1(a) A charity uses a desktop computer to record financial donations that it receives. The computer contains a single core, 2.4GHz processor with 2MB cache.

A processor uses the Von Neumann architecture.

i. Describe what is meant by the term 'Von Neumann architecture'.

---

[2]

ii. Give **one** way that the Harvard architecture differs from the Von Neumann architecture.

---

[1]

(b) A charity is concerned that the performance of a computer is not sufficient and wishes to replace the processor.

Give **two** features of a replacement processor that would increase the typical performance of the computer.

1 ---

---

2 ---

---

[2]

(c) **Fig. 1** shows assembly code written using the Little Man Computer (LMC). The program calculates and outputs the total amount that is donated to a charity in any particular day.
Depending on the amount, an additional bonus may be added to each amount donated.

```
start      INP
           STA donation
           SUB hundred
           BRP bonus
nobonus    LDA total
           ADD donation
           STA total
           OUT
           BRA start
bonus      LDA total
           ADD donation
           ADD twenty
           STA total
           OUT
           BRA start
hundred    DAT 100
twenty     DAT 20
donation   DAT 0
total      DAT 0
```

Fig. 1

i. The program shown in **Fig. 1** is run **once** using **three** different inputs. Therefore, while the program is running once, it will output the updated total three times.

Give the total values that are output when the values **10**, **50** and **120** are input into this program.

Output for 10 ----------

Output for 50 ----------

Output for 120 ----------

[3]

ii. Write LMC code that will reset the value of the memory location labelled `total` to zero and then stop the program.

---

[4]

iii. This program is run on a processor that allows pipelining.

Define the term ‘pipelining’.

[3]

iv. Explain **one** benefit to a charity of using a processor that allows pipelining.

[2]

(d) The processor contains registers including the accumulator and the program counter. The contents of these registers are modified during the Fetch-Decode-Execute cycle.

i. Describe how the accumulator is used during the Fetch-Decode-Execute cycle.

[2]

ii. Describe how the program counter is used during the Fetch-Decode-Execute cycle.

[2]

iii. State the name of **three** other registers that are used during the Fetch-Decode-Execute cycle.

1

2

3

[3]

(e) * A charity has several desktop computers in their office that use a CISC processor. They are considering buying mobile devices for their staff to use when they are not in the office.

Discuss whether these mobile devices should use the same CISC processors that are used in their desktop computers or if they should use a RISC processor instead.

You should include the following in your answer:

- the difference between each processor type
- the suitability of each processor type for mobile devices.

[12]

2(a) A video streaming service uses a relational database. An extract of the data from two tables from this database is shown in Fig. 2.

`Membership` contains data about current memberships that customers hold and `package` contains data about different streaming packages available.

Username	FirstName	StartDate	PackageType
User001	Amaya	08/05/2016	Premium
User002	Amit	06/06/2019	Basic
User003	Tom	17/08/2019	Free
User004	Kareem	08/08/2017	Basic
User005	Sarah	25/03/2020	Premium

Membership

PackageType	CostPerMonth(£)	Adverts
Premium	12.99	false
Basic	7.99	true
Free	0.00	true

Package

Fig. 2

i. State what is meant by the term 'primary key'.

---

[1]

ii. Identify the foreign key used in the database and the table name where this is a foreign key.

Foreign Key ---

Table Name ---

---

[2]

iii. Identify the data type of the `CostPerMonth(£)` field.

[1]

iv. Give the name of the field that could be stored using a Boolean data type.

[1]

(b) The `Adverts` field indicates if customers will be shown adverts. `true` indicates that customers will be shown adverts, and `false` indicates that adverts are not shown.

Write Structured Query Language (SQL) to return the `Username` and `FirstName` fields for all customers who see adverts.

[5]

(c) When new customers join the streaming service, their name, email address and contact details are captured so that they can be entered into the database.

i. Identify **one** method of capturing a new customer's personal data, describing why this method is suitable.

Method _____

_____

Suitability _____

_____

_____

_____

[3]

ii. Sometimes the company may need to move or backup its data they hold about customers.

Identify **two** methods of exchanging data with other computer systems.

1 _____

_____

2 _____

_____

[2]

(d) A relational database supports ACID transactions. ACID stands for Atomicity, Consistency, Isolation and Durability.

i. Describe what is meant by a transaction being durable.

[2]

ii. Give **one** way that durability can be achieved for a completed transaction.

[1]

iii. Explain how record locking can be used to ensure that the ACID principle of isolation is achieved when carrying out multiple transactions.

[3]

iv. Give **one** disadvantage of using record locking.

[1]

(e) The Copyright Designs and Patents Act 1988 applies to all videos that are streamed.

Explain how this act applies to the videos.

[2]

(f) All videos that are streamed are compressed. Customers have the option to choose from watching the videos with lossy compression or lossless compression.

Explain how this choice will impact the customer.

[5]

(g) A program is written using an object-oriented programming paradigm and uses a class called `video` to organise videos that are streamed to customers.

The class `video` has these attributes:

- name
- number of views
- star rating.

The constructor method will set the name attribute to the name that is passed in as a parameter. The constructor will also initially set the number of views to 0 and the star rating to 3.

i. Write program code or pseudocode to declare the class `video` and initialise the required attributes as private.

You should include **both** the attribute definitions and the constructor method in your answer.

[7]

ii. A public method called `updateviews()` will update the number of views after a video has been viewed.

This method is defined inside the `video` class.

Write program code or pseudocode for the method `updateviews()` to increase the number of views by one.

---

[2]

3(a)

i. Convert the hexadecimal value **B7E** to a binary number.

---

[1]

ii. 110010101 is a binary number that is represented using sign and magnitude.

Convert this binary number to a denary number.

---

[1]

iii. Complete this binary subtraction. Both numbers are 8-bit integer values represented using two's complement.

Show the result in the same format and show your working.

0110 1101 –

0011 0100

---

[3]

(b) The normalised floating point number 1010 1110 is stored using 4 bits for the mantissa and 4 bits for the exponent, both in two's complement.

Give the denary version of this number, showing your working.

[4]

(c) **Table 3** here shows floating point numbers that are stored using 6 bits for the mantissa and 3 bits for the exponent, both in two's complement.

Tick (✓) one box in each row to state whether each number is normalised or not normalised.

Binary number	Normalised	Not normalised
010101 100		
110101 111		
011010 010		
101010 110		

Table 3

[4]

4 * Amit is studying Computer Science at university. He has been asked to write an assignment on Artificial Intelligence (AI).

Discuss the extent to which you think computer systems will inherit the biases and discrimination of their programmers as the use of AI increases.

You should include the following in your answer:

- the meaning of AI
- examples of when AI may be affected by bias
- the measures that can be taken to prevent people being affected by bias in AI.

[9]

5(a) A programmer creates this function shown in **Fig. 5** using a high-level language.

```
function mystery(x,y)
    total = x + y
    while x >= 10 then
        x = x - 10
        y = y - 10
        total = total + x + y
    endwhile
    return total
endfunction
```

Fig. 5

i. State the value output by the line `print(mystery(10,20))`

---

[1]

ii. State the value output by the line `print(mystery(0,70))`

---

[1]

iii. State the value output by the line `print(mystery(45,55))`

---

[1]

(b) Before the code in **Fig. 5** can be executed, a translator must be used.

i. State the purpose of a translator.

---

[1]

ii. Explain **two** differences between a compiler and an interpreter.

Difference 1 ---

Difference 2 ---

---

[4]

(c) For each statement shown in **Table 5**, tick (✓) **one** box in each row to indicate which stage of compilation each action takes place at.

	Lexical analysis	Syntax analysis	Code generation
Comments and whitespace are removed			
Keywords are replaced with tokens			
Object code is created			
Symbol table created for variables			
Builds an abstract syntax tree			

Table 5

[5]

(d) Describe the purpose of code optimisation.

---

[2]

(e) A programmer creates another function to count and return how many capital letters are in a string that is passed into the function as a parameter.

The `asc()` function takes in a character and returns its ASCII value. For example `asc("A")` returns 65. Capital letters have ASCII values between 65 and 90 inclusive.

i. Complete the function below.

```
function countCapitals(text)
    // initialise counter to 0
    capCount = 0
    // loop through each character in the string passed in
    for x = 0 to text.length-1
        c = text.subString(x, 1)
        // check if character is a capital
        if asc(c) >= 65 ……
            // if so, increment counter
            ……
        endif
    next x
    ……
endfunction
```

[3]

ii. Give **one** similarity between ASCII and Unicode.

---

[1]

iii. Give **two** differences between ASCII and Unicode.

Difference 1 ---

Difference 2 ---

---

[2]

(f) * A programmer has been asked by a client to create a complex computer program. Compare the spiral model and waterfall lifecycle methodologies for this task.

You should include the following in your answer:

- how both methodologies could be used to develop a complex computer program
- the benefits of each methodology for this task
- the drawbacks of each methodology for this task.

[9]

6(a) Anika's computer runs a multi-tasking operating system. She has access to a printer and a broadband internet connection through a wireless connection. The operating system uses scheduling algorithms such as first come first served and round-robin.

i. Explain why the computer's operating system uses a first come first served algorithm when sending documents to the printer.

[2]

ii. Explain why the computer's operating system uses a round-robin algorithm for allocating processor time.

[3]

iii. Describe **one** other scheduling algorithm.

[2]

(b) Anika uses an encrypted messaging program to communicate with her friends. The computer uses the TCP/IP stack.

i. Explain what happens at the application layer of the TCP/IP stack when using this program.

[5]

ii. Explain what happens at the link layer (sometimes referred to as the “network interface layer”, “network access layer” or simply the “network layer”) of the TCP/IP stack when using this program.

[2]

END OF QUESTION PAPER