ZIMSEC

For Performance Measurement

6023 2024 MS1

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- This resource is designed for **practice, revision, and guidance** only.
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NEUROPULSE AI

1 (a) Define a *character set* giving examples. [2]

(b) Represent the denary value 187 in:

(i) Octal, [1]

(ii) Hexadecimal. [1]

(c) Explain why 187 can not be represented as an 8 bit, 2's compliment binary number. [2]

1 (a) Define a *character set* giving examples.

A character set is a collection of characters that a computer recognizes and can process. It includes letters, digits, punctuation marks, and control characters.

Examples: ASCII, Unicode.

(b) Represent the denary value 187 in:

(i) Octal [1 mark]

187 in octal = **273**

(ii) Hexadecimal [1 mark]

187 in hexadecimal = **BB**

TIP – USE THE UNIVERSAL NUMBERLINE TO CONVERT EASILY

INDEX	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
DENARY	128	64	32	16	8	4	2	1
BINARY	1	0	1	1	1	0	1	1
DEC VAL	2		4	2	1		2	1
OCT		=2			=7			=3

BINARY	1	0	1	1	1	0	1	1
DEC VAL	8		2	1	8		2	1
HEX				=11				=11
				=B				=B

Muchishona we are saying, when tring to find Oct, group 3 bits from the right, find the sum of all numbers tagged by 1s , for HEX, group 4 bits from the right and do the same. The probability of getting it wrong using this method is 0.00%

(c) Explain why 187 cannot be represented as an 8-bit, 2's complement binary number. [2 marks]
In 8-bit 2's complement representation, the range of values is from -128 to 127.
Since 187 > 127, it exceeds the maximum value that can be represented with 8-bit 2's complement.
Therefore, 187 cannot be represented in 8-bit 2's complement format.

2 **(a)** Convert the denary value –6.3125 to a normalised floating point number. 8 bits for mantissa and 4 bits for the exponent. Show your working. [3]

First things first, our number is **negative**, secondly, our number is a floating point number.

Lets take a look at our fractional point a bit,

0.3125 How do we convert it to binary

Case 1- Lazy Approach

0.3125 is equivalent to 5/16

But what fractions add up to 5/16??

2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-5}
1	1/2	1/4	1/8	1/16	1/32	1/64
0	0	1	0	1	0	0

So we found out that ¼ + 1/16 = 5/16 ryt?

Great so our binary number is 0.0101

Case 2- Boring but Effective

Step	Decimal × 2	Integer Part	Fractional Part	Binary Digit
1	0.3125 × 2 = 0.625	0	0.625	0
2	0.625 × 2 = 1.25	1	0.25	1
3	0.25 × 2 = 0.5	0	0.5	0
4	0.5 × 2 = 1.0	1	0.0	1

Final answer $0.312510 = 0.0101_2$

Now that we know how to convert fractions to binary lets finish our question

- 4 bits for exponent
- 8 bits for mantissa
- Total size: 1 (sign) + 4 (exponent) + 8 (mantissa) = 13 bits

Let's re-do the conversion of −6.3125 step by step

Format

Field	Size	Description
Sign	1 bit	0 for positive, 1 for negative
Exponent	4 bits	Stored with bias = 7
Mantissa	8 bits	Fraction bits after normalization

Step-by-Step Conversion

Convert Decimal to Binary

6.3125=110.0101

Normalize

$110.0101=1.100101\times2^2$

Calculate Bias and Stored Exponent:

- Actual exponent = 2
- Bias = $2^{(4-1)} - 1 = 7$
- Stored exponent = $2 + 7 = 9 = 1001_2$

Mantissa (8 bits after the point):

From 1.100101... → take bits after the point:
100101 → pad to 8 bits [ngaakwane 8] → 10010100

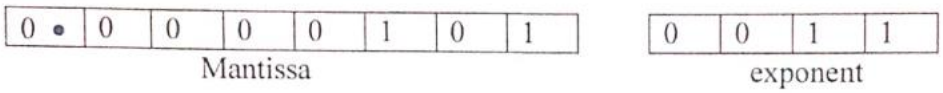
Final Table

Field	Bits	Explanation
Sign	1	Number is negative
Exponent	1001	2 (actual) + 7 (bias) = 9
Mantissa	10010100	8 bits from fractional part of normalized binary

Final 13-bit Result

1 1001010 1001

(b)



The floating point value above is **not** normalised, normalise the number.
Show your working. [3]

Remember rules for a normalized number, it should begin with 01 or 10

So what do we do? Shift your decimal point till you reach the next normal state , in this case lets shift to the right till we reach 01 after that we replace all the trimmed bits and append to the end of your number, lastly , modify your exponent by adding the value of the trimmed bits ,if you jumped 4 nits, you add +-4 bits depending with the shift direction

Mantissa

0	.	0	0	0	0	1	0	1

Trim off those bits (-4)

Exponent

0	0	1	1

In Dec ,this is equal to 3, add that (-4) and get 3-4 =-1

New Exponent (-1)

1	1	1	1

Hence the normalized Number is

Mantissa

0 .	1	0	1	0	0	0	0

Exponent

1	1	1	1

(c) Study the pseudocode below.

```
Procedure Add
        Declare MyNum:  FLOAT = 1.3
            For i = 1 to 5
                MyNum = MyNum + 0.3
                print (MyNum)
            Next i
End procedure
```

Dry run the pseudocode and show the output. [3]

i	MyNum Before	MyNum After +0.3	Printed Output
1	1.3	1.6	1.6
2	1.6	1.9	1.9
3	1.9	2.2	2.2
4	2.2	2.5	2.5
5	2.5	2.8	2.8

3 (a) Explain the role of the *Domain name system*. [2]

1. DNS translates human-readable domain names (e.g. www.google.com) into IP addresses that computers use to communicate.
2. It allows users to access websites using easy-to-remember names instead of complex numerical IP addresses.
3. It helps route internet traffic efficiently by directing devices to the correct servers.

(b) (i) Describe the Routing Information Protocol. [5]

(ii) State **three** advantages of Open Shortest Path First LINK (OSPFL). [3]

(b)(i) Describe the Routing Information Protocol (RIP). [5 Marks]

1. RIP is a distance-vector routing protocol used in small to medium-sized networks.
2. It determines the best route to a destination based on the number of hops (maximum of 15).
3. Routers using RIP periodically broadcast their routing tables to neighboring routers (every 30 seconds).
4. RIP uses the Bellman-Ford algorithm to calculate paths.
5. It is simple to configure but not suitable for large or complex networks due to slow convergence and hop limit.

(b)(ii) State *three* advantages of Open Shortest Path First Link (OSPF). [3 Marks]

1. Faster convergence than RIP – quickly updates routes when the network changes.
2. Scalable – suitable for large and complex networks using hierarchical design.
3. Uses cost as a metric – more accurate routing decisions based on link speed.

4	(a)	Define the term *cloud computing*.	[1]
	(b)	Give **three** advantages of cloud computing.	[3]
	(c)	Explain **three** cloud service models.	[6]

4 (a) Define the term *cloud computing*.

Cloud computing is the delivery of computing services (such as storage, servers, and software) over the internet on demand.

4 (b) Give *three* advantages of cloud computing.

1. Cost-effective – Reduces the need to buy and maintain physical hardware.
2. Scalability – Resources can be scaled up or down as needed.
3. Accessibility – Services can be accessed from anywhere with an internet connection.

4 (c) Explain *three* cloud service models.

Model	Explanation
IaaS (Infrastructure as a Service)	Provides virtualized computing resources such as servers, storage, and networking. Users manage OS and applications (e.g., AWS EC2).
PaaS (Platform as a Service)	Offers a platform with tools for developers to build, test, and deploy applications without managing the infrastructure (e.g., Google App Engine).
SaaS (Software as a Service)	Delivers software applications over the internet on a subscription basis (e.g., Google Docs, Microsoft 365). Users only use the application.

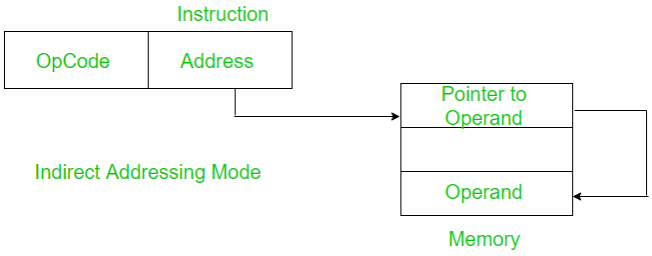
5	(a)	Explain the following types of memory address:	
	(i)	Direct addressing,	[2]
	(iii)	Indirect addressing,	[2]
	(iii)	Indexed addressing.	[2]

(i) Direct addressing: The instruction directly contains the memory address of the operand.

Example: LOAD R1, 1000H (Load the content of memory location 1000H into Register R1).

(ii) Indirect addressing: The instruction contains an address that points to another memory location, which in turn holds the actual address of the operand.

Example: LOAD R1, [2000H] (Load the content of the memory address stored at location 2000H into Register R1). If 2000H contains 3000H, then 3000H is the actual data address.



(iii) Indexed addressing: The effective address is calculated by adding a constant (from the instruction) to the value in an index register, useful for accessing arrays.

Example: LOAD R1, 50H(X) (Load the content of the memory address (50H + content of Index Register X) into Register R1). If X contains 10H, the effective address is 60H.

(b) Explain the circumstances for which the following addressing modes are useful

(i) indirect addressing, [2]

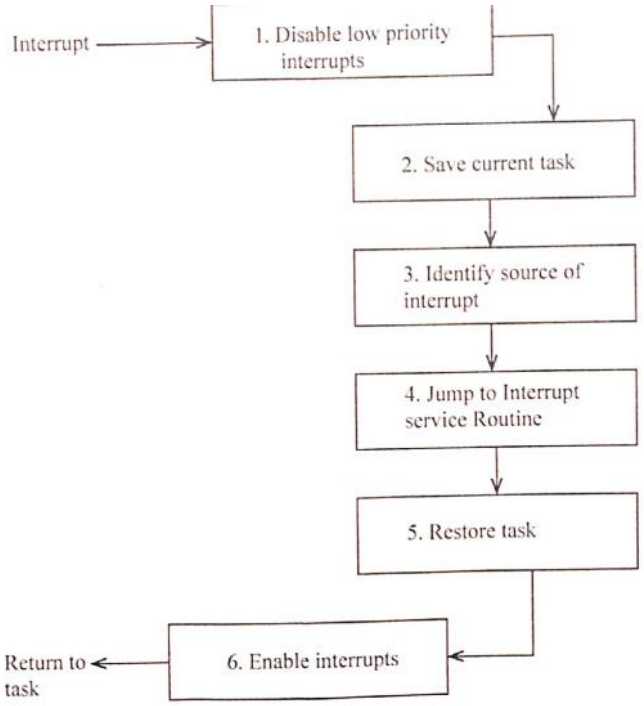
(ii) indexed addressing. [2]

(i) Indirect addressing is useful when the address of the operand is not known at compile time but is stored in a register or memory location.This mode is particularly useful for implementing pointers and passing parameters by reference. It allows a program to access data located at an address that is calculated or determined during runtime.

(ii) indexed addressing is useful for accessing elements of an array or a data structure.This mode uses a base address and an index register. The final address is calculated by adding the base address to the value in the index register. This makes it easy to iterate through an array by simply incrementing the index register.

6 (a) A method of reading and processing sensor data is to use interrupts. Each sensor is connected so that it can send an interrupt signal to the processor if its value changes.

On receipt of an interrupt signal, the processor carries out a number of steps as shown in the following diagram.



(i) State the purpose of the following:

(i) State the purpose of the following:

1. Step 1: Disable low priority interrupts
   - Purpose: To prevent other (especially lower-priority) interrupts from disturbing the processor while it is dealing with the current interrupt. This ensures the interrupt is handled safely without being interrupted itself.
2. Step 6: Enable interrupts
   - Purpose: To re-allow interrupts after the current interrupt service routine (ISR) has been completed. This restores the processor to its normal state of responding to new interrupts.

(ii) Explain how the current task is saved in Step 2.

- The processor saves the contents of key registers (such as the **Program Counter, Status Register, and Accumulator**) onto the **stack**.
- This ensures that once the interrupt service routine is finished, the processor can **resume the interrupted task** exactly where it left off.

(iii) State two benefits of using interrupts to read and process sensor data.

1. **Efficiency** – The processor does not waste time continuously checking (polling) sensors; it only reacts when a sensor actually changes state.
2. **Faster response** – Interrupts allow the processor to immediately respond to important events from sensors in real time.

(b) Explain how a parallel processor system works. [2]

(c) Give an example of an application for which it would be sensible to use parallel processing. Justify your choice. [2]

(b) Explain how a parallel processor system works. [2]

- A parallel processor system uses **multiple processors/cores** that work **simultaneously** on different parts of a task or on different tasks.
- The workload is **divided into smaller subtasks** which are executed concurrently, increasing speed and efficiency.

(c) Give an example of an application for which it would be sensible to use parallel processing. Justify your choice. [2]

Example: Weather forecasting / scientific simulations / image processing / AI training.
Justification: These applications require processing of **large volumes of data** or **complex calculations** that would take too long on a single processor, but can be completed faster by distributing the tasks across many processors.

7 (a) Explain the following terms:

(i) *Data Integrity*, [1]

(ii) *Data security*. [1]

(b) Describe **three** potential computer system risks in an organisation. [6]

(c) Suggest **two** tools used to eliminate vulnerability in an organisation. [2]

7(a) Explain the following terms:

(i) Data Integrity – Ensuring that data is accurate, consistent, and reliable throughout its lifecycle.

(ii) Data Security – Protecting data from unauthorised access, alteration, or destruction.

7(b) Describe three potential computer system risks in an organisation.

1. Malware or viruses that can corrupt files, steal data, or disrupt services.
2. Hardware failure such as a hard disk crash leading to loss of important business data.
3. Human error including accidental deletion, misconfiguration, or misuse of systems.

7(c) Suggest two tools used to eliminate vulnerability in an organisation.

1. Firewall to block unauthorised access to the network.
2. Antivirus or antimalware software to detect and remove malicious programs.

8 (a) Explain the difference between *static* and *dynamic implementation of data structures*. [2]

(b) Give **two** advantages of static data structures over dynamic data structures. [2]

(c) (i) Draw a binary tree diagram for the following data.

Mozambique, Angola, Botswana, Zimbabwe, Zambia, Namibia. [3]

(ii) Produce an algorithm to insert a new country into its correct position in the binary tree in **(c)(i)**. [5]

(d) (i) State the problem that arises when a non-leaf node is removed from a binary tree. [1]

(ii) Explain how this problem can be overcomed. [2]

8(a) Explain the difference between static and dynamic implementation of data structures.

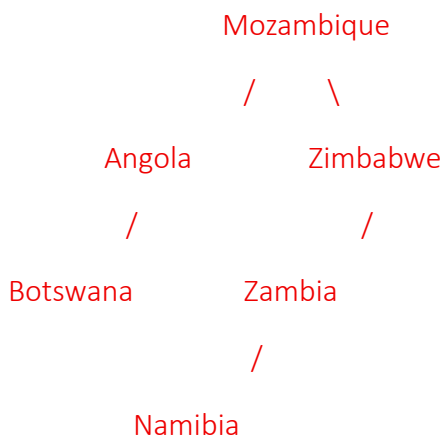
- Static data structures are created with a fixed size at compile time and cannot grow or shrink during program execution.
- Dynamic data structures can grow or shrink at runtime as memory is allocated or deallocated as needed.

8(b) Give two advantages of static data structures over dynamic data structures.

1. Easier to implement since memory allocation is done at compile time.
2. Faster access as elements are stored in contiguous memory locations.

8(c)(i) Draw a binary tree diagram for the following data: Mozambique, Angola, Botswana, Zimbabwe, Zambia, Namibia.

Insertion order determines the tree. If Mozambique is the root and data is inserted alphabetically:



8(c)(ii) Produce an algorithm to insert a new country into its correct position in the binary tree in (c)(i).

```
Algorithm InsertCountry(root, newCountry)
  If root is null
        Create new node with newCountry
        Set root to new node
  Else if newCountry < root.data
        InsertCountry(root.left, newCountry)
  Else if newCountry > root.data
        InsertCountry(root.right, newCountry)
  End If
End Algorithm
```

8(d)(i) State the problem that arises when a non-leaf node is removed from a binary tree.

- Removing a non-leaf node breaks the tree structure because its child nodes lose their parent.

8(d)(ii) Explain how this problem can be overcome.

- Replace the deleted node with either its in-order predecessor (largest value in the left subtree) or its in-order successor (smallest value in the right subtree).
- This maintains the binary tree property and keeps all nodes connected correctly.

A school enrols learners into form 1 and lower 6. Each form has several classes. All class names are different. Each form has a number of class teachers. The teachers always teach the same class. Each teacher has a unique Teacher ID of STRING data type.

(a) Describe the relationship shown in the diagram. [1]

(b) A relational database is created to store the class and teacher data. The two table designs for form 1 are:

B CLASS (ClassCode, Number of Desks)
A TEACHER(TeacherID, FirstName, FamilyName,…)

(i) Add one more field to the TEACHER table. [1]

(ii) Explain how the relationship in part **(a)** is implemented. [2]

(a) Describe the relationship shown in the diagram.

Each teacher teaches one class, and each class is taught by one teacher.
This is a one-to-one relationship between teacher and class.

(b)(i) Add one more field to the TEACHER table.

Possible field: PhoneNumber or EmailAddress or SubjectSpecialisation.

(b)(ii) Explain how the relationship in part (a) is implemented.

- The relationship is implemented by using the TeacherID as a **foreign key** in the CLASS table.
- This links each class record to the unique teacher who teaches it.

(c) In lower 6 of the school, there are a number of classes and a number of teachers.

The relationship for lower 6 of the school is as follows:

(i) Explain the degree of relationship shown. [1]

(ii) The design for the Lower 6 is as follows:

B – TEACHER(TeacherID, FirstName, FamilyName,Specialism)
B – CLASS(ClassName, NumberOfDesks, Specialism)
B – TEACHER: B – CLASS (…)

Complete the attributes for the third table.
Underline its primary key. [2]

(iii) Draw the relationships on an entity relationship (E-R) diagram. [3]

(i) Explain the degree of relationship shown.

- **many-to-many**.

(ii) Complete the attributes for the third table and underline its primary key

Step 1: Identify the relationship type

The relationship between **B-TEACHER** and **B-CLASS** is **many-to-many**. In relational databases, a many-to-many relationship is resolved by introducing a **third table**, often called a **junction table** or **linking table**.

Step 2: Determine the attributes of the third table

The third table will include the **primary keys** from both linked tables as its own attributes. These keys will **collectively form a composite primary key** for the new table.

Step 3: Define the table attributes and underline the primary key

The junction table linking **B-TEACHER** and **B-CLASS** will have the following attributes:

Answer:

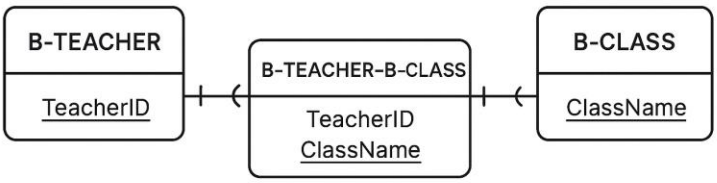
B-TEACHER–B-CLASS (*TeacherID*, *ClassName*)

- Here, **TeacherID** comes from **B-TEACHER** and **ClassName** comes from **B-CLASS**.
- Both attributes together form the **composite primary key**, which is **underlined**.

(iii) Draw the relationships on an E-R diagram

The relationship between **B-TEACHER** and **B-CLASS** is **many-to-many**, represented in an E-R diagram using **Crow's Foot notation(chi diagram Chiya chine malines neka circle to show relationships)** at both ends of the connecting line.

- This indicates that:
  - **One teacher** can be associated with **many classes**.
  - **One class** can be associated with **many teachers**.
- The **junction table** (B-TEACHER–B-CLASS) resolves this many-to-many relationship in the relational model.



10 (a) (i) Define *Intellectual Property* giving an example. [2]

(ii) Compare the terms *copyright* and *Patent*. [4]

(b) Describe **two** offences that are found in each of the following computer laws in Zimbabwe:

(i) The computer Misuse Act 1990. [2]

(ii) The Copyright Design and Patents Act 1988. [2]

(i) Define Intellectual Property (IP) giving an example:

- **Definition:** Intellectual Property (IP) refers to creations of the mind, such as inventions, literary and artistic works, designs, symbols, names, and images used in commerce, over which the creator has legal rights.
- **Example:** A software program, a novel, a logo, or a patented invention.
  Example: Microsoft Windows is protected as intellectual property.

(ii) Compare the terms copyright and patent:

Aspect	Copyright	Patent
Definition	Protects original literary, artistic, and musical works.	Protects new inventions or processes.
Duration	Usually lasts for the life of the author + 50-70 years.	Usually lasts 20 years from filing.
Purpose	Prevents unauthorized copying or reproduction.	Prevents others from making, using, or selling the invention without permission.
Example	A book, music, or software code.	A new machine, chemical process, or device.

(b) Describe two offences found in the following computer laws in Zimbabwe:

(i) Computer Misuse Act 1990:

1. **Unauthorized access to computer systems** – Accessing a computer system without permission.
2. **Data modification or destruction** – Intentionally altering or destroying data without authorization.

(ii) Copyright, Designs and Patents Act 1988:

1. **Copyright infringement** – Copying or distributing copyrighted material without permission.
2. **Unlawful use of patented inventions** – Using or selling a patented invention without the owner's consent.

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