

Computer Science

Time allowed: 1.5 hours (90 minutes)

The questions in this paper are divided into two sections: A and B.
Answer **TWO** questions in total, i.e. the only question in section A and your choice of question from section B. Each question answered will be worth 50 marks.

SECTION A

1. a) In a ‘typed’ programming language of your choice (not in a database), what data structures or primitive data types would be most appropriate for storing each of the following? Please specify the programming language used. You should provide reasons for your answers:

- The exam mark of student
- Geographical and height position of the aircraft during the flight at the current moment
- The weight of a person, in kilograms
- The person address line 1, e.g. 346 Terrace Road, Apartment 7
- The information about allergies which the specific person has
- The height of a house, in number of floors
- The person’s result of COVID test
- The number of visitors of a museum each day in a month
- The result of mathematical comparison such as $(2x-y+z > 3a*b)$
- The humidity reading in each room in a house

[15 marks]

b) Number can be represented as sum of powers of two. That representation can be written as a string, e.g. “118 = 64+32+16+4+2”.

Write an algorithm in clear pseudo code, i.e. write down the detailed steps using ideas like:

```
if (something is true)      or      while (some condition is true)
then                          do some action
    do action 1                repeatedly
else
    do action 2
```

that describes how you can programmatically output the list of described above representations of numbers from 100 to 300.

You should try to make your algorithm as efficient as possible. Your answer should specify the data structures that you use, list any optimisations that you have made, and may describe other optimisations that you could make, specifically addressing the trade-off between memory use and execution speed. You may wish to add additional comments to explain your algorithm.

[19 marks]

c) In clear, detailed steps (as in question 1. b, above) indicate how you could determine if a phrase is a palindrome (i.e. reads the same backwards as forwards). The phrases “MADAM I’M ADAM”

“PEEP” and “ABLE WAS IERE I SAW ELBA” are all palindromes (we ignore spaces and punctuation).

[16 marks]

SECTION B

2. Giving examples from your own experience where necessary:

a) Explain the difference between volatile and non-volatile memory in a computer system. Provide examples of each type of memory and discuss their respective roles in computer operations.

[16 marks]

b) Discuss the importance of standards, such as networking protocols. Explain how adherence to standards facilitates interoperability and the exchange of information between diverse systems.

[17 marks]

c) Software parallelization is widely used in computer programming. Discuss how developers can design and implement parallel algorithms to leverage multiple processing units for improved performance. Provide an example of a programming scenario where software parallelization is advantageous.

[17 marks]

3. a) Many devices are now marketed as “Internet-enabled”, from coffee machines to smartphones to home fitness equipment to cars. Discuss the significance of devices having internet connectivity and how it impacts their functionality and user experience.

[15 marks]

b) Explain the concept of random algorithms (with random behaviour) in computer science. Provide an example of a problem where a random algorithm is employed and discuss how randomness can be beneficial in solving that problem.

[18 marks]

c) Explain what is usually meant by the phrase *the Internet of Things* (IoT) and the effects that IoT devices have on society. Your answer should consider what the IoT is, what benefits the IoT might provide to users and society. Explain how IoT is transforming various industries and highlight potential challenges associated with the widespread adoption of IoT technologies.

[17 marks]