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Computer science
Higher level
Paper 1

Friday 29 October 2021 (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.

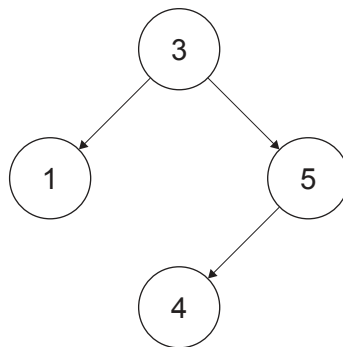
1. State **two** differences between primary storage and secondary storage. [2]
2. State the hexadecimal representation of the binary number 10001010. [1]
3. (a) Outline what is meant by a sorting algorithm. [2]
(b) Outline **one** difference between a bubble sort algorithm and a selection sort algorithm. [2]
4. Assume $X = 5$, $Y = 3$ and $A = \text{TRUE}$.

Determine the value of the following expression:

$$((X > 5) \text{ XOR } A) \text{ AND } (Y + 2 > 4)$$

Show all your working. [2]

5. (a) Identify **one** difference between a binary tree and a non-binary tree. [1]
(b) Given the following binary search tree (BST), draw the resulting BST after the deletion of the root node. [2]



6. Explain why compression of data is beneficial when transmitting data files across a network. [3]

7. A group of programmers are involved in creating a new software product. They create many new sub-programs but also use existing sub-programs within the product.
- (a) Outline why a sub-program is considered an example of abstraction. [2]
 - (b) Evaluate the use of designing and developing different parts of software products concurrently. [3]
 - (c) Outline **one** way in which users can be informed of software updates. [2]
8. Explain how an operating system manages peripherals. [3]

Turn over

Section B

Answer **all** questions.

9. A new computer system is being developed using prototypes.
- (a) (i) Outline **one** advantage of using surveys as a method of obtaining requirements from stakeholders. [2]
 - (ii) Outline **one** disadvantage of using surveys as a method of obtaining requirements from stakeholders. [2]
 - (b) Identify **one other** method of obtaining requirements from stakeholders. [1]
 - (c) Outline **two** advantages of using prototypes. [4]
 - (d) Explain why more than one cycle of analysis and design might be needed. [3]
 - (e) Explain why this computer system should be tested thoroughly before being put into operation. [3]
10. A company has a large networked computer system.
- Some of its data is non-sensitive data that would cause no risk to the company if accessed. Some data, however, is sensitive, such as the company's financial records and documents that contain trade secrets and personal information about employees or clients.
- (a) Outline **two** ways in which access to sensitive data can be managed. [4]
 - (b) Outline **two** ways to improve the security of the company's network. [4]
- Data corruption can result in data loss.
- (c) Explain how corrupted data files can be recovered. [4]
- The company is considering implementing a virtual private network (VPN).
- (d) Explain **one** benefit to the company of using a VPN. [3]

11. A rail transport company uses a global positioning system (GPS) to determine a train's position.
- (a) Explain how GPS works. [4]

The GPS data is used to provide real-time arrival data on video displays in train stations.

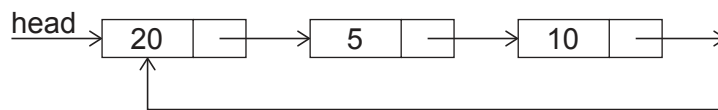
- (b) (i) State **one** data item concerning the arrival of a train that may be provided on the video display. [1]
- (ii) Outline how sensors can be used in combination with GPS to provide more accurate arrival data. [2]

The GPS data is made publicly available so that software developers can use it to build apps.

The mobile application *ATrainAway* uses the real-time train GPS data as well as the GPS data from the user's smartphone.

- (c) Outline **two** pieces of information that the *ATrainAway* application could provide to the user. [4]
- (d) Discuss the advantages **and** disadvantages of using GPS in transportation systems. [4]

12. Consider the following circular linked list:



where *head* is an external pointer that points to the first node in the circular linked list.

Three operations are performed on this circular linked list in the following order:

- 1 A node containing the number 30 is inserted at the beginning of the circular linked list.
- 2 The last node is deleted from the circular linked list.
- 3 The first node is deleted from the beginning of the circular linked list.

- (a) Sketch a diagram showing the resulting circular linked list. [3]
- (b) Outline how the last node of the circular linked list is identified. [2]
- (c) Describe the steps required to calculate the sum of all numbers held in this circular linked list. [4]

Arrays and linked lists are used to store linear data.

- (d) Compare the use of arrays and linked lists. [4]

A linked list can be used to implement a data structure queue.

- (e) Identify **two** applications of a queue data structure. [2]

Turn over

13. A bus company provides services within a city. Passengers can look up the distance between any two bus stations on any of its routes.

For each route, a one-dimensional string array is used to store the names of all bus stations on the route and a two-dimensional array is used to store the distances between the bus stations (in kilometres). Only the lower triangle of the two-dimensional array is used to store the distances.

Figure 1 shows data about Route X, a bus route between Oppox and Dovely.

Figure 1: One-dimensional string array, ROUTE_X_NAMES, and two-dimensional array, ROUTE_X_DISTANCES, for Route X

ROUTE_X_NAMES		ROUTE_X_DISTANCES									
		[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
[0]	Oppox	[0]	0	0	0	0	0	0	0	0	0
[1]	Thamesley	[1]	1.2	0	0	0	0	0	0	0	0
[2]	Brinkley	[2]	2.2	1.0	0	0	0	0	0	0	0
[3]	Kiko	[3]	6.6	3.4	2.2	0	0	0	0	0	0
[4]	Endsley	[4]	5.7	4.5	3.5	1.3	0	0	0	0	0
[5]	Kingsley	[5]	7.1	5.9	4.9	2.7	1.4	0	0	0	0
[6]	Allapay	[6]	8.0	6.8	5.8	3.6	2.3	0.9	0	0	0
[7]	Kronos	[7]	10.1	9.1	6.9	4.7	3.4	2.0	1.1	0	0
[8]	Longlines	[8]	10.5	9.3	8.1	5.9	4.6	3.2	2.3	1.2	0
[9]	Dovely	[9]	11.3	10.1	9.1	6.9	5.6	4.2	3.3	2.1	0.9

For example, the distance between Kingsley and Kronos (2.0 kilometres) can be found in ROUTE_X_DISTANCES [7][5].

(This question continues on the following page)

(Question 13 continued)

- (a) State the distance between Kiko and Longlines. [1]

The two-dimensional array `ROUTE_X_DISTANCES` is valid if all the entries on and above the main diagonal are zero and all the entries below the main diagonal are greater than zero.

Figure 2 shows an invalid form of `ROUTE_X_DISTANCES`.

Figure 2: Invalid form of two-dimensional array `ROUTE_X_DISTANCES`

	[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
[0]	0	0	0	0	0	0	0	0	0	0
[1]	1.2	0	0	0	0	5.9	0	0	0	0
[2]	2.2	1.0	0	0	0	0	0	0	0	0
[3]	6.6	3.4	2.2	0	0	0	0	0	0	0
[4]	5.7	4.5	3.5	1.3	0	0	0	0	0	0
[5]	7.1	0	4.9	2.7	1.4	0	0	0	0	0
[6]	8.0	6.8	5.8	3.6	2.3	0.9	0	0	0	0
[7]	10.1	9.1	6.9	4.7	3.4	2.0	1.1	0	0	0
[8]	10.5	9.3	8.1	5.9	4.6	3.2	2.3	1.2	0	0
[9]	11.3	10.1	9.1	6.9	5.6	4.2	3.3	2.1	0.9	0

- (b) Construct an algorithm in pseudocode that checks the elements of the array `ROUTE_X_DISTANCES` and outputs whether the array is valid or not. [5]
- (c) Construct an algorithm in pseudocode that inputs the names of two bus stations and outputs the distance between them. If any of the inputted names are not found, the method should output an appropriate message. [6]

The array `ROUTE_X_TIMES` (Figure 3) stores the approximate number of minutes it takes for a bus to travel to a bus station from the previous one. For example, `ROUTE_X_TIMES [6]` stores the number of minutes it takes for a bus to travel from Kingsley to Allapay: 7 minutes.

Figure 3: The array `ROUTE_X_TIMES`

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
0	5	6	6	8	4	7	5	6	6

- (d) Explain how this data could be used to determine the number of minutes it takes for a bus to travel between any two bus stations. [3]

References: