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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.

- 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 or 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.

Converts electrical signals into mechanical action to remove defective products.

[2]

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

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

1 Dedicated to a single task.

2 Its functionality is limited.

[2]

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

Difficult to update or adapt for other tasks, and repairs or upgrades requires specialist knowledge. [1]

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

Entity *An object about which data is stored.*

Primary key *A unique attribute/field or their combination used to uniquely identify each record in a table.*

Referential integrity *Ensures all references are consistent across all data entries.*

[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.

- *Access Rights: Every user can have access to minimum amount of data required by them.*
- *Backup & recovery procedures: take regular backups (e.g. weekly) so that data can be recovered in the event of contingency.*
- *Encryption: It turns data into cipher text so that any unauthorized access can be stopped seeing it.*
- *Record & table locking: This mechanism helps maintain data accuracy and consistency during concurrent data operations.*

[4]

- (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).

- 1. Separate the repeating groups of the attributes,
E.g; Subject & Subject code.
- 2. Ensure atomicity.
- 3. Establish a PK. E.g: StudentID.

[4]

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

2^{10} 10^6
 ↳ Based on power 2 → Based on 10
 $1024B$ 10 mill 1,000,000

[1]

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

-196

$196 \quad 1100\ 0100$
 $\underline{000011000100}$
 $-196 \quad 111100111100$

Answer [1]

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

100001100101
 $8 \quad 6 \quad 5$

865

Answer [1]

- (iii) Convert the unsigned binary integer into denary.

$256 \ 128 \ 64 \ 32 \ 16 \ 8 \ 4 \ 2$
 000111010110
 $\underline{+ \quad \quad \quad \quad \quad \quad \quad \quad \quad}$
 470

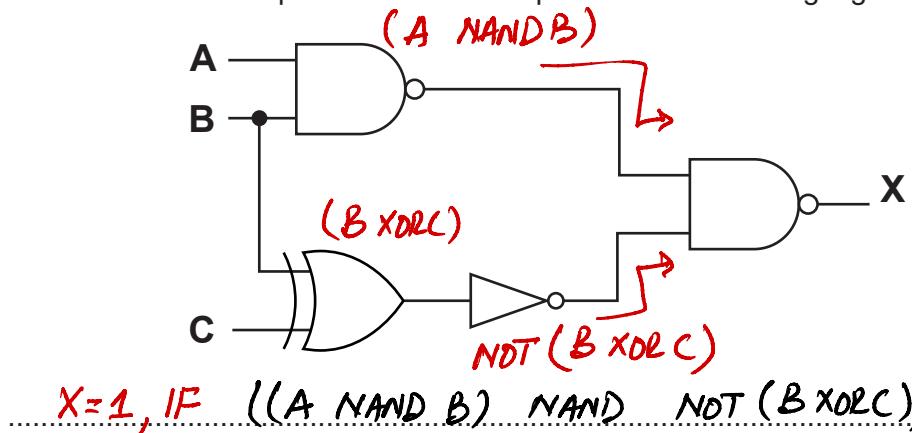
Answer [1]

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

Application Financial/Banking Calculations.

Justification Sometimes deal numbers b/c of the Limited Storage
 bits can't save very large or very small fractions,
 which leads to bits drop and ultimately to rounding
 error and financial figures gets charged. BCD doesn't
 has such discrepancy. [2]

- 4 (a) Write the Boolean expression that corresponds to the following logic circuit.



[3]

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

$$X = A \text{ XOR } (B \text{ AND } (A \text{ NAND } B) \text{ AND } \text{NOT } C)$$

A	B	C'	$(AB)'$	Working space $B \cdot (AB)'$	N	X
0	0	0	1	0	0	0
0	0	1	0	0	0	0
0	1	0	1	1	1	1
0	1	1	0	1	0	0
1	0	0	1	0	0	1
1	0	1	0	0	0	1
1	1	0	0	0	0	1
1	1	1	0	0	0	1

[2]

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

Ensuring data can only be accessed or disclosed to authorized persons. [1]

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

Ensuring the accuracy, completeness and consistency of data during its entire lifecycle. [1]

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

Phishing email A form of social engineering attack often used to steal user data, including credentials and credit card numbers. Using emails pretends to be from an official body, which requires user to click a link.

Spyware Software that enables user to obtain covert info about another's computer activities by transmitting data covertly from their hard disks. It is downloaded to user's machine without their knowledge.

[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
✓	

Justification
 - Efficiency & practicality.
 - Perceptual Coding.
 - Bandwidth considerations.

 [3]

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

- Increasing the Sampling resolution.
 - Higher accuracy and quality.
 - Greater file size
 - Decreasing the Sampling resolution:
 - Lower accuracy & quality
 - Smaller file size [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 *Image file size = Resolution × colour depth (WxH)*

$$2048 \times 1024 \times 10 = 20971520 \text{ bits / 8}$$

$$2621440 \text{ Bytes} / 1024 = 2560 \text{ kB} / 1024 = 2.5 \text{ MiB}$$

Estimated file size in mebibytes *2.5* [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.

Because - It is 4Bytes address , whereas IPv6 is 16B.

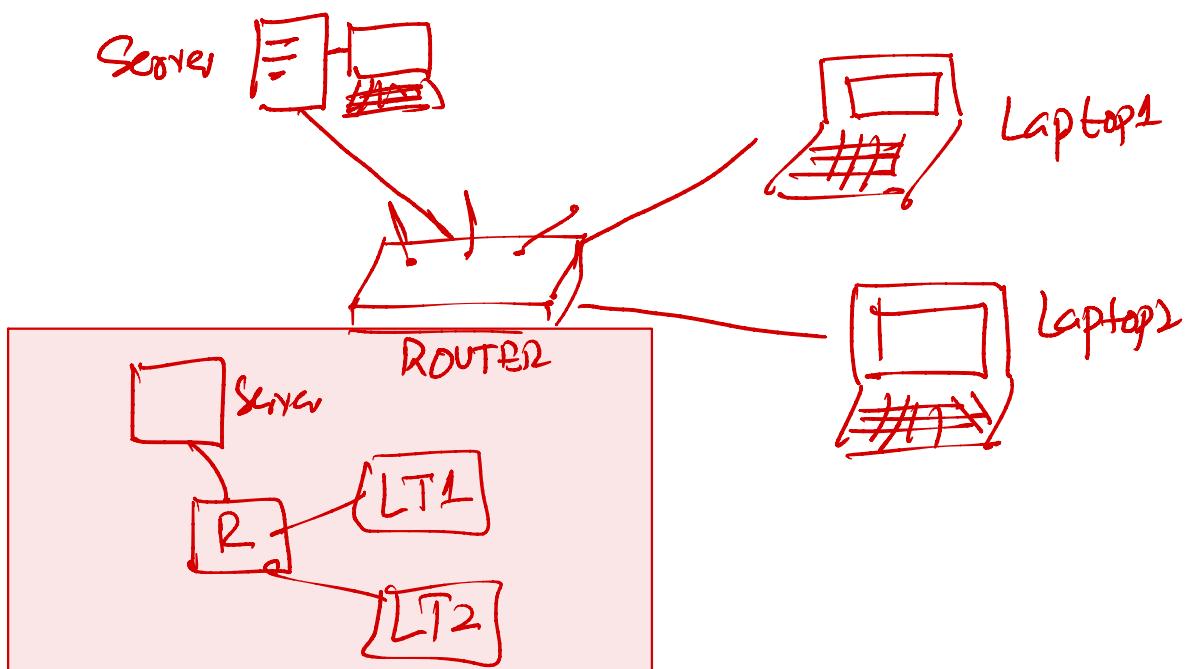
- It has 4 groups, whereas IPv6 has 8.



[2]

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

Draw a diagram of the topology of the LAN.

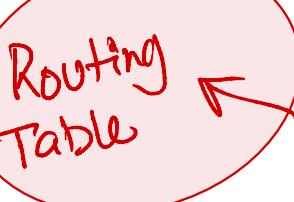


[2]

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

- Sender Laptop sends data to the router
- data has recipient's address
- Router finds it out (the destination address)
- Router transmits the data 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.

- 1 Enhanced security & isolation.
- 2 Improved network performance & reduced congestion
- 3 Simplified management.
- 4 Efficient use of IP addresses.

2

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.....

.....

[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.

- 1 Monitoring the communication channel (Carrier Sensing)
- 2 Transmitting data and detecting collisions.
- 3 Reacting to collision (Collision handling)

[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	an IP address that is assigned to a device to allow direct access on the internet
static IP address	A fixed IP address.
Private	an IP address used for internal LAN communication only
dynamic IP address	It changes each time a device de-joins the network.

[4]

- 8 A computer has an Operating System (OS).

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

To provide 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.

Utility software *Disk defragmenter*.

Explanation

[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

[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.

Address Bus: Transports mem. addresses to memory.

It specifies the location in mem. to be read.

Data Bus: Carries actual data to mem.

It transfers data from RAM to CD.

Buffer: Temp. store data to match the speed difference b/w computer parts involved in data processing or transmission.

[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 & OUTPUT*
 ADD *Arithmetic Operations*
 JPE *Unconditional & Conditional instructions*
 CMI *Comparison 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 True
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

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

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

[4]

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