COMPUTER SCIENCE

Time allowed: 1½ hours

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 number of athletes in a race
   - The height of a person, in metres
   - The type of house a person lives in
   - A UK phone number e.g. 07799123456
   - The result of a mathematical expression such as y>x
   - The highest temperature each day for the last month
   - A collection of information about an individual person – name, age, height, NI number, etc.
   - The same collection of information about each member of a group of people
   - A pile of cards to be used in a game of solitaire
   - The state of the board in a game of chess

   [15 marks]

   b) Write an algorithm in clear pseudo code, i.e. write down the 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 might find all the prime numbers less than 3000. A prime number is one that can only be divided wholly by 1 and itself (like 3, 5, 7, 11, etc.).

   See over ...

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.

[18 marks]

c) A software engineer is writing software to process a large text file of data. The file contains comma separated data in the format *city 1, city 2, distance in miles*. Describe the data structures and/or variable types that she might reasonably use to store these data within her program in the following cases, and the algorithm she might use to sort the data. Your answer should give an explanation for the decisions, among which you may wish to include performance issues. You may assume that the data can already be loaded into the program.

   i.   The data will only be used to display the data within an unsorted printed list.
   ii. The data are to be used within the program to produce a list sorted by start destination (i.e. *city 1*).
   iii. The data are to be used within the program to produce a list sorted by *distance*.

[17 marks]

SECTION B

2. With reference to a simple model of a desktop computer system:
   a) Explain each of the following terms, and describe the role that each item carries
      out within the computer:
   (i) CPU

   [5 marks]

   (ii) RAM

   [2 marks]

   (iii) Data bus

   [2 marks]

   (iv) CPU cache

   [3 marks]

   b) Explain what you understand to be the differences between **working memory**
      and **permanent storage**. Your answer should include the physical and the
      conceptual difference between the two.

   [8 marks]

   c) Computing hardware is becoming increasingly capable of performing many
      tasks in parallel rather than necessarily processing single instructions faster.
      Discuss the reasons for this move towards increasing parallelisation, and your
      understanding of the steps that hardware manufacturers have taken to facilitate
      it.

   [18 marks]

   d) What benefits (or drawbacks) has this increasing hardware parallelisation had
      on software developers and on end-users? Your answer should consider users
      of a range of different types of software.

   [12 marks]

3. a) 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, the
      potential dangers of the IoT, and what technical steps developers should take
      to reduce those dangers. You may also include any other topics that you
      consider to be relevant to the question.

   [35 marks]

   b) IoT devices have the potential to generate large quantities of data. Memory and
      Storage are generally measured in the same units, with the prefixes:
      M   G   T   P   E
      Give the names for these units, a precise definition of the multiplier that they
      represent, and the relationship between each. Your answer should consider the
      different number bases used by computers and by humans.

   [15 marks]