Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9618/12**

Paper 1 Theory Fundamentals **October/November 2023**

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use an HB pencil for any diagrams, graphs or rough working.
- Calculators must **not** be used in this paper.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].
- No marks will be awarded for using brand names of software packages or hardware.

This document has **16** pages. Any blank pages are indicated.

[Turn over

1 A factory makes chocolate bars.

The factory uses a conveyor belt that moves the products from one stage of production to the next stage.

(a) An automated system counts the number of chocolate bars made at the end of production.

The system includes a sensor positioned above the conveyor belt.

Identify **one** appropriate type of sensor that can be used.

infra-red / proximity (sensor) [1]

(b) A second automated system removes chocolate bars with an incorrect weight from the production line.

Describe the role of an **actuator** in this second system.

- Actuator generates a signal / causes an action / converts electrical energy into a mechanical force
- ... to push an arm // to open a trap door // to pick up the chocolate bar with the incorrect weight

[2]

(c) The factory has many different machines with embedded systems.

(i) Identify **two** features of embedded systems.

- Dedicated to a single task OR limited number of functions
- Built into a larger system OR integrated into a larger system
- An embedded system must contain a processor, memory and an I/O capability OR Dedicated hardware

[2]

(ii) Identify **one** drawback of embedded systems.

- Difficult to change / update the firmware by the user OR Difficult to upgrade devices to take advantage of new technology
- Cannot be easily adapted for another task
- Troubleshooting faults/upgrading is a specialist task
- Devices are often thrown away rather than repaired as difficult to upgrade or repair

[1]

3

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[Turn over

2 **(a)** State what is meant by the following terms in a relational database model.

Entity

An object about which data can be stored

Primary key

The unique attribute / combination of attributes used to identify the record / tuple

Referential integrity
- Makes sure that if data is changed in one place the change is reflected in all related records - cascading update/delete
- Makes sure that data that does not exist cannot be referenced
- Ensures that every foreign key has a corresponding primary key // A logical dependency of a foreign key on a primary key
- Ensures that the data in the database is consistent / up to date
- Prevents records from being added/deleted/modified incorrectly
- Makes sure any queries return accurate and complete results [3]

(b) Authentication is one method a Database Management System (DBMS) can use to improve the security of a database.

Describe **other** methods that a DBMS can use to improve the security of a database.

- Backup / recovery procedures
- … automatically takes copies of the database and store off site on a regular basis / weekly, etc.
- ... so that the data can be recovered if lost

- Use of access rights
- … some users are given different access permissions to different tables
- ... read/write, read only, full access, etc.

- Views
- … different users are able to see different parts of the database
- ... only see what users need to see // by example

[4]

- Record and table locking
- … prevents simultaneous access to data
- ... so updates are not lost // data is not overwritten

- Encryption
- ... the data is turned into ciphertext
- ... so it cannot be understood without a decryption key

(c) The following database table is not normalised.

StudentName	DateOfBirth	TutorGroup	Subject	SubjectCode
Yuwei Chen	01/09/2004	SMH	English, Maths, Computer Science	EN, MA, CS
Claudia Raj	23/02/2005	JMB	Maths, Physics, Art	MA, PY, AR
Aamil Akram	24/01/2005	KMB	Art, Design, English language	AR, DE, EN
Areeba Faraz	21/12/2004	SMH	English language, Chemistry, Design	EN, CH, DE

Explain how to modify the table to put it into First Normal Form (1NF).

- Identify repeating groups of attributes ...
- ... Subject and SubjectCode
- Ensure each field is atomic
- ... StudentName should be split into e.g. FirstName and LastName
- Identify the primary key for the table

[4]

3 **(a)** State **one** difference between a kibibyte and a megabyte.

- kibibyte = 1,024 bytes OR 210 bytes and
  megabyte = 1000 kilobytes OR 1 000 000 bytes OR 103 kilobytes OR 106 bytes
- kibi is binary prefix and mega is denary prefix .... [1]

(b) **(i)** Convert the denary value into a 12-bit two's complement binary integer.

−196

Answer .....1111 0011 1100.. [1]

(ii) Convert the Binary Coded Decimal (BCD) into denary.

100001100101

Answer ...865... [1]

(iii) Convert the unsigned binary integer into denary.

000111010110

Answer ....470.. [1]

(c) Identify **one** practical application of BCD **and** justify why BCD is used in this application.

- An application that performs financial / banking calculations
- ... because it is difficult to represent decimal values exactly in normal
  binary and financial transactions use only two decimal places and must
 be accurate, no accumulating errors
OR
- Electronic displays, e.g. calculators, digital clocks
- ... because visual displays only need to show individual digits
- ... because conversion between denary and BCD is easier
OR
- The storage of the date and time in the BIOS of a PC [2]
- ... because conversion with denary is easier

4 **(a)** Write the Boolean expression that corresponds to the following logic circuit.
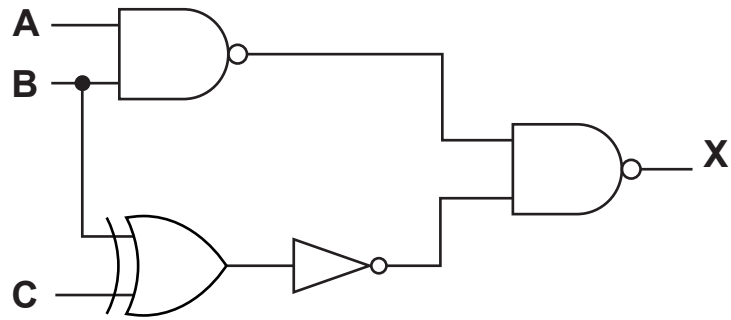
- A NAND B
- NOT(B XOR C)
- Final NAND

X = A NAND B NAND (NOT(B XOR C)

[3]

(b) Complete the truth table for the logic expression:

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

A	B	C	Working space	X
0	0	0		0
0	0	1		0
0	1	0		1
0	1	1		0
1	0	0		1
1	0	1		1
1	1	0		1
1	1	1		1

[2]

5 (a) State the meaning of **privacy of data**.

  • Ensuring data can only be accessed by / disclosed to authorised persons OR

  • Ensuring data cannot be accessed by / disclosed to unauthorised persons [1]

(b) State the meaning of **integrity of data**.

  • Ensuring the accuracy / completeness / consistency of data (during / after processing)

  • Ensuring the data is up to date [1]

(c) Describe the following threats to a computer system.

Phishing email • The email pretends to be from an official body

  • ... persuading individuals to disclose private information OR by example such as bank details

  • ... or requesting authentication by redirecting to an unofficial/unauthorised website OR inviting a user to click a link

Spyware

  • Malware downloaded without the user's knowledge

  • ... which secretly records the user's actions / keystrokes on the computer

  • ... and sends logs of the actions to a third party

[4]

6 (a) A real-time video of a music concert needs to be streamed to subscribers.

Tick (✓) **one** box to identify the most appropriate type of compression **and** justify your answer.

Lossy	Lossless

Lossy compression (ticked)
• Loss of quality will not be noticed
• Needs to be viewed in real time so less bandwidth needed if file size
smaller
• Smaller file sizes will reduce buffering so the video will play more
smoothly
• Viewers may watch on different devices, so may not need high quality
resolution

Lossless compression (ticked)
• Original recording may not have been made in high resolution
• Could be streaming to high bandwidth devices
• The reduction in the file size is sufficient for the receiving device
• Viewers do not want any loss of quality

[3]

(b) Explain the impact of changing the sampling resolution on the accuracy of a sound recording.

Increase sampling resolution
• … the number of bits used for each sample is increased
• … there will be more values available to represent each sample // more
amplitudes can be represented
• ... each binary amplitude/note in the digital recording is closer to the
analogue amplitude/note
• … quantisation errors are reduced
• … the digital soundwave is closer to the original analogue soundwave

Decrease sampling resolution
• … the number of bits used for each sample is decreased
• … there will be fewer values available to represent each sample // fewer
amplitudes can be stored
• ... each binary amplitude/note in the digital recording is further from the
analogue amplitude/note
• … quantisation errors are increased
• … the digital soundwave is less like the original analogue soundwave

[3]

(c) A bitmap image has a resolution of 2048 pixels wide and 1024 pixels high.

The image has a bit depth of 10 bits per pixel.

Estimate the file size of the bitmap image in mebibytes. Show your working.

Working

(2048 * 1024 * 10) / (8 * 1024 * 1024)

Estimated file size in mebibytes   2.5 mebibytes

[2]

7 A Local Area Network (LAN) contains four devices:

- a router
- two laptop computers
- a server.

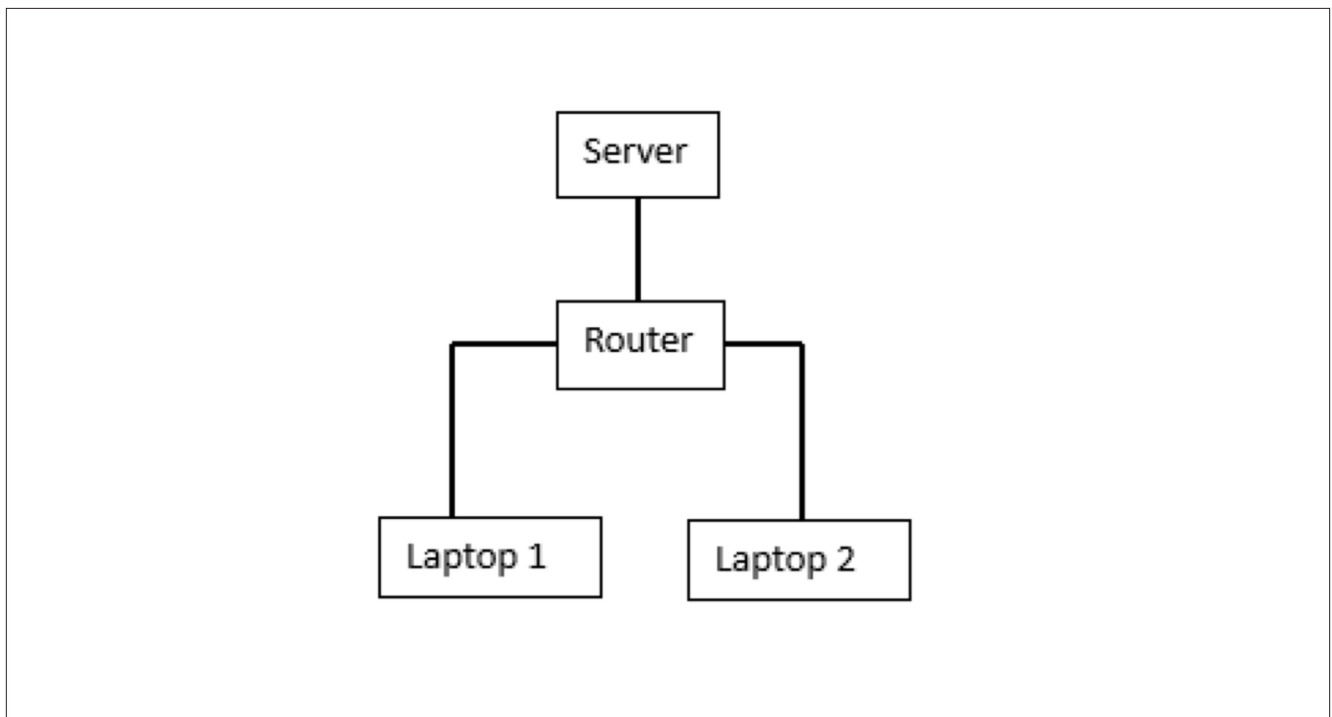**(a)** The server has the IP address 192.168.3.2

Explain why this is **not** an IPv6 address.

- Only has four groups of digits OR IPv6 has eight groups
- Uses dotted notation instead of colons
- Because it is a 32 bit / 4 byte address OR IPv6 is 128 bits / 16 bytes

[2]

(b) (i) The LAN is set up as a star topology.

Draw a diagram of the topology of the LAN.

[2]

(ii) Explain how data is transmitted between the two laptops in the LAN.

- The data from the sending laptop is transmitted to the router
- The data has address of recipient
- The router determines recipient's destination address
- ... by using a routing table
- The router transmits data directly / only to recipient

[2]

(iii) Subnetting can be used to separate a network into logical segments.

Describe **two other** reasons why subnetting is used in a network.

- To improve the security of the LAN
- … so that devices do not receive unintended data
- … so that a compromised device does not expose the whole network
- ... so not all devices can access all segments
- To make the network management easier
- … because faults can be isolated more efficiently
- ... by appropriate example
- To make the network easier to expand // For better control of network growth
- … by allowing for greater range of IP addresses to be available
- To improve network performance
- To reduce network congestion
- … by localising network communications // by dividing data between segments
- … so that devices are not flooded with data
- … because data sent between devices on the same subnet stays within the subnet

[4]

(c) State **three** tasks performed by devices to deal with collisions when using the Carrier Sense Multiple Access / Collision Detection (CSMA/CD) protocol in a network.

- To monitor the communications channel
- To send data only when there is no data being transmitted / the line is quiet / idle
- To detect a collision and then stop transmissions of further data OR transmit a jamming signal
- To calculate a random wait time / back-off time
- ... then retransmit the data after that random wait time
- Increase random time if multiple collisions

[3]

(d) The following incomplete table contains types of IP addresses and their descriptions.

Complete the table by writing the missing types of IP addresses and the missing descriptions.

Type of IP address	Description
public IP address	an IP address that is assigned to a device to allow direct access on the internet
static IP address	an IP address that is fixed / doesn't change each time a device re-joins a LAN / network
private IP address	an IP address used for internal LAN communication only
dynamic IP address	an IP address that may be refreshed / changed each time a device re-joins a LAN / network

[4]

8 A computer has an Operating System (OS).

(a) State **one** purpose of the Operating System.

- To hide the complexities of the hardware from the user
- To provide a platform for software to run
- To provide a user interface

[1]

(b) The Operating System has utility software.

The purpose of some utility software is to improve security.

Identify **one** example of utility software that is **not** intended to improve security.

Explain why this software is needed.

- Defragmentation software
- … because over time saving and deleting of small files fragments the disk
- ... the software makes (individual) files contiguous
- … so access time to the files is improved
- … because head movement is reduced

- Disk contents analysis/disk repair software
- … to identify and mark bad sectors
- ... to restore corrupted files
- ... to recover lost data (due to hardware failure)

- File compression
- … to reduce the size of files
- ... which saves storage and memory space // by example
- ... and reduces transmission time // by example

- Disk formatter
- … to prepare a disk for use // set up the file system
- ... to partition the disc
- ... to delete all the data from the disc

[3]

(c) An optical disc reader/writer is connected to the computer.

(i) Give the name of **one** port that can provide a connection for the optical disc reader/writer.

- USB / Universal Serial Bus
- HDMI

[1]

(ii) Describe the roles of the address bus, the data bus **and** buffers in the process of writing data to the optical disc reader/writer.

Buffers
- A buffer temporarily holds data until it is ready to be transmitted to the device

Address Bus
- The address of the data to be written to the device (in RAM) is carried on the address bus

Data Bus
- All data to be written to the device / buffer is carried on the data bus

[3]

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

Instruction		Explanation
Opcode	Operand	
LDD	<address>	Direct addressing. Load the contents of the location at the given 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
STO	<address>	Store the contents of ACC at the given address
ADD	#n	Add the denary number n to the ACC
JMP	<address>	Jump to the given address
INC	<register>	Add 1 to the contents of the register (ACC or IX)
CMP	<address>	Compare the contents of ACC with the contents of <address>
CMI	<address>	Indirect addressing. The address to be used is at the given address. Compare the contents of ACC with the contents of this second address
JPE	<address>	Following a compare instruction, jump to <address> if the compare was True
IN		Key in a character and store its ASCII value in ACC
OUT		Output to the screen the character whose ASCII value is stored in ACC
END		Return control to the operating system
<address> can be an absolute or a symbolic address # denotes a denary number, e.g. #123		

(a) The instructions in the processor's instruction set can be grouped according to their function.

Identify the instruction group for each of the following opcodes.

IN ....Input and output of data...

ADD ....Arithmetic operations..

JPE ....Unconditional and conditional instructions..

CMI ....Compare instructions...

[4]

(b) The current contents of main memory and selected values from the ASCII character set are given on page 15.

Trace the program currently in memory using the trace table when the input is '1'.

Address	Instruction
10	LDR #0
11	IN
12	STO 101
13	LDX 110
14	CMP 100
15	JPE 21
16	LDD 101
17	ADD #16
18	INC IX
19	STO 100
20	JMP 13
21	OUT
22	END
...	⟩
100	0
101	0
...	⟩
110	51
111	65

ASCII value	Character
49	1
50	2
51	3
52	4
...	⟩
65	A
66	B
67	C
68	D

Instruction address	ACC	IX	Memory address				Output
			100	101	110	111	
			0	0	51	65	
10		0					
11	49						
12				49			
13	51						
14							
15							
16	49						
17	65						
18		1					
19			65				
20							
13	65						
14							
15							
21							A
22							

[4]

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