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Computer science

Higher level

Paper 1

5 May 2023

Zone A morning | **Zone B** afternoon | **Zone C** afternoon

2 hours 10 minutes

Instructions to candidates

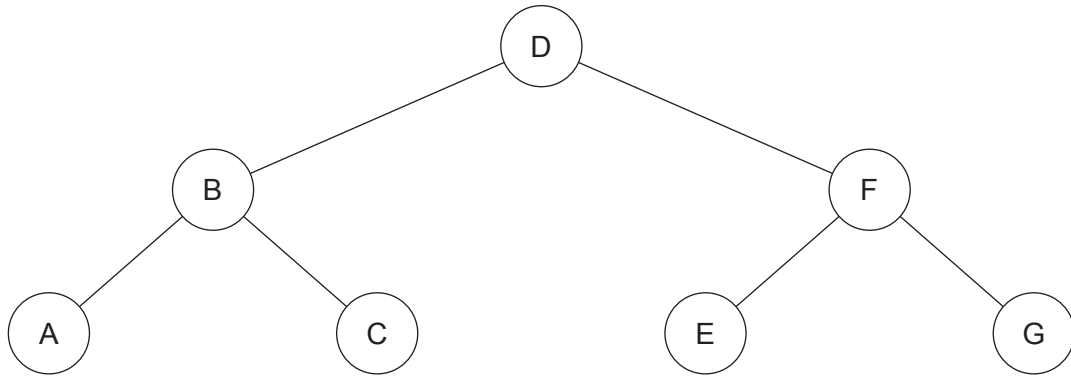
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer all questions.
- The maximum mark for this examination paper is **[100 marks]**.

Section A

Answer **all** questions.

1. Outline the function of a web browser. [2]
2. Identify **two** applications of queues in computing. [2]
3. Outline **one** reason for using Unicode to represent data in a computer system. [2]
4. Sensors that take readings of the levels of different pollutants have been installed at a number of sites along a river. Each reading is sent to a central computer, where it is processed and analysed.
 - (a) Define the term *interrupt*. [1]
 - (b) Describe how polling could be used in this situation. [3]
5. Construct a truth table for the logic expression [4]
$$A \text{ NAND } (B \text{ NOR } C)$$
6. Outline what is meant by a collection. [2]
7. Distinguish between random access memory (RAM) and read-only memory (ROM). [2]

8. Consider the following binary tree, in which each node stores a value greater than all the values in the node's left subtree and less than those in its right subtree.



- (a) Identify the leaf nodes in this binary tree. [1]
 - (b) State the result of the postorder traversal. [1]
 - (c) Sketch the resulting binary tree after the deletion of the root node. [3]
9. Outline **one** advantage of the use of virtual memory. [2]

Turn over

Section B

Answer **all** questions.

10. An organization needs to improve its current computer systems. The systems are legacy systems with a large number of end users.

- (a) Identify **two** issues concerning the roles of end users that must be considered in relation to the new system. [2]
- (b) Outline the meaning of the term “legacy system”. [2]
- (c) Identify **one** method of gathering requirements from end users. [1]

The organization needs to use existing data in the new system.

- (d) Explain **one** problem that may occur during data migration. [3]

A decision needs to be made on whether to use parallel running or a direct changeover method of implementation.

- (e) Explain **one** advantage of using parallel running instead of a direct changeover. [3]
- (f) End users will require training in the use of the new system.
 - (i) Identify **one** method of training for end users. [1]
 - (ii) Evaluate the advantages and disadvantages for the end user of the method of training identified in (f)(i). [3]

11. Many organizations use a virtual private network (VPN) to enable employees working remotely to access files that are held on the organization’s server.

- (a) State **two** technologies that are required to provide a virtual private network (VPN). [2]
- (b) Identify **two** factors that may affect the speed of data transmission. [2]
- (c) Explain why data compression would be used when data is transmitted. [3]

A large amount of sensitive data is stored online and needs to be protected.

- (d) Outline how encryption is used to protect data. [2]
- (e) Describe the role of a firewall. [2]

Employees are increasingly working from home.

- (f) Discuss the social impacts of this changed work pattern on employees. [4]

12. Smart control systems can manage the temperature within a house.
- (a) Outline the steps involving the sensor, processor and output transducer to manage the temperature in the house. [5]
 - (b) Describe the role of feedback in this control system. [2]
 - (c) The smart control system is managed by an operating system.
 - (i) Describe **one** function of an operating system. [2]
 - (ii) Outline **one** reason why a dedicated operating system would be used. [2]
 - (d) Compare and contrast a centralized control system with a distributed control system for managing the temperature of a house. [4]

Turn over

13. Consider the following recursive method:

```

rec(A)
  if A >= 2
    then
      return rec(A-2) + rec(A-1)
    else
      return 1
  end if
end rec

```

(a) Determine the value of `rec(5)` (*show all your working*). [4]

(b) Outline **two** disadvantages of recursive methods. [4]

A stack is a data structure that is used in the implementation of a recursive method.

(c) Outline the purpose of the stack access method `isEmpty()`. [2]

The stack `TOWNS` holds several town names, and the name “Cardiff” is on the top of the `TOWNS` stack (see **Figure 1a**).

An algorithm is needed that will reverse the contents of the `TOWNS` stack. The name “Geneva” should be on top of the `TOWNS` stack after reversing its contents (see **Figure 1b**).

Figure 1: Example data held on the `TOWNS` stack before and after execution of the requested algorithm

a. The content in the `TOWNS` stack before it is reversed

| |
|---------------|
| Cardiff |
| Washington DC |
| The Hague |
| Singapore |
| Geneva |

b. The content in the `TOWNS` stack after it is reversed

| |
|---------------|
| Geneva |
| Singapore |
| The Hague |
| Washington DC |
| Cardiff |

(d) Construct an algorithm that will reverse the `TOWNS` stack **using an empty queue**. You may assume that the `TOWNS` stack is inputted and a new empty queue named `TEMP` is initialized.

You must use stack access methods **and** queue access methods in your response. [5]

14. A program is developed to simulate the roll of dice in a game.

Three dice are thrown, with faces that have numbers from 1 to 6.

The dice are thrown seven times, and the data are stored in a two-dimensional array called `DICEDIAL` (see **Figure 2**).

Figure 2: The example data stored in the `DICEDIAL` array

| | [0] | [1] | [2] |
|-----|-----|-----|-----|
| [0] | 4 | 2 | 2 |
| [1] | 4 | 4 | 4 |
| [2] | 5 | 2 | 3 |
| [3] | 6 | 5 | 5 |
| [4] | 5 | 5 | 6 |
| [5] | 1 | 1 | 4 |
| [6] | 3 | 2 | 1 |

(a) Construct an algorithm in pseudocode to calculate the product of all values stored in the `DICEDIAL` array. [3]

The sub-program `DuplicateNum(DICEDIAL, R)` checks whether there are repeated numbers in row `R`. If the numbers are not repeated, it returns 0, otherwise it returns the repeated number.

The `DuplicateNum()` sub-program will produce the following from the values used in **Figure 2**:

`DuplicateNum(DICEDIAL, 0)` returns 2

`DuplicateNum(DICEDIAL, 1)` returns 4

`DuplicateNum(DICEDIAL, 2)` returns 0

(b) Construct an algorithm in pseudocode for the sub-program `DuplicateNum(DICEDIAL, R)`. [4]

The sub-program `lowestRT(DICEDIAL)` accepts the `DICEDIAL` array and outputs the lowest row total and the indexes of all the rows with that total.

From the example data given in **Figure 2**, `lowestRT(DICEDIAL)` would output that the lowest row total is 6, and it occurs in the rows with indexes 5 and 6.

(c) Construct an algorithm in pseudocode for the sub-program `lowestRT(DICEDIAL)`. [8]