

Date : October 11, 2025
Total Marks : 100
Writing Time : 150 minutes (2.5 hours)
Reading Time : 15 minutes (prior to writing time)

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
 - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
 Part II - 6 Short Answer Questions

All questions under SECTION A are **COMPULSORY**.
 - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part on a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **10 printed pages**, including this instruction page.

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SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. Which of the following is the fastest type of memory?
 - a) Hard Disk
 - b) RAM
 - c) Cache
 - d) SSD
2. You are designing a search feature for a large e-commerce platform. The search must handle millions of queries per day with low latency. Which data structure or approach is MOST efficient for prefix searches (e.g., autocomplete)?
 - a) Linked List
 - b) Hash Table
 - c) Trie
 - d) Stack
3. You need to find the shortest path between nodes in a graph representing a city map with weighted edges. Which algorithm is MOST appropriate if weights are all non-negative?
 - a) Depth-First Search (DFS)
 - b) Dijkstra's Algorithm
 - c) Prim's Algorithm
 - d) BFS
4. Which of these is an example of open-source software?
 - a) Microsoft Word
 - b) Google Chrome
 - c) Apache HTTP Server
 - d) Adobe Photoshop
5. What is it called when IP address conversion is done when going to the internet over the local network?
 - a) Exchange
 - b) NAT
 - c) PAT
 - d) DHCP
6. What is the tool used to distribute the traffic to the servers evenly?
 - a) Email Security Gateway
 - b) EDR
 - c) IDS
 - d) Load Balancer

7. What is the network technology that provides a safe connection to a distant network?
- a) Dynamic Host Configuration Protocol (DHCP)
 - b) Application Layer
 - c) Virtual Private Network (VPN)
 - d) Wireless LAN (WLAN)
8. According to the OSI Reference model, in which layer are the “ATM, Token Ring, Frame Relay, and Ethernet” protocols located?
- a) Application Layer
 - b) Datalink Layer
 - c) Transport Layer
 - d) Session Layer
9. What is the primary function of DNS (Domain Name System)?
- a) Convert IP addresses to domain names
 - b) Secure data transmission over the network
 - c) Assign IP addresses dynamically
 - d) Route packets across networks
10. In Python, what does the following code do?
- ```
def func(lst):
 return sum(lst) / len(lst)
print(func([1, 2, 3, 4, 5]))
```
- a) Returns the sum of the list
  - b) Returns the average of the list
  - c) Returns the median of the list
  - d) Returns the product of the list
11. Suppose each hydropower project generates revenue (in Nu. million) and the following program has been written to aid analysis. What does the program print?

```
#include <iostream>
using namespace std;
int main() {
 int revenue[5] = {500, 700, 800}; // Tala, Chukha, Mangdechhu
 int total = 0;

 for (int i = 0; i < 5; i++)
 total += revenue[i];

 cout << total;
 return 0;
}
```

- a) 0
  - b) 2000
  - c) Garbage value
  - d) Compilation Error
12. How can you include an external CSS file in an HTML document?
- a) `<link href="styles.css">`
  - b) `<style src="styles.css">`
  - c) `<css src="styles.css">`
  - d) `<script src="styles.css">`
13. What file contains user account information in most Linux systems?
- a) `/etc/shadow`
  - b) `/etc/users`
  - c) `/etc/passwd`
  - d) `/home/users`
14. You want to monitor a growing log file in real-time, showing only the last 50 lines and updating continuously. Which command is BEST?
- a) `cat /var/log/syslog`
  - b) `tail -n 50 -f /var/log/syslog`
  - c) `head -n 50 /var/log/syslog`
  - d) `grep ERROR /var/log/syslog`
15. A system admin notices that a particular process is consuming 95% of CPU constantly. Which command combination is BEST to identify and handle the problem?
- a) `ps aux | grep <process>` and `kill -9 <pid>`
  - b) `ls -l /var/log` only
  - c) `top` or `htop` then `kill` or `renice`
  - d) `chmod 777` on the binary
16. How do you search for a pattern in a file using the terminal?
- a) `find`
  - b) `grep`
  - c) `locate`
  - d) `Search`
17. What is the main advantage of PaaS over IaaS?
- a) More storage
  - b) Full control of OS
  - c) Abstracts infrastructure management
  - d) Cheaper data centers

18. Your company runs a web app with unpredictable traffic spikes. Which cloud feature is MOST useful to handle sudden demand automatically?
- a) Multi-tenancy
  - b) Elasticity
  - c) Virtualization
  - d) High Availability
19. A cloud customer configures security groups incorrectly, causing a breach. Whose responsibility is this under the Shared Responsibility Model?
- a) Cloud provider
  - b) Both provider and customer
  - c) Customer
  - d) Third-party vendor
20. What is the key difference between a container and a VM?
- a) VMs are lighter
  - b) Containers include full OS
  - c) Containers share the host kernel
  - d) Containers are slower
21. Which SQL command is used to remove a table completely?
- a) DELETE
  - b) DROP
  - c) REMOVE
  - d) ERASE
22. You are tasked with running analytics on structured + semi-structured + unstructured data. Which is MOST suitable?
- a) RDBMS
  - b) Data Warehouse
  - c) Data Lake
  - d) Cache DB
23. Which of the following is a characteristic of Big Data's 5Vs?
- a) Velocity
  - b) Virtualization
  - c) Visualization
  - d) Versioning
24. Which is NOT an example of AI chatbots?
- a) ChatGPT
  - b) Google Bard
  - c) Cloud
  - d) Claude

25. The role of a Certificate Authority (CA) is to
- a) Encrypt all internet traffic
  - b) Issue and verify digital certificates
  - c) Generate public/private key pairs
  - d) Block insecure websites
26. Which key does Bob use to decrypt Alice's message encrypted with his public key?
- a) Alice's public key
  - b) Alice's private key
  - c) Bob's public key
  - d) Bob's private key
27. After the secure session is established in HTTPS, data is transmitted using
- a) Public key encryption
  - b) Symmetric key encryption
  - c) Digital signatures only
  - d) Hashing only
28. What is the name given to the output produced by the functions used for integrity check?
- a) Public Key
  - b) Collision
  - c) Hash
  - d) Verification Number
29. A public API endpoint allows search queries. You discover that an attacker can inject SQL commands through query parameters. What is the MOST appropriate fix?
- a) Validate and sanitize input; use parameterized queries
  - b) Add API keys
  - c) Enable Cross-Origin Resource Sharing
  - d) Increase server CPU
30. Which of the following is safer than the others?
- a) SSL 3.0
  - b) TLS 1.3
  - c) TLS 1.0
  - d) SSL 2.0

**PART II – Short Answer Questions [20 marks]**

**This part has 6 Short Answer Questions. Answer ALL the questions. Marks for each question are indicated in the brackets.**

1. You are given a list of integers representing scores in a game, e.g. `nums = [3, 1, 1, 4, -20, 0]`. Write a program using the language of your choice to find the maximum score without using built-in `max()` or sorting. Explain how your code would behave if the list is empty, contains duplicates or all negative numbers. **(5 marks)**
2. Your organization's computers are frequently targeted by malware. Suggest three key measures to prevent malware infections. Explain briefly why each measure is important. **(3 marks)**
3. Your company has an Employee table as shown below. Write an SQL query to count the number of employees in each department. **(2 marks)**

| emp_id | name    | dept  | salary |
|--------|---------|-------|--------|
| 101    | Alice   | HR    | 5000   |
| 102    | Bob     | IT    | 6000   |
| 103    | Charlie | HR    | 5500   |
| 104    | David   | IT    | 6200   |
| 105    | Eva     | Sales | 4500   |

4. Explain machine learning and differentiate supervised v/s unsupervised learning. **(2 marks)**
5. You have joined a government office that has 200 devices including PCs, mobiles, printers, and laptops, and it's expected to grow. The subnet is 192.168.1.0/24. **(5 marks)**
  - a. Can all devices be assigned IPs in this subnet?
  - b. Should you keep it this way?
  - c. If not, propose a better solution with justification.
6. A company installs smart sensors to monitor energy usage and adjust lighting automatically. What technology is being used here and explain the technology? **(3 marks)**

**SECTION B: CASE STUDY [50 marks]**

**Choose either CASE I OR CASE II from this section. Each case study carries 50 marks. Mark for each sub-question is indicated in the brackets.**

**CASE I**

You are hired as a network engineer for the Department of Public Records (DPR), a fictional government agency, which is setting up a new branch office in Gelephu Mindfulness City. This office provides services like document verification, digital ID issuance and public record access.

You are required to build and operate a secure, scalable and resilient network infrastructure.

**1. Network Design (15 marks)**

Draw a simple network diagram for the DPR branch office. Label the main components and briefly explain what each component's role is in the network. While designing keep following consideration in mind:

- 1.1. There are two types of users (staff and citizens)
- 1.2. They have 2 departments (IT and service center)
- 1.3. They also have on-premise servers.

**2. IPv4 Subnetting Design (10 marks)**

Design the IPv4 subnetting for the branch office that has:

- 2.1. The IT department with 10 devices
- 2.2. The Service Center with 100 devices
- 2.3. A maximum of 240 citizens will be accessing the services at the same time
- 2.4. 3 servers on-premises.

Your answer should be presented in tabular format, including: Subnet, Subnet Mask, Network Address, Broadcast Address, Usable IP Range, Usable IPs(count) per subnet. Also consider scalability in your design to accommodate future growth.

**3. Network Performance Issue (10 marks)**

After a few days of operation, the staff in the Service Center report slow internet speeds.

- 3.1. What tools and methods would you use to identify the root cause of this performance issue? **(5 marks)**
- 3.2. How would you optimize the network to improve speed and reliability? **(5 marks)**

**4. Remote Server Management (10 marks)**

A system administrator needs to remotely manage both Windows and Unix servers from home. The servers should remain secure while allowing full access for administrative tasks. Propose a solution each with an explanation to fulfill the following conditions? **(10 marks)**

- 4.1. The administrator must securely connect to the office network from home, ensuring all traffic is encrypted.

- 4.2. For Windows servers, the administrator needs access to the graphical interface remotely.
- 4.3. For Unix servers, the administrator needs to manage the system via the command line.
- 4.4. Ensure the person connecting is really the authorized administrator, even if the password is stolen.
- 4.5. Restrict which network traffic can reach the servers, minimizing exposure to attacks.

### 5. Centralized Network Management with SDN (5 marks)

After a year, DPR plans to centralize the management of all branch office networks. You proposed to adopt SDN.

Explain to the management what Software-Defined Networking (SDN) is, and its benefits in streamlining network management across multiple branch offices?

### CASE II

The **National Referral Hospital (NRH)** is the largest healthcare institution in the country, providing comprehensive medical services including emergency care, specialized treatments, surgical procedures, and outpatient services. The hospital serves patients from across the nation and operates 24/7 with multiple departments including Emergency, Surgery, Pediatrics, Cardiology, Oncology, Radiology, and Laboratory Services.

To improve operational efficiency and patient care quality, NRH wants to implement a comprehensive **Hospital Management System (HMS)** to manage its complex operations. The HMS should capture the following information:

- **Patient Information** such as Patient ID, Name, Age, Gender, Contact Number, Emergency Contact, Address (Village, Geog, Dzongkhag), Blood Group, Medical History, Registration Date, Status (Active/Discharged/Deceased)
- **Appointment Information** such as Appointment ID, Date, Time, Type (Consultation/Follow-up/Emergency), Status (Scheduled/Completed/Cancelled), Remarks
- **Medical Procedure Information** such as Procedure ID, Procedure Type (Surgery/Diagnostic/Therapeutic), Name, Date, Duration, Cost, Equipment Used, Outcome, Complications (if any)
- **Staff Information** such as Staff ID, Name, Specialization, Department, Shift Timings, Contact Details, Qualification, Experience, Employment Status (Active/On Leave/Terminated)

*\* Note: The above data scenario is provided as a baseline. You may add additional attributes or tables if required to accurately model the HMS database.*

### 1. Entity-Relationship Model (10 marks)

- 1.1. Identify the entities, their attributes, and relationships for the HMS database. (3 marks)
- 1.2. Explain the difference between a composite key and a candidate key. (2 marks)
- 1.3. Develop an ER model illustrating the relationships, cardinalities, and constraints. (5 marks)

**2. Normalization (8 marks)**

- 2.1. Differentiate between 1NF, 2NF and 3NF with examples. **(3 marks)**  
2.2. Normalize the following table into 3NF. List the steps and the final tables. **(5 marks)**

|                      |                    |                       |                  |                        |             |             |             |
|----------------------|--------------------|-----------------------|------------------|------------------------|-------------|-------------|-------------|
| <i>AppointmentID</i> | <i>PatientName</i> | <i>PatientContact</i> | <i>StaffName</i> | <i>StaffDepartment</i> | <i>Date</i> | <i>Time</i> | <i>Type</i> |
|----------------------|--------------------|-----------------------|------------------|------------------------|-------------|-------------|-------------|

**3. SQL Queries (10 marks)**

Write a SQL for the following:

- 3.1. To register a new patient. **(2 marks)**  
3.2. To schedule an appointment. **(2 marks)**  
3.3. To update the contact number of an existing patient. **(2 marks)**  
3.4. To fetch all surgical procedures performed in the last 30 days. **(2 marks)**  
3.5. To list all staff members on leave in the *Surgery* department. **(2 marks)**

**4. Database Transactions and Concurrency (6 marks)**

- 4.1. Define a transaction and explain ACID with an HMS example. **(4 marks)**  
4.2. Two doctors updating the same record – concurrency control. **(2 marks)**

**5. Software Development Life Cycle (10 marks)**

- 5.1. What is SDLC? Name three methodologies. **(2 marks)**  
5.2. Differentiate functional vs non-functional requirements. Identify 2 of each for HMS. **(4 marks)**  
5.3. Explain unit, integration, system and UAT testing. **(4 marks)**

**6. System Security and Data Protection (6 marks)**

- 6.1. Explain what RBAC is and how it simplifies access management in the HMS. Provide an example showing how different staff roles would have different permissions. **(3 marks)**  
6.2. List and briefly describe three critical security measures that should be implemented in the HMS to safeguard sensitive patient data and ensure secure system operations. **(3 marks)**

**TASHI DELEK**