determine the best salesman (the one with the highest total number of sales); and it should output the best salesman and the highest total number of sales. Assume there will not be a tie for best salesman. *[8 marks]*

3. (a) (i) Define the term *file*. *[2 marks]*

(ii) Identify **two** reasons why it is convenient to use files in applications which involve large data sets. *[2 marks]*

(b) A file usually consists of a number of *records*. Each record is made up of *fields*.

(i) Define the term *key field*. *[2 marks]*

(ii) With reference to a *fully-indexed file*, explain the difference between *logical file organization* and *physical file organization*. *[4 marks]*

(c) A small shop uses a computer to keep a daily check on its stock levels. Information regarding the sale of goods is recorded in a *sequential transaction file* named `UpdateFile`.

At the end of the day the master file, `StockFile`, is updated with information from the transaction file, `UpdateFile`, and stored in a new master file, `NewStockFile`. Each file is sorted so the item number field is in ascending order.

For example, if the contents of `StockFile` and `UpdateFile` before an update are:

`StockFile`

item no.	description	quantity	…other fields…
1100	Choc/white	52	
1200	Herb tea	35	
1206	Green tea	23	

`UpdateFile`

item no.	quantity
1100	14
1206	4

Then, after updating, the contents of the new master file named `NewStockFile` will be:

`NewStockFile`

item no.	description	quantity	…other fields…
1100	Choc/white	**38**	
1200	Herb tea	35	
1206	Green tea	**19**	

(i) Outline why the files, `StockFile` and `UpdateFile`, should be sorted in the same order. *[2 marks]*

(ii) Outline the algorithm to update records in `StockFile` with information from `UpdateFile` to create `NewStockFile`. *[8 marks]*

4. *This question requires the use of the case study*.

(a) Terminal 5 has a number of areas that require access to be authorized. The management of the airport is considering introducing different methods of security across the airport.

Smart cards, *magnetic strip cards* and *bar codes* can be used by airport staff as a means of gaining access to any secure area within the airport. The smart cards do not contain biometric information.

(i) Outline why the use of smart cards is an effective security measure. *[2 marks]*

To enhance security the smart cards could be linked to biometric identification systems.

(ii) State **two** types of biometric identification systems. *[2 marks]*

(iii) Describe how biometric identification systems work. *[4 marks]*

(iv) Compare the different levels of security that could be applied to staff and passengers. *[4 marks]*

(b) Operation of each of the airport computer systems is controlled by the **operating system**. Operating systems can be either single or **multi-user** and are capable of allowing **multi-tasking**.

(i) Define the term *operating system*. *[1 mark]*

(ii) Define the term *multi-user*. *[1 mark]*

(iii) Define the term *multi-tasking*. *[1 mark]*

(iv) Identify **three** reasons for multi-tasking in Air Traffic Control. *[3 marks]*

(v) Explain how a multi-user system is used in the check-in system. *[2 marks]*

(c) Outline the principal characteristics of the following modes of operation.

(i) *batch processing* *[2 marks]*

(ii) *real-time processing* *[2 marks]*

(iii) *online processing* *[2 marks]*

(This question continues on the following page)

(Question 4 continued)

(d) Identify an appropriate method of data processing for

(i) Air Traffic Control; *[1 mark]*

(ii) the Billing system. *[1 mark]*

(e) Computer systems at a modern airport are linked via a *network*.

(i) With reference to the airport systems, outline the meaning of the terms *client* and *server*. *[4 marks]*

(ii) State **one** hardware device required in networking and outline its function. *[2 marks]*

(iii) Explain the importance of *network protocols* within airport systems. *[2 marks]*

(f) Explain how a linked list could be an appropriate data structure for use in the Air Traffic Control system. *[4 marks]*