M09/5/COMSC/HP1/ENG/TZ0/XX

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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 1

Tuesday 19 May 2009 (afternoon)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Section A: answer all the questions.
- Section B: answer all the questions.

2209-7011

9 pages

SECTION A

*Answer **all** the questions.*

1. State **two** differences between RAM and ROM. *[2 marks]*

2. State **two** functions of an operating system. *[2 marks]*

3. Using 5-bit two's complement format,

(a) state the value of the maximum integer that can be stored. *[1 mark]*

(b) state the value of the minimum integer that can be stored. *[1 mark]*

4. State **one** advantage of using data compression software on graphics files before transmitting the files over a network. *[1 mark]*

5. Describe the function of a *compiler*. *[2 marks]*

6. Describe **one** difference between a *syntax error* and a *logic error*. *[2 marks]*

7. Outline what is meant by the term *user-defined method* in relation to Java programs. *[1 mark]*

8. Explain **two** advantages of using a modular approach in constructing computer programs. *[4 marks]*

9. Explain **two** differences between the analysis and design stages of the software development life cycle. *[4 marks]*

10. Define the following terms:

(a) *overflow error* *[1 mark]*

(b) *underflow error*. *[1 mark]*

11. State the simpler form of the Boolean expression $A \bullet B + A \bullet \overline{B}$. *[1 mark]*

12. In relation to accessing data stored in a file or an array, state the BigO efficiency of

(a) retrieving a specific data record from a sequential access file. *[1 mark]*

(b) retrieving a specific data record from a direct access file. *[1 mark]*

(c) locating a specific data item in an array if the index is known. *[1 mark]*

(d) locating a specific data item in an array if the index is not known. *[1 mark]*

13. In relation to computer networks,

(a) define the meaning of the term *wide area network* (WAN). *[2 marks]*

(b) explain **one** advantage of using packet switching in a WAN. *[2 marks]*

14. In relation to processor configuration,

(a) describe the function of a *data bus*. *[2 marks]*

(b) describe the function of the *accumulator*. *[2 marks]*

15. Consider the method shown below.

```
double m(double n, int[] a)
{
  a[0] = 23;
  //more statements follow
}
```

(a) State the scope of the variable `n`. *[1 mark]*

(b) State the data type of the value returned by the method. *[1 mark]*

An integer array `b` is initialised with the values {12, 23, 34, 45}.
The following call is made.

```
d = m(12.23, b);
```

(c) Explain why the assignment `a[0] = 23` in the body of the method changes `b[0]` in the calling part of the program. *[3 marks]*

SECTION B

*Answer **all** the questions.*

16. Consider the program shown below.

```
public class HLP1
{
  static int[][] a = { {1, 3, 4, 4, 7},
                       {2, 3, 4, 5, 6},
                       {8, 2, 2, 3, 5}
                     };
  public static void main(String[] args)
  {
    display(1, 3);
    double p = run(2, 2);
    output(p);
  }
  static void display(int d, int j)
  {
    for (int i = 0; i < j; i++)
      output(a[i][d]);
  }
  static double run(int d, int j)
  {
    double t = 0;
    for (int i = 0; i < j; i++)
      t = t + a[i][d];
    return t;
  }
}
```

To illustrate how array elements are addressed, the value of `a[2][0]` is 8.

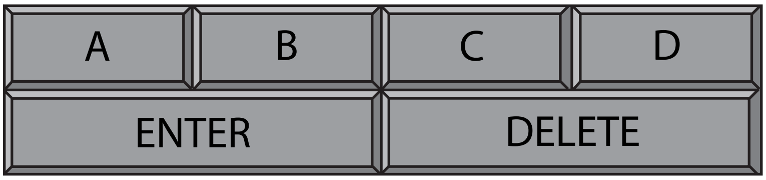
(a) State the output from the call `display(1, 3);` . *[2 marks]*

(b) Explain the operation of the statement `t = t + a[i][d];` . *[3 marks]*

(c) Explain the operation of the statement `double p = run(2, 2);` . *[3 marks]*

(d) Explain what would happen if the call `run(2, 4)` was made in the program. *[2 marks]*

17. The keyboard shown below controls access to a computer room by allowing a **three** character access code to be input followed by pressing the **ENTER** key. If the **DELETE** key is pressed the last character is removed to correct a mistake that has been made.



A buffer is used to store the key presses before they are removed by the processor after the **ENTER** key is pressed.

The sequence of key presses, **A**, **C**, **C**, **DELETE**, **DELETE**, **B**, **D**, **ENTER** would result in the code **ABD** being processed by the computer.

If more than three letters are pressed in succession a warning sound is made.

(a) State the character code that is processed by the computer, given the following key presses.

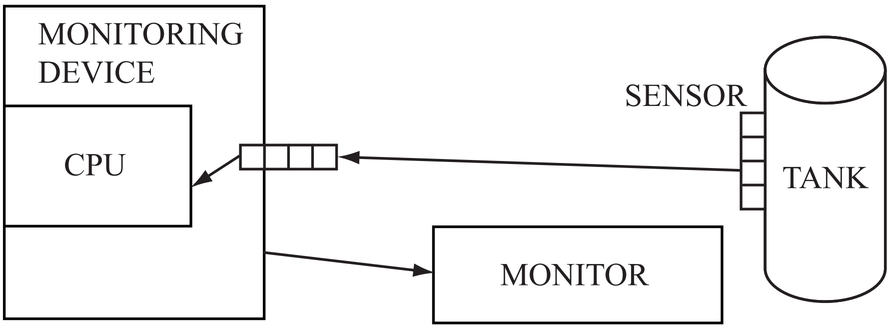
A, **B**, **A**, **DELETE**, **DELETE**, **A**, **C**, **ENTER** *[1 mark]*

(b) Outline a suitable data structure to store the characters in the buffer. *[3 marks]*

(c) Outline a sequence of steps to insert characters into the data structure. *[3 marks]*

(d) Outline a sequence of steps to sound the warning. *[3 marks]*

18. The diagram below shows a monitoring device with a CPU that has a **serial** input port connected to a 4-bit register. The 4 bits represent the number of litres of petrol in a storage tank as an unsigned integer.



(a) Calculate, showing your working, the maximum capacity of the storage tank. *[2 marks]*

When the register is written to, an interrupt is triggered and the CPU executes a program that checks the value stored in the register. If the value is less than a specified amount an alert message is displayed on an operator's monitor.

(b) Describe **three** stages in the operation of an *interrupt*. *[3 marks]*

Data in the sensor on the tank is stored using a 4-bit parallel register. Every 4 minutes this data is transferred to the monitoring device's 4-bit register.

(c) Explain the nature of the problem that exists in interfacing the sensor to the input port. *[2 marks]*

(d) Identify **three** steps that are undertaken by the control system after the data is sent by the sensor. *[3 marks]*

19. Users request information from a search engine by entering a query string. For example, “What is the longest river?”.

(a) State the main characteristic of an operating system that enables many users to request searches at the same time. *[1 mark]*

The search software attempts to match the key words in the query string to the location of the answer. (Note that more than one possible location may be indentified.)
For example, “longest river” is matched to www.riverStats.com and www.RiverNile.com.

(b) Suggest a suitable data structure that could be used to store the key words and the associated address of the web server. *[2 marks]*

(c) Explain how the data structure could be efficiently searched using the key words. *[2 marks]*

(d) Explain what operations would need to be performed on the key words in the query string to access the data structure. *[2 marks]*

(e) Identify **three** modifications that would need to be made to the software in order to store an ordered list of the most commonly selected locations for each query. *[3 marks]*

20. Consider the following three classes and the `Driver` program shown below.

```
public class Thing
{
  private String name;
  public Thing(){}
  void setName(String name){this.name = name;}
  public String getName(){return name;}
}
public class Thing1 extends Thing
{
  private String name;
  Thing1(String name){this.name = name;}
  public String getName(){return name;}
}
public class Thing2 extends Thing
{
  private String name;
  Thing2(String name){this.name = name;}
  public String getName(){return name;}
}
public class Driver
{
  public static void main(String[] args)
  {
    Thing[] things = new Thing[3];

    things[0] = new Thing();
    things[0].setName("Cat Family");
    things[2] = new Thing1("Lion");
    things[1] = new Thing2("Tiger");

    output(things[0].getName());
    output(things[1].getName());
    output(things[2].getName());
  }
}
```

(a) Define the term *encapsulation*. *[2 marks]*

(b) Explain **one** advantage of making the variable `name` private. *[2 marks]*

(c) Outline the programming technique associated with the use of the key word **`extends`** in

`public class Thing1 extends Thing`

and

`public class Thing2 extends Thing`. *[2 marks]*

(d) Outline the programming technique used to enable the method `getName()` to correctly execute in the three output statements. *[2 marks]*

(e) Discuss **one** advantage of using this technique. *[2 marks]*

21. Consider the following Boolean statement.

$$F = \overline{A} \bullet B \bullet C + A \bullet B \bullet C + A \bullet B \bullet \overline{C} + \overline{A} \bullet \overline{B} \bullet C$$

(a) Copy and complete the following truth table. *[4 marks]*

A	**B**	**C**	**F**
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

(b) Determine the minimised Boolean expression, by clearly showing or describing the steps followed. *[3 marks]*

(c) Draw a circuit for the minimised expression obtained in part (b). *[3 marks]*