

COMPUTER SCIENCE

HIGHER LEVEL (questions 1-17) - 2 hours 10 minutes

PAPER 1

MOCK EXAM

INSTRUCTIONS TO CANDIDATES

- Do not turn over this examination paper until instructed to do so.
- **Answer all questions.**

Answer all questions. Write all answers on the lined paper provided.

1. Outline how **backups** can prevent data **loss**.

[2 marks]

*Data loss means that data has been destroyed (erased) or changed incorrectly.
A backup is an extra copy of the original/correct data.
If data is lost, the backup copy can be **restored** - copied from the backup device back onto the original storage device.*

2. Explain how data is exchanged between **RAM**, the **CPU**, and **cache memory**.

[2 marks]

Data and/or programs are copied from permanent storage into RAM when a program starts. When a CPU needs data or an instruction, it is transferred from RAM into the CPU. The cache sits between RAM and CPU, providing temporary storage that is faster than RAM. Typically, a part of a program that is needed repeatedly (e.g. a loop) will be stored in cache.

3. Outline what happens in RAM when the **Operating System** starts an **application**.

[2 marks]

The OS finds the application in permanent storage (hard disk). It checks how much RAM is required to load the program into memory. The OS finds that much free RAM space, allocates it for this program, and then loads (copies) the program into this RAM space.

4. (a) Convert the **decimal** number **56** to **binary**.

[1 mark]

$32+16+8 \rightarrow 00111000$

(b) Convert the **binary** number **01011100** to **hexadecimal** (base 16).

[1 mark]

$0101 \rightarrow 4+1 \rightarrow 5 \quad 1100 \rightarrow 8+4 \rightarrow 12 \rightarrow C \Rightarrow 5C \text{ hex}$

5. Outline **two** essential functions of a **compiler**.

[2 marks]

Any two of the following:

Parses source code into meaningful pieces.

Displays error messages if the source code is written incorrectly.

If no errors are found, produces executable machine language code.

6. Outline a **software** solution that can reduce the amount of time required to transmit data in a **Wide Area Network**.

[2 marks]

The obvious answer is compression.

File size is reduced by removing redundant data,

hence making the file smaller and requiring less transfer time.

7. Explain what a **truncation error** is, including an **example** of when it might occur.

[2 marks]

When a decimal value is stored, it is allocated a specific amount of memory, for example 64 bits for a Java double variable. In many cases, the actual binary representation is a repeating binary decimal. After 64 bits, the rest is truncated (removed). For example, $1/10 = 0.0001100110011\dots$ bin and this will be truncated after 64 bits. This does not happen with $1/2$, because $1/2 = 0.1$ in binary (non repeating).

8. Outline **one** advantage of creating a prototype before **designing** a computer system.

[2 mark]

Either of the following:

A visual prototype shows what the interface will probably look like.

This makes it easier for a designer to discuss the intended system with the intended user.

- or -

A functional prototype lets the programmer try out some of the difficult tasks, to determine whether the intended design will be achievable.

9. An **external hard-disk** is considerably slower than an **internal hard-disk**.

Explain **two reasons** that an external hard-disk is better than an internal hard-disk for making backup copies, despite the slower speed.

[2 marks]

(i) An external hard-disk can be used for backups. Since it is removable and portable, it can be stored in a safe place, like somewhere distant from the actual computer, hence safe from disasters like fires and theft.

(ii) If very large amounts of data need to be stored, multiple external hard-disks can be used, whereas it is probably not possible to attach an unlimited number of internal drives.

#10

The GOOD STUFF company has a web-site, where **anybody** can place orders for products.

To place an order, the customer must:

- choose a product
- enter customer name
- enter customer's address
- enter a credit card number

The order is then **printed on paper** and sent to a warehouse, where the products are packaged and delivered. Orders are shipped without any **verification**.

- (a) Outline how **data validation** might be used during the **ordering** process. *[1 mark]*
- (b) Explain the difference between **data validation** and **data verification**. *[2 marks]*
- (c) Outline how the **web-server** can **securely store** the user's private data, preventing GOOD STUFF employees from stealing and misusing bank information. *[2 marks]*

The web-site must maintain a list of all the items they sell, with prices, as well as all the customer data (name, address, credit card). The web-server must also communicate with the customers and print a paper order that is sent to the GOOD STUFF warehouse.

- (d) Draw a diagram showing how data moves between the following modules: *[5 marks]*

Customer's PC
Web server
Product and Prices Database
Printing paper order

(10 answers)

(a)

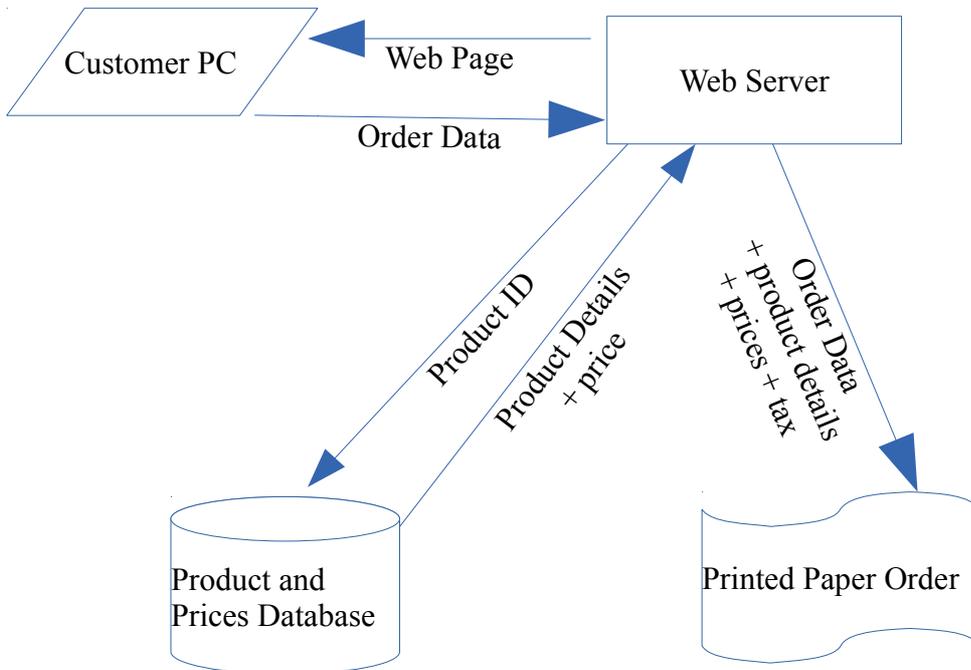
For example, the system can check that a credit card number contains the correct number of digits, and that the check-digit matches the other digits correctly.

(b) Verification checks whether data is ACTUALLY correct - for example, checking whether a credit card number has been used before by the same customer.

Validation checks whether the data COULD be correct, by checking that the FORMAT matches requirements. For example, the user name should have TWO names, separated by a blank space.

(c) The data should be ENCRYPTED, so that even if an employee has access, they cannot read the data without a password to decrypt it.

(d) Be sure to label arrows showing the DATA FLOW between modules.



#11

- (a) Outline how a Bubble Sort algorithm functions. [2 marks]
- (b) Assume that a Bubble Sort algorithm requires 10 seconds to sort an array containing 1 million numbers. State approximately how long the same algorithm would require to sort 4 million numbers. [2 marks]
- (c) Using pseudocode, construct an algorithm that finds the LARGEST value in an array that contains 1 million numbers. Assume that the numbers are already stored in an array named DATA. Do NOT assume that the numbers are sorted – they are in a random order. [4 marks]
- (d) Assume that your algorithm in part (c) requires 2 seconds to find the largest value in an array of 1 million numbers. State how long the same algorithm would require to find the largest number in an array containing 4 million numbers. [2 marks]

#11 Answers : ~~~~~

- (a) Go through the entire list, comparing each item to it's neighbor (next item).
Swap the two items if they are out of order.
Repeat going through the list again - make N passes for a list of N items.
- (b) $O(n^2) \implies 4N$ items takes $4^2 = 16$ times as long = 160 sec
- (c)

```
LARGEST = DATA[0]
loop C from 1 to 999999
  if DATA[C] > LARGEST then
    LARGEST = DATA[C]
end loop
output LARGEST
```
- (d) $O(n) \implies 2 \times 4 = 8$ sec

#12

A college occupies a building on three levels. A computer network, **using wires**, is in place but needs to be extended. It is suggested that the current system be replaced by a wireless network which provides connection to a file server and a separate gateway out to the Internet.

- (a) State 3 groups of **stakeholders** who should be involved in the problem **investigation and analysis**. [3 marks]
- (b) Outline one method for obtaining needs and requests from a large group of stakeholders (say 1000 people). [1 mark]
- (c) Assuming that the network software will NOT include a GUI interface, describe two **usability issues** that should be considered carefully during the design phase. [4 marks]
- (d) Describe **one ethical problem** that might result from a lack of clear and thorough **user documentation**. [2 marks]

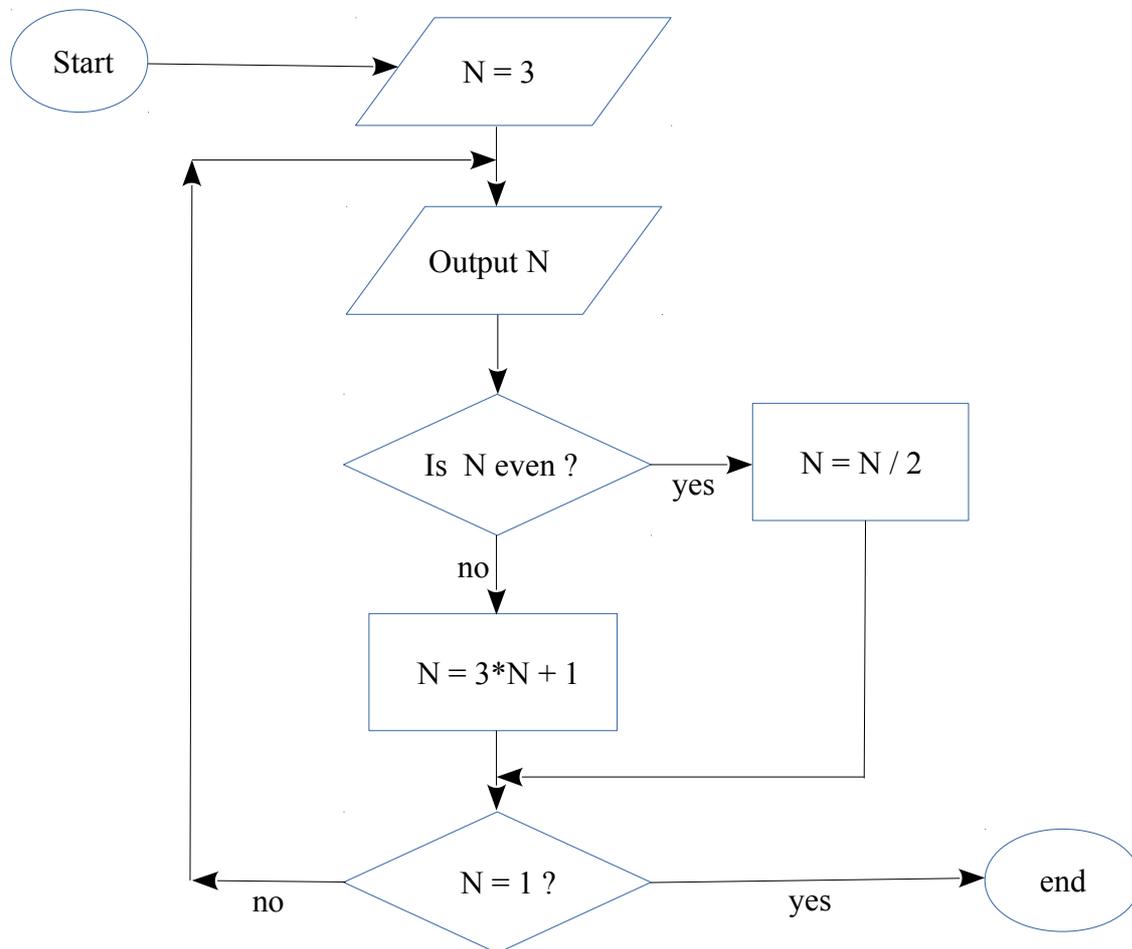
#12 Answers ~~~~~

- (a) Students, Faculty (teachers), Technicians
- (b) An ONLINE questionnaire is a poor solution, since access is not easy with wires. A better solution would be a paper questionnaire.
- (c) This is about the NETWORK software - that is not Windows or Mac OS.
(i) technicians must use old-fashion CLI tools to debug problems and change settings
(ii) if users are expected to fix things on the personal devices, then it's important that the Network OS communicates effectively with the personal device OS, so that users do not need to confront a CLI interface.
- (d) If user documentation is unclear or incomplete, some users may not succeed in performing required tasks. For example, if a student is expected to use the university web-site to register for courses, and it is difficult to understand, then they might not get the courses they wish before the courses are full.

#13

The flowchart below represents an algorithm that displays a sequence of numbers.

The word “even” means that a number is evenly divisible by 2, for example 4 , 6, 8, 10.



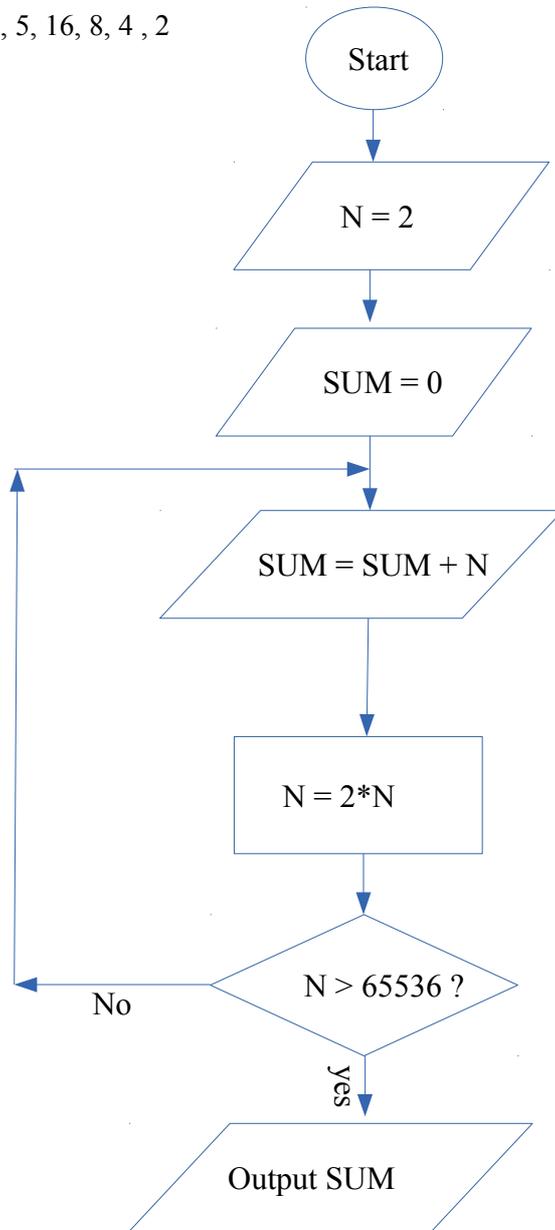
(a) Read the algorithm and state the sequence of numbers that it produces. [4 marks]

(b) Draw a flowchart for an algorithm that ADDS UP the following numbers and outputs the total.
 $2 + 4 + 8 + 16 + 32 + 64 + \dots + 65536$ [6 marks]

#13 Answers

(a) 3, 10, 5, 16, 8, 4, 2

(b)



#14

An airport uses a computer system to **check in** passengers for flights. An airline employee **scans** each passenger's **passport** to identify the passenger. Then a **central computer** searches for a corresponding **reservation**. Finally, the clerk can select a seat for the passenger and record this in the **database**. Then a **paper boarding card** is printed and given to the passenger, who walks to the boarding gate.

When passengers **board the plane**, a stewardess **scans** each passenger's passport again, as well as scanning the **boarding card**. The passport and boarding card are checked against the central database, to make sure that the passenger is boarding the correct plane.

- (a) Explain the role of **optical character recognition** in this system. *[2 marks]*
- (b) Explain why **automatic facial recognition** is not needed in this system. *[2 marks]*
- (c) Describe the need for a **network** in this system. *[2 marks]*
- (d) Discuss **one advantage** and **one disadvantage** of using a **wired network** as opposed to using a **wireless network** for this system. *[4 marks]*
- (e) Describe one advantage of using **RFID** chips in the boarding cards rather than just using simple paper cards. *[2 marks]*

#14 Answers

- (a) When scanning the passport, the passenger's name must be recognized by performing OCR and then checking the name against a database.
- (b) There are two clerks involved who meet the passenger and then can decide whether the passenger's face matches the passport. To do this via facial recognition would require:
- (a) a high quality camera
 - (b) a picture of the passenger's face stored in a database for comparison
- In theory, this might be done by comparing the camera image to the picture on the passport, but this requires a sophisticated computer system, at substantial cost.
- (c) Since the passenger visits various stations during their check-in and boarding, a network allows each station to access the data that is stored on a central server, as well as passing some information from one station to another. For example, if a passenger skips one of the stations, the next station can show that the passenger did not show up at the previous station.
- (d) Advantage : Wired networks provide better security at a lower cost, since only people with a wire can access the network. In WIFI, other people with their own devices can access the network. Security is not actually difficult, but requires somewhat different methods,.
- Disadvantage : A wire must be available at each of the check-in stations, and this will be true for many airlines, so probably requiring hundreds or thousands of cables. Wifi is easier to install, providing service for many more people, including passengers.
- (e) RFID chips are easily readable by an appropriate scanner and highly reliable. If coffee spills on the boarding card, or it is bent, the RFID chip will still work, whereas a bar-code reader or some other paper-based device might fail.

#15

There are many possible ways to store a **list** of data in a computer.

One possibility is to use an **array**. Another possibility is to use a **collection**.

An array is a **static** data structure, whereas a **collection** is a **dynamic** data structure.

(a) Explain the major difference between **static** and **dynamic** data structures.

[2 marks]

A **stack** is a list with specific access methods:

- **push(DATA)** is used to put a value into a stack

- **pop()** is used to remove an item from a stack

Study the following algorithm.

```
// Assume INFO is a stack that is empty
// Assume NAMES is an array containing 5 names
NAMES = ["Al", "Betty", "Carl", "Deb", "Ed"]
loop C from 0 to 4
    DATA = NAMES[C]
    INFO.push( DATA )
end loop
loop while not INFO.isEmpty()
    DATA = INFO.pop()
    output DATA
end loop
```

(b) State what will be displayed by the algorithm above -
be sure to write your solution in the correct order.

[3 marks]

(c) Explain the essential difference between a **stack** and a **queue**.

[2 marks]

~~~~~

It is possible to use **parallel arrays** to store various types of data, for example the NAME and AGE and PHONE of a list of students.

(d) Explain how the same data could be stored in a COLLECTION of OBJECTS.

[3 marks]

## #15 Answers

- (a) A static array has a fixed size, for example 100 items.  
A dynamic collection grows as new items are added,  
and shrinks (uses less memory) when items are deleted.
- (b) Ed , Deb, Carl, Betty, Al
- (c) Stacks are LIFO - Last In First Out - as demonstrated in part (b).  
Queues are FIFO - First In First Out - like a line in a cafeteria.
- (d) There will be one object for each student.  
Each object contains the fields: NAME, AGE, PHONE  
Then each object is .ADDED to the collection, like this:

```
STU = new Object()
input(STU.NAME)
input(STU.AGE)
input(STU.PHONE)
INFO.add(STU)
```

Then the data is accessed using the collection's access commands./

**#16**

A candy company is designing a new **automated vending machine**, where customers can buy candy. These machines will be available in airports, shopping malls, on street corners, etc.

The goal is to make the machines work without using cash. They intend to create a system so that customers can pay by using their mobile phone. They will place a call to a phone number printed on the front of the machine and place their order. Then the candy will slide out of a slot in the machine. The candy company will collect money from the customer's telephone account.

The vending machines should be further automated. By using facial recognition technology, the vending machine will display advertisements chosen according to gender and age. For example, the machine might advertise chewing gum for girls, chocolate for boys, mints for men, etc.

The advertising choices will be based on the items that have actually been purchased by customers in the past. A large database will collect data on all the transactions over a long period of time, and analyze popularity according to age and gender. For this to be useful, the vending machines must have a permanent connection to the central database.

- (a) Describe a type of **sensor** that could be used to activate the advertising screen whenever a pedestrian comes close to the machine. [2 marks]
- (b) The **processing** for the facial recognition could be performed directly inside the vending machine, or it could be performed by a central computer. Describe **one advantage** and **one disadvantage** of using a central computer for doing the facial recognition processing. [3 marks]
- (c) Assuming that the facial recognition is performed by a central computer, outline **three other needs** for **three different microprocessors** in the vending machine. [3 marks]
- (d) The vending machine might require a **secondary storage device**.  
Explain how the vending machine could display graphical advertisements if it does NOT contain a secondary storage device. [2 marks]

#16 answers

(a) Many different types of sensors are possible. The simplest is probably a motion sensor, that uses sonar or radar to detect motion in front of the machine.

If the ADS should be "targetted", then a camera should try to detect the gender of the visitor and select appropriate ads.

(b) Advantage : Facial recognition is a complex computing task, so it seems simpler and cheaper to do it in the server.

Disadvantage : It requires communication and data transfer, which may be time consuming and unreliable.

(c) 1 - Communication is still required, for example to fetch ads, so a processor must manage the Internet communication.

2 - A graphics processor is needed to power the display, especially for ADS

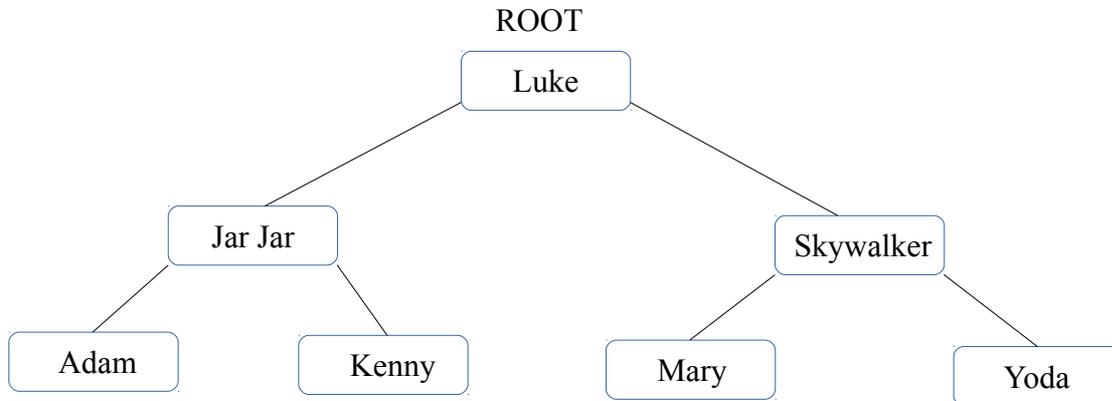
3 - A CPU is need to do the essential processing tasks like calculating a price for an item and accepting payment.

Many other answers are possible.

(d) The ads must be fetched from a server. This is probably better, as the ads can be changed and expanded easily in the server, rather than loading them separately into every candy machine.

#17

Below is a **balanced binary search tree** .



- (a) State what would be printed by a **PRE-ORDER traversal** of this tree. *[2 marks]*
- (b) Explain where a new node containing "Louise" would be added to this tree. *[1 mark]*
- (c) Explain why **deleting** a node from a binary-search tree could be significantly more complex than adding a new node. *[2 marks]*
- (d) Draw a binary tree which correctly represents this formula:  

$$(a + b) / (c - d * e)$$
*[3 marks]*
- (e) Look at your answer to (d). State what would be printed by a **POST-ORDER traversal** of the formula tree. *[2 marks]*

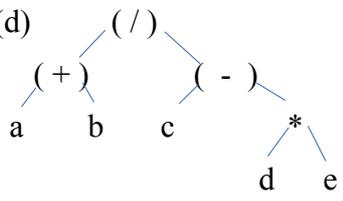
(a) Luke , JarJar, Adam , Kenny , Skywalker , Mary, Yoda

(b) Right child of Kenny

(c) Deleting a LEAF node is simple enough, changing the pointer above it to NULL.

But deleting an internal node (a parent with children) is a big problem,  
because all children and sub-children must be re-attached to other parents.

Adding nodes is much simpler, because they always go into a leaf position.

(d)  (you can do a better drawing job with a pen)

(e) a b + c d e \* - /