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COMPUTER SCIENCE

9618/13

Paper 1 Theory Fundamentals

October/November 2022

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 **20** pages. Any blank pages are indicated.

1 A digital audio message needs to be recorded.

(a) Tick (✓) **one** box in each row to identify the effect of each action on the accuracy of the recording.

| Action | Accuracy increases | Accuracy decreases | Accuracy does not change |
|---------------------------------------------------------------------|--------------------|--------------------|--------------------------|
| Change the sampling rate from 40 kHz to 60 kHz. | | | |
| Change the duration of the recording from 20 minutes to 40 minutes. | | | |
| Change the sampling resolution from 24 bits to 16 bits. | | | |

[2]

(b) The audio message is recorded with a sampling rate of 50 kHz and a sampling resolution of 16 bits.

The recording is 20 minutes in length.

Calculate the file size of the recording.

Give your answer in megabytes **and** show your working.

Working

.....

.....

.....

Answer megabytes

[2]

(c) A computer uses a buffer when playing the audio message.

Explain the purpose of a buffer in a computer system using **one other** example.

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[3]

- 2 The relational database `ASTRONOMY` is used to store data about telescopes, the companies that own the telescopes and the photographs taken by the telescopes.

The database has these three tables:

`COMPANY`(`TelephoneNumber`, `CompanyID`, `CompanyName`)

`PHOTOGRAPH`(`PhotoID`, `TelescopeID`, `DateTaken`, `TimeTaken`, `Elevation`)

`TELESCOPE`(`TelescopeID`, `CompanyID`, `SerialNumber`)

- (a) Complete the following table by writing the correct answer for each item.

| Item | Answer |
|---------------------------------------------------------------------------------------|--------|
| a suitable field for the primary key in <code>COMPANY</code> | |
| a candidate key in <code>TELESCOPE</code> | |
| the degree of relationship between <code>TELESCOPE</code> and <code>PHOTOGRAPH</code> | |

[3]

- (b) A Database Management System (DBMS) has several features.

Identify the feature that describes the relationship between data and its structure.

..... [1]

- (c) Complete the SQL script to return the total number of telescopes owned by the company whose ID begins with `HW`.

```
SELECT ..... (.....)
FROM TELESCOPE
WHERE ..... LIKE .....
```

[4]

(d) Write the SQL script to add **one** field to the table PHOTOGRAPH to store the resolution of the photograph, e.g. 1920 × 1068.

.....
.....
.....
..... [2]

(e) The photographs are stored as bitmap images.

Complete the statements about bitmap images by writing the missing words.

The of a bitmap image is the number of bits that are used to store each pixel.

Metadata about the image is stored in the of the file.

[2]

(f) Describe the purpose of a query processor in a DBMS.

.....
.....
.....
..... [2]

- 3 Draw **one** line from each Operating System (OS) management task to its most appropriate description.

| OS Management task | Description |
|---------------------|-----------------------------------------------------------|
| hardware management | dynamically allocates memory to processes |
| security management | marks unallocated file storage for availability |
| memory management | installs programs for devices connected to external ports |
| process management | validates user and process authenticity |
| | allows processes to transfer data to and from each other |

[4]

4 (a) A Central Processing Unit (CPU) contains several special purpose registers and other components.

(i) State the roles of the following registers.

Memory Address Register (MAR)

.....

.....

Memory Data Register (MDR)

.....

.....

[2]

(ii) State when interrupts are detected during the Fetch-Execute (F-E) cycle.

.....

..... [1]

(b) A computer system contains a system clock.

Describe the purpose of the system clock.

.....

.....

.....

..... [2]

(c) Upgrading secondary storage to solid state typically improves the performance of computer systems.

Identify **one other** upgrade to the hardware **and** explain why it improves the performance of a computer system.

Upgrade

Explanation

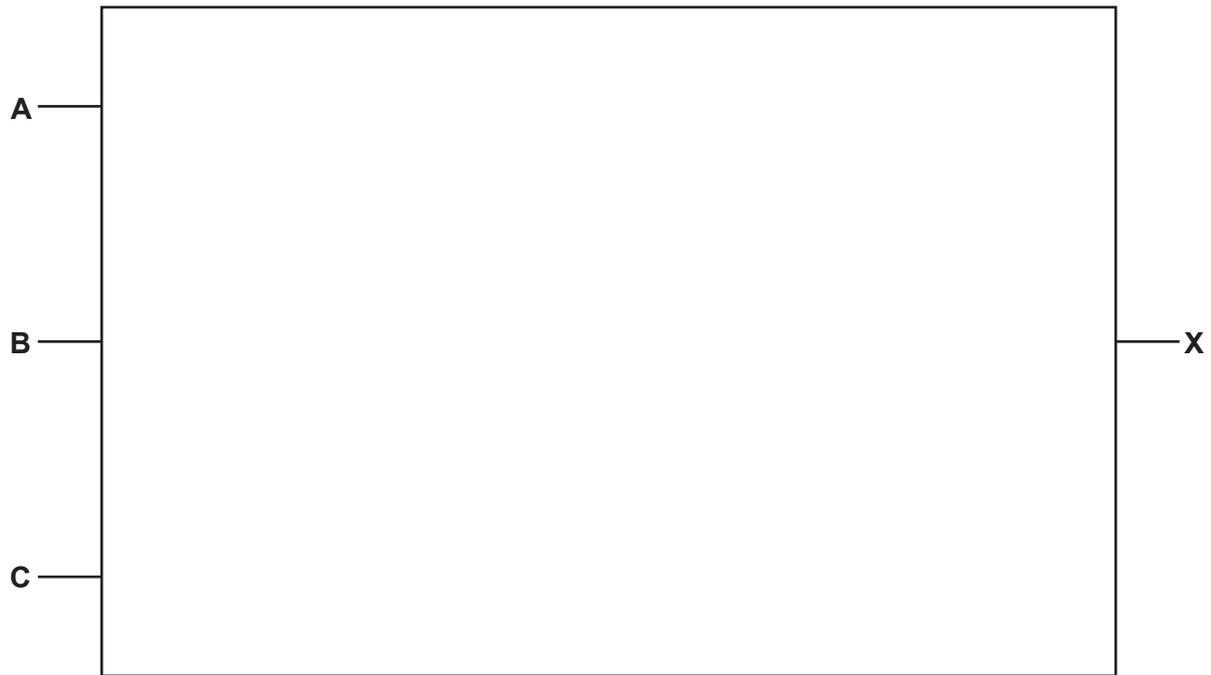
.....

.....

[2]

- 5 (a) Draw a logic circuit for the logic expression:

$$X = \text{NOT} ((\text{NOT} (\mathbf{A} \text{ AND } \mathbf{B})) \text{ OR } (\text{NOT} (\mathbf{B} \text{ AND } \mathbf{C})))$$



[3]

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

$$Y = (\text{NOT } \mathbf{P} \text{ AND } \mathbf{Q}) \text{ OR } (\mathbf{Q} \text{ AND } \text{NOT } \mathbf{R})$$

| P | Q | R | Working space | Y |
|----------|----------|----------|----------------------|----------|
| 0 | 0 | 0 | | |
| 0 | 0 | 1 | | |
| 0 | 1 | 0 | | |
| 0 | 1 | 1 | | |
| 1 | 0 | 0 | | |
| 1 | 0 | 1 | | |
| 1 | 1 | 0 | | |
| 1 | 1 | 1 | | |

[2]

Question 6 begins on page 10.

- 6 The following table shows part of the instruction set for a processor. The processor has one general purpose register, 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 |
| 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 |
| MOV | <register> | Moves the contents of the accumulator to the given register (IX) |
| STO | <address> | Store contents of ACC at the given address |
| ADD | <address> | Add the contents of the given address to the ACC |
| ADD | #n | Add the denary number n to the ACC |
| SUB | #n | Subtract the denary number n from the ACC |
| INC | <register> | Add 1 to the contents of the register (ACC or IX) |
| JMP | <address> | Jump to the given address |
| CMP | #n | Compare the contents of ACC with number n |
| 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 |
| JPN | <address> | Following a compare instruction, jump to <address> if the compare was False |
| 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
 B denotes a binary number, e.g. B01001101

(ii) Explain the purpose of **relative addressing** in an assembly language program.

.....

.....

.....

..... [2]

(b) The following table shows another part of the instruction set for the processor.

| Instruction | | Explanation |
|-------------|-----------|----------------------------------------------------------------------------------------------------|
| Opcode | Operand | |
| AND | #n | Bitwise AND operation of the contents of ACC with the operand |
| AND | Bn | Bitwise AND operation of the contents of ACC with the binary number n |
| AND | <address> | Bitwise AND operation of the contents of ACC with the contents of <address> |
| XOR | #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 | Bitwise OR operation of the contents of ACC with the operand |
| OR | Bn | Bitwise OR operation of the contents of ACC with the binary number n |
| OR | <address> | Bitwise OR operation of the contents of ACC with the contents of <address> |
| LSL | #n | Bits in ACC are shifted logically n places to the left. Zeros are introduced on the right-hand end |
| LSR | #n | Bits in ACC are shifted logically n places to the right. Zeros are introduced on the left-hand end |

<address> can be an absolute or a symbolic address
 # denotes a denary number, e.g. #123
 B denotes a binary number, e.g. B01001101

(i) The current contents of the ACC are:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|---|---|

Show the contents of the ACC after the execution of the following instruction.

AND B01001100

.....

.....

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

[1]

(ii) The current contents of the ACC are:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
|---|---|---|---|---|---|---|---|

Show the contents of the ACC after the execution of the following instruction.

OR B01001111

.....

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

[1]

(iii) The current contents of the ACC are:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
|---|---|---|---|---|---|---|---|

Show the contents of the ACC after the execution of the following instruction.

LSR #2

.....

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| | | | | | | | |
|--|--|--|--|--|--|--|--|

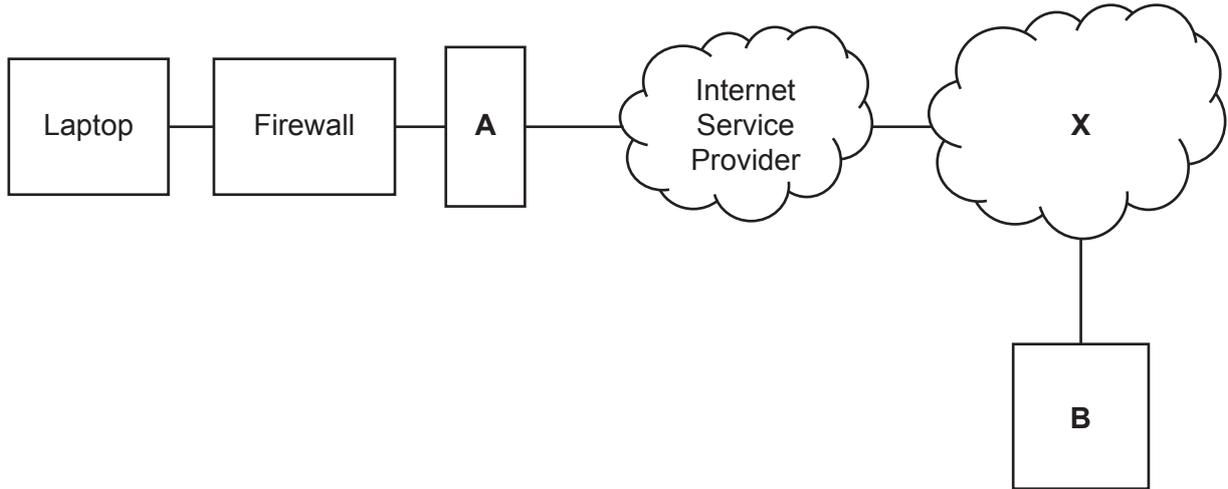
[1]

(c) One instruction group is data movement.

Give the name of **one other** instruction group.

.....
 [1]

7 (a) The diagram shows the hardware and software used to retrieve files stored on the cloud.



Complete the following table by writing the answer for each row.

Answer

| | |
|-------------------------------------------------------------------------------|--|
| The name of device A that allows the laptop to connect to the internet | |
| A type of cloud, X | |
| An example of an application, B , that can run on the cloud | |

[3]

(b) Give **one** advantage and **two** disadvantages of transmitting data using satellites instead of copper cables.

Advantage 1

.....

Disadvantage 1

.....

Disadvantage 2

.....

[3]

(c) Local Area Networks (LANs) can be made up of several subnetworks.

(i) Give **two** benefits of dividing a network into subnetworks by subnetting the LAN.

1

.....

2

.....

[2]

(ii) A subnet mask is used when subnetting a LAN.

Two devices on the LAN are located in different subnetworks.

The IP addresses and corresponding subnet masks are shown:

| Device IP address | Subnet mask |
|-------------------|---------------|
| 10.10.12.1 | 255.0.0.0 |
| 192.168.12.4 | 255.255.255.0 |

Identify the following network ID and host ID.

The network ID for the device with the IP address 10.10.12.1

.....

The host ID for the device with the IP address 192.168.12.4

.....

[2]

8 (a) (i) Explain why some programs are distributed under an open source licence.

.....
.....
.....
..... [2]

(ii) Explain how a programmer benefits from distributing a program under a commercial licence.

.....
.....
.....
..... [2]

(b) A commercial program for a vehicle repair garage includes an Artificial Intelligence (AI) module that can diagnose faults and suggest repairs.

Describe **one** economic impact the AI module may have on the garage.

.....
.....
.....
..... [2]

9 (a) (i) Convert the unsigned binary value into hexadecimal.

10010011

Answer [1]

(ii) Convert the unsigned binary value into denary.

10010011

Answer [1]

(b) State **two** benefits of using Binary Coded Decimal (BCD) to represent values.

Benefit 1

.....

Benefit 2

.....

[2]

10 (a) Explain the importance of feedback in a control system.

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.....
.....
.....
.....
..... [3]

(b) (i) Identify **one** sensor that could be used in a car alarm system.

Justify your choice.

Sensor

Justification

.....
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..... [2]

(ii) The car alarm is an example of an embedded system.

Describe the characteristics of an embedded system.

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.....
.....
.....
..... [3]

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