1 **(a)** Tick (✓) **one** box to identify the correct logic statement for this truth table.

A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

☐ NOT (**A** AND **B** AND **C**)

☐ (**A** XOR **B**) NOR **C**

☐ (**A** OR **B** OR **C**) NOR **C**

☐ NOT **A** AND NOT **B** AND NOT **C**

[1]

(b) Draw a logic circuit for the logic expression:

X = NOT (NOT **A** AND (NOT **B** XOR **C**))

[2]

2 A video doorbell is attached to the front door of a house. The doorbell uses a motion sensor to detect when a visitor walks in front of the door. When the motion sensor is activated:

- The digital camera in the doorbell starts recording a video.
- A message is transmitted to a smartphone so that the person who lives in the house can watch the video.

The doorbell also has a button that can be pressed. When the button is pressed, a message is transmitted to a smartphone to play the doorbell sound.

The videos are stored on the doorbell's internal secondary storage device and overwritten when the secondary storage device is full.

(a) The video doorbell can be considered an example of an embedded system.

Identify **two** characteristics of the doorbell that suggest it is an embedded system.

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2 .....

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[2]

(b) State whether the video doorbell is a monitoring system or a control system.
Justify your choice.

Monitoring or control system .....

Justification .....

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[2]

(c) The video doorbell has both primary memory and secondary storage.

(i) Identify **two** items of data that the video doorbell will store in primary memory.

1 .....

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2 .....

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[2]

(ii) The video doorbell has a solid state (flash) secondary storage device.

Complete the table by writing the answer or answers to each statement about the principal operation of solid state (flash) memory.

Statement	Answer
the **two** types of logic gate that can be used to create solid state devices	1 ..... 2 .....
the number of transistors contained in each cell	.....
the type of gate that can retain electrons without power	.....
the type of gate that allows or stops current from passing through	.....

[4]

(iii) The video doorbell uses a buffer.

Describe how the video doorbell will use the buffer.

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..... [2]

(d) The digital camera has a microphone which is used to record the sound for the video.

The user changes the sampling rate that the microphone uses from 44.1 kHz to 88.2 kHz.

Describe how this change in sampling rate will affect the performance of the video doorbell.

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..... [3]

(e) The video doorbell allows both real-time and on-demand bit streaming.

(i) State what is meant by bit streaming.

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..... [1]

(ii) Give **two** differences between real-time and on-demand bit streaming.

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2 .....

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[2]

3 A software developer is writing a computer program.

(a) The developer uses an interpreter while writing the program code because it is easier for debugging.

Explain **one** reason why it is easier to debug the program code using an interpreter instead of a compiler.

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..... [2]

(b) The program is ready to be sold to customers.

The developer uses a compiler because it creates an executable file.

Explain the reasons why the need to create an executable file makes the complier the appropriate choice when the program is complete.

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..... [3]

4 The following table shows part of the instruction set for a processor. The processor has two registers: the Accumulator (ACC) and an Index Register (IX).

Instruction		Explanation
Opcode	**Operand**	
LDM	#n	Immediate addressing. Load the number n to ACC
LDD	<address>	Direct addressing. Load the contents of the location at the given address to ACC
LDI	<address>	Indirect addressing. The address to be used is at the given address. Load the contents of this second address to ACC
LDX	<address>	Indexed addressing. Form the address from <address> + the contents of the Index Register. Copy the contents of this calculated address to ACC
LDR	#n	Immediate addressing. Load the number n to IX
ADD	#n/Bn/&n	Add the number n to the ACC
ADD	<address>	Add the contents of the given address to the ACC
SUB	#n/Bn/&n	Subtract the number n from the ACC
SUB	<address>	Subtract the contents of the given address from the ACC
INC	<register>	Add 1 to the contents of the register (ACC or IX)
<address> can be an absolute or a symbolic address # denotes a denary number, e.g. #123 B denotes a binary number, e.g. B01001010 & denotes a hexadecimal number, e.g. &4A		

(a) The current contents of memory are shown:

Address	Data
19	24
20	2
21	1
22	3
23	5
24	4
25	22

The current contents of the ACC and IX are shown:

ACC	12
IX	1

Complete the table by writing the content of the ACC after each program has run.

Program number	Code	ACC content
1	`LDD 20` `ADD #2`	
2	`LDX 22`	

3	`LDI 25`
	`INC ACC`
	`SUB 22`	

4	`LDD 19`
	`LDM #5`
	`LDM #25`	

[4]

(b) The processor includes these bit manipulation instructions:

Instruction		Explanation
Opcode	**Operand**	
AND	#n/Bn/&n	Bitwise AND operation of the contents of ACC with the operand
AND	<address>	Bitwise AND operation of the contents of ACC with the contents of <address>
XOR	#n/Bn/&n	Bitwise XOR operation of the contents of ACC with the operand
XOR	<address>	Bitwise XOR operation of the contents of ACC with the contents of <address>
OR	#n/Bn/&n	Bitwise OR operation of the contents of ACC with the operand
OR	<address>	Bitwise OR operation of the contents of ACC with the contents of <address>
<address> can be an absolute or a symbolic address # denotes a denary number, e.g. #123 B denotes a binary number, e.g. B01001010 & denotes a hexadecimal number, e.g. &4A		

The current contents of memory are shown:

Address	Data
30	01110101
31	11111111
32	00000000
33	11001100
34	10101010

The current content of the ACC is shown:

1	0	0	1	1	0	1	0

Complete the table by writing the content of the ACC after each program has run.

The binary number 10011010 is reloaded into the ACC before each program is run.

Program number	Code	ACC content
1	AND 31	
2	XOR B01001111	
3	OR #30	

[3]

5 A bank allows customers to access their accounts using an application that they can download onto a device such as a smartphone.

(a) The system that allows customers to access their accounts using the application is a client-server model.

Describe the roles of the different devices in this model.

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..... [4]

(b) The bank wants to protect the integrity of its data while transferring the data to other banks. Parity check is one example of data verification.

Complete the description of parity check when Computer A is transmitting data to Computer B.

Computer A and Computer B agree on whether to use ..... parity. Computer A divides the data into groups of ..... . The number of 1s in each group is counted. If the agreed parity is ..... and the group has an even number of 1s, a parity bit of 1 is appended, otherwise a parity bit of 0 is appended.

In a parity ..... check the bytes are grouped together, for example in a grid. The number of 1s in each column (bit position) is counted. A bit is assigned to each column to make the column match the parity. These parity bits are transmitted with the data as a parity ..... .

[5]

(c) The bank also needs to keep its customers' data private and secure.

(i) The bank's network has a firewall.

Explain how a firewall can help protect the customers' data.

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..... [3]

(ii) Customers need to use biometric authentication to access their accounts.
One biometric authentication method is facial recognition.

Facial recognition uses Artificial Intelligence (AI).

Describe how AI is used in facial recognition.

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..... [4]

6 A company is developing a website that will allow users to create an account and then play a quiz every day. The data about the users and the quizzes are stored in a database.

A user must select a unique username and enter a valid email address to create an account. All users must be over the age of 16. A new quiz is given to the users every day. Each quiz is stored in its own text file.

The database stores the filename of each quiz and the date it can be played. The user gets a score for each quiz they complete, which is stored in the database. The scores are used to give each user a rating, for example Gold.

(a) Create a 3-table design for this database normalised to Third Normal Form (3NF).

Give your table design in the format:

`TableName(PrimaryKey, Field1, Field2, …)`

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..... [6]

(b) The company is using a Database Management System (DBMS) to set up the database.

Describe what is meant by the following DBMS features:

Data dictionary .....

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Logical schema .....

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[4]

(c) The company has another database, FARMING, for a different game.

The database FARMING has a table named EVENT which is shown with some sample data.

PlayerID	EventID	Category	Points
000123	3	Build	100
000124	1	Grow	36
000123	4	Grow	22
000123	7	Create	158
000125	3	Grow	85
000125	4	Build	69

(i) The database FARMING has a second table created named PLAYER that has the primary key PlayerID.

The field PlayerID in EVENT needs to be set up as a foreign key to link to PlayerID in PLAYER.

Write a Structured Query Language (SQL) script to change the table definition for EVENT to link the foreign key to PLAYER.

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..... [2]

(ii) Write an SQL script to return the number of events that each player has completed.

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..... [3]

7 Complete the binary addition. Show your working.

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  1 0 0 1 1 1 1 0
  0 1 1 0 0 0 0 1
+ 0 0 0 1 1 0 0 1
```

[3]

8 A business is creating a local area network (LAN) in its office.

(a) The business is deciding which topology to use.

Tick (✓) **one or more** boxes in each row to identify the topology, or topologies, each statement describes.

Statement	Bus	Star	Mesh
all devices connect to one central device			
all devices connect to a central cable			
multiple paths for the packets to travel along			
robust against damage because if any line fails, the rest of the network retains full functionality			
most likely to lose data through collisions			

[5]

(b) The LAN will connect to the internet through a router. The router has a public IPv6 address.

(i) State why the router has a public IP address.

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..... [1]

(ii) One difference between an IPv4 and IPv6 address is that the numbers in an IPv4 address are separated by full stops and in an IPv6 address they are separated by colons.

Identify **two other** differences between an IPv4 and IPv6 address.

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2 .....

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