

Computer Science Fundamentals

Mid-Term Examination

Code: CS-204

Term: Fall 2026

Student
Name

Date

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i General Instructions

- This paper contains **25 multiple-choice questions** across 4 pages. Attempt **all** questions.
- Each question is worth **4 marks**. There is **no negative marking** for incorrect answers.
- Select the **single best answer** and fill the corresponding bubble on your answer sheet.
- Total duration: **90 minutes**. Maximum score: **100**.
- Non-programmable scientific calculators are permitted. All other electronic devices must be switched off.
- Do not write on the question paper. Rough work may be done on the last page.

SECTION A: Core Concepts **Q1–Q12** **48**
marks

	Section	Scored	Max
For Examiner Use	A		48
	B		52
	Total		100

Section A: Core Concepts

48 Marks

1. Which data structure operates on a Last-In-First-Out (LIFO) principle?

- A. **Queue** — elements are removed in the order they were added.
- B. **Stack** — the most recently added element is removed first.
- C. **Deque** — elements can be added or removed from either end.
- D. **Priority Queue** — elements are removed based on assigned priority.

2. What is the worst-case time complexity of searching for an element in an unbalanced Binary Search Tree containing n nodes?

- A. $O(1)$ — constant time regardless of tree structure.
- B. $O(\log n)$ — logarithmic time, assuming the tree remains balanced.
- C. $O(n)$ — linear time when the tree degenerates into a linked list.
- D. $O(n \log n)$ — linearithmic time due to node comparisons.

3. The Synapse distributed database uses consistent hashing to partition data across nodes. What is the primary advantage of consistent hashing over simple modulo-based partitioning?

- A. It eliminates the need for data replication across nodes.
- B. It minimizes key remapping when nodes are added or removed.
- C. It guarantees uniform data distribution under all workloads.
- D. It encrypts partition keys using a built-in hash function.

4. In the context of operating systems, what is a *race condition*?

- A. A scheduling policy that prioritizes the fastest process first.
- B. A scenario where process execution speed determines output correctness.
- C. A situation where multiple threads access shared data and the result depends on execution order.
- D. An optimization technique that reduces context-switching overhead.

5. The TCP three-way handshake involves which sequence of control flags?

- A. SYN, ACK, FIN
- B. SYN, SYN-ACK, ACK
- C. SYN, ACK, RST
- D. ACK, SYN-ACK, FIN

6. A Vertex Robotics engineer needs to sort a dataset of 10^6 floating-point numbers stored in an array. The data is uniformly distributed. Which algorithm would provide the best average-case performance?

- A. Bubble Sort — simple but quadratic in the average case.
- B. Merge Sort — guarantees $O(n \log n)$ regardless of input distribution.
- C. Quicksort — $O(n \log n)$ average case with good cache locality.
- D. Insertion Sort — efficient only for nearly-sorted or small datasets.

7. Which of the following is **not** a characteristic of a relational database management system?

- A. Data organized in tables with rows and columns.
- B. Support for ACID-compliant transactions.
- C. Schema-free document storage with nested JSON objects.
- D. Enforcement of referential integrity through foreign keys.

8. Consider the Boolean expression $\overline{A \cdot B} + \overline{A} + \overline{B}$. Which logic gate combination does this simplify to?

- A. AND gate only
- B. OR gate only
- C. XOR gate
- D. NAND gate followed by a NOR gate

9. In the Nimbus cloud orchestrator, a microservice instance fails and is restarted automatically. This is an example of which architectural pattern?

- A. Circuit Breaker — prevents cascading failures by stopping calls to a failing service.
- B. Self-Healing — the system detects failures and recovers without human intervention.
- C. Bulkhead Isolation — limits the blast radius by partitioning resources.
- D. Event Sourcing — reconstructs state by replaying a sequence of events.

10. What does the HTTP status code 429 indicate?

- A.** Unauthorized — the client must authenticate to access the resource.
- B.** Not Found — the requested resource does not exist on the server.
- C.** Too Many Requests — the client has exceeded a rate limit.
- D.** Internal Server Error — the server encountered an unexpected condition.

11. A Meridian Financial application processes payment transactions. To ensure exactly-once delivery semantics in their message queue, they should use:

- A.** At-most-once delivery with client-side deduplication.
- B.** Idempotent message processing with acknowledgement tracking.
- C.** Synchronous RPC calls instead of asynchronous messaging.
- D.** Broadcast delivery to all consumer instances simultaneously.

12. Which data structure would be most efficient for implementing a Least Recently Used (LRU) cache with $O(1)$ get and put operations?

- A.** Binary heap with an auxiliary array.
- B.** Doubly linked list combined with a hash map.
- C.** Balanced binary search tree with parent pointers.
- D.** Circular buffer with a linear probing hash table.

Section B: Applied Concepts

52 Marks

13. Apex Gaming is designing a multiplayer matchmaking system. They need a data structure that supports efficient range queries (finding players within a skill range) and nearest-neighbor search. Which structure is most suitable?

- A. Red-Black Tree — balanced binary tree with $O(\log n)$ operations.
- B. KD-Tree — partitions space for efficient multidimensional queries.
- C. Skip List — probabilistic structure with $O(\log n)$ average operations.
- D. Adjacency List — represents graph connections between players.

14. In the context of database indexing, what distinguishes a clustered index from a non-clustered index?

- A. A clustered index can be created on multiple columns simultaneously.
- B. A clustered index determines the physical order of rows in the table.
- C. A clustered index is always faster for write-heavy workloads.
- D. A clustered index exists only in memory and is never persisted to disk.

15. Consider the following pseudocode: `function mystery(n):`

```
    if n ≤ 1: return n
    return mystery(n-1) + mystery(n-2)
```

What is the time complexity of `mystery(n)`?

- A. $O(n)$ — linear recursion depth.
- B. $O(n \log n)$ — divide-and-conquer pattern.
- C. $O(2^n)$ — exponential due to overlapping subproblems.
- D. $O(\log n)$ — binary reduction of input size.

16. The Nexa SecureAuth system stores user passwords. Which approach provides the strongest protection against credential leaks?

- A. Encrypting passwords with AES-256 and storing the ciphertext.
- B. Hashing passwords with SHA-256 and a static application-wide salt.
- C. Hashing passwords with bcrypt using a unique, random salt per user.
- D. Encoding passwords with Base64 before storing them in the database.

17. Which network topology provides the highest fault tolerance against single-link failures?

- A. Star — all nodes connect to a central hub, creating a single point of failure.
- B. Bus — all nodes share a single communication line.
- C. Ring — each node connects to exactly two neighbors in a closed loop.
- D. Mesh — every node has a dedicated point-to-point link to every other node.

18. In the OSI model, which layer is responsible for end-to-end reliable data delivery and flow control?

- A. Data Link Layer (Layer 2)
- B. Network Layer (Layer 3)
- C. Transport Layer (Layer 4)
- D. Session Layer (Layer 5)

19. Vertex Robotics' autonomous drone uses a real-time operating system. Which scheduling algorithm guarantees that the highest-priority task always executes first?

- A. Round-Robin — allocates equal time slices to all tasks.
- B. First-Come-First-Served — processes tasks in arrival order.
- C. Preemptive Priority Scheduling — higher-priority tasks preempt lower-priority ones.
- D. Shortest Job First — selects the task with the smallest estimated runtime.

20. What is the primary purpose of a *load balancer* in a distributed web application?

- A. To encrypt all traffic between the client and the server cluster.
- B. To distribute incoming requests across multiple server instances.
- C. To cache database query results for faster subsequent access.
- D. To compile and minify static assets before serving them to clients.

21. The Synapse Data Platform processes streaming events using Apache Kafka. Which guarantee does Kafka provide for message ordering?

- A. Global ordering across all partitions of a topic.
- B. Ordering within a single partition, but not across partitions.
- C. No ordering guarantees at any level of the system.
- D. Strict total ordering enforced by the ZooKeeper coordination service.

22. In object-oriented programming, the Liskov Substitution Principle states that:

- A. Classes should be open for extension but closed for modification.
- B. Subtypes must be substitutable for their base types without altering correctness.
- C. A class should have only one reason to change.
- D. Depend on abstractions, not on concrete implementations.

23. Nimbus Analytics runs a MapReduce job over 10 TB of log data stored in HDFS. The job completes successfully but some reducer output files are empty. What is the most likely cause?

- A. The NameNode ran out of memory during job initialization.
- B. The input data had no keys mapping to those specific reducer partitions.
- C. The JobTracker failed to assign map tasks to those nodes.
- D. The replication factor was set too low for the output directory.

24. Apex Gaming's backend team observes that their API response times increase sharply when the number of concurrent users exceeds 5,000. The database connection pool is configured with a maximum of 100 connections. Which architectural change would most effectively address this bottleneck?

- A. Increase the database connection pool size to 500 and add more RAM to the database server.
- B. Introduce a read-replica database and route all read queries to the replica.
- C. Add an in-memory caching layer (e.g., Redis) in front of the database for frequently accessed data.
- D. Replace the relational database with a graph database optimized for relationship queries.

25. Consider a Meridian Financial application that uses two-phase locking for transaction concurrency control. Transaction T_1 holds a shared lock on row R_1 and requests an exclusive lock on row R_2 . Simultaneously, T_2 holds a shared lock on R_2 and requests an exclusive lock on R_1 . Which phenomenon has occurred?

- A. Dirty Read — T_2 reads uncommitted data written by T_1 .
- B. Write Skew — two transactions read the same data and make inconsistent writes.
- C. Deadlock — each transaction waits for the other to release its lock, causing a cyclic dependency.
- D. Phantom Read — a transaction reads rows that were inserted by another concurrent transaction.

End of Examination

Please review your answers carefully before submitting. Ensure that:

- All 25 questions have been attempted.
- Your answer sheet bubbles are filled completely and clearly.
- Your name, date, and ID number are written legibly on both the question paper and answer sheet.

This space is intentionally left for rough work.