

CS Subject wise MCQ (Total 550)

- 1. Data Structure & Algorithm – 50**
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Data Structures & Algorithms – 50 MCQs

1. Which of the following is true about a stack?

- A) Follows FIFO order
- B) Follows LIFO order
- C) Follows random access order
- D) None of the above

Answer: B) Follows LIFO order

Explanation: Stack is a linear data structure that follows **Last In First Out (LIFO)** principle. The last element inserted is the first to be removed.

2. What is the worst-case time complexity of inserting an element at the beginning of a singly linked list?

- A) $O(1)$
- B) $O(n)$
- C) $O(\log n)$
- D) $O(n^2)$

Answer: A) $O(1)$

Explanation: In a singly linked list, inserting at the beginning just requires changing the head pointer to the new node, which takes constant time.

3. Which data structure is most suitable to implement recursion?

- A) Queue
- B) Stack
- C) Linked List
- D) Array

Answer: B) Stack

Explanation: Recursion uses the **call stack** internally. Each function call is pushed onto the stack and popped after execution.

**4. What is the time complexity of searching an element in a balanced binary search tree (BST)?

- A) $O(n)$
- B) $O(\log n)$
- C) $O(n \log n)$
- D) $O(1)$

Answer: B) $O(\log n)$

Explanation: In a balanced BST, each comparison reduces the search space by half. Hence, time complexity is logarithmic.

5. Which sorting algorithm is the fastest on average for large datasets?

- A) Bubble Sort
- B) Quick Sort
- C) Insertion Sort
- D) Selection Sort

Answer: B) Quick Sort

Explanation: Quick Sort has **average time complexity $O(n \log n)$** and is efficient for large datasets. Bubble, Insertion, and Selection have $O(n^2)$ average complexity.

6. What is the space complexity of Merge Sort?

- A) $O(1)$
- B) $O(n)$
- C) $O(\log n)$
- D) $O(n \log n)$

Answer: B) $O(n)$

Explanation: Merge sort requires an auxiliary array of size n to store merged elements. Hence, its space complexity is $O(n)$.

7. What is the maximum number of nodes at level l in a binary tree?

- A) 2^{l-1}
- B) l^2
- C) 2^l
- D) l

Answer: A) $2^{(l-1)}$

Explanation: In a binary tree, level numbering starts from 1 (root), and maximum nodes at level $l = 2^{(l-1)}$.

8. Which traversal of a binary tree results in nodes being visited in sorted order?

- A) Preorder
- B) Inorder
- C) Postorder
- D) Level-order

Answer: B) Inorder

Explanation: Inorder traversal of a BST visits nodes in ascending sorted order.

9. Which data structure is used in implementing a priority queue efficiently?

- A) Stack
- B) Heap
- C) Queue
- D) Linked List

Answer: B) Heap

Explanation: A heap (min-heap or max-heap) allows insertion and extraction of the highest/lowest priority element efficiently ($O(\log n)$).

10. The height of a complete binary tree with n nodes is:

- A) n
- B) $\log_2 n$
- C) $n/2$
- D) \sqrt{n}

Answer: B) $\log_2 n$

Explanation: Complete binary tree is balanced. Maximum height is proportional to $\log_2 n$.

11. Which algorithm is used to find the shortest path in a weighted graph?

- A) Prim's algorithm
- B) Dijkstra's algorithm
- C) Kruskal's algorithm
- D) DFS

Answer: B) Dijkstra's algorithm

Explanation: Dijkstra's algorithm finds the **shortest path** from a source vertex to all other vertices in a weighted graph.

12. In a graph, a cycle is detected using which technique efficiently?

- A) BFS
- B) DFS
- C) Topological Sort
- D) Both B & C

Answer: D) Both B & C

Explanation: DFS can detect cycles in a graph using recursion stack; **Topological Sort** fails if a cycle exists in a directed graph.

13. Which of the following is an in-place sorting algorithm?

- A) Merge Sort
- B) Quick Sort
- C) Radix Sort
- D) Counting Sort

Answer: B) Quick Sort

Explanation: Quick Sort swaps elements within the array itself, requiring only $O(\log n)$ extra space for recursion. Merge Sort requires $O(n)$ extra space.

14. Which data structure is ideal for implementing undo functionality in software?

- A) Queue
- B) Stack

- C) Linked List
- D) Array

Answer: B) Stack

Explanation: Undo stores operations in **LIFO order**; the last action is undone first, which suits a stack.

15. What is the worst-case time complexity of Linear Search?

- A) $O(1)$
- B) $O(\log n)$
- C) $O(n)$
- D) $O(n^2)$

Answer: C) $O(n)$

Explanation: Linear search may check all n elements if the target is at the end or not present.

16. Which of the following is a self-balancing binary search tree?

- A) BST
- B) AVL Tree
- C) Binary Heap
- D) Graph

Answer: B) AVL Tree

Explanation: AVL Tree automatically balances itself after insertions/deletions to maintain $O(\log n)$ height.

17. In a circular queue, if front = 3, rear = 7, and size = 10, what is the number of elements?

- A) 4
- B) 5
- C) 6
- D) 7

Answer: B) 5

Explanation: Number of elements in circular queue = $(\text{rear} - \text{front} + \text{size}) \% \text{size}$
 $+ 1 = (7 - 3 + 10) \% 10 + 1 = 5$.

18. Which algorithm is stable in sorting?

- A) Quick Sort
- B) Heap Sort
- C) Merge Sort
- D) Selection Sort

Answer: C) Merge Sort

Explanation: Merge Sort **preserves relative order of equal elements**, hence it is stable. Quick Sort and Heap Sort are not stable.

19. What is the time complexity of inserting an element in a max-heap?

- A) $O(1)$
- B) $O(\log n)$
- C) $O(n)$
- D) $O(n \log n)$

Answer: B) $O(\log n)$

Explanation: Insertion requires placing the element at the end and then **heapifying up**, which takes $O(\log n)$.

20. Which of the following is a non-linear data structure?

- A) Array
- B) Stack
- C) Graph
- D) Queue

Answer: C) Graph

Explanation: Graphs have nodes connected arbitrarily and do not form a linear sequence; arrays, stacks, and queues are linear.

21. In a hash table, which collision resolution technique uses linked lists?

- A) Open Addressing
- B) Chaining
- C) Linear Probing
- D) Quadratic Probing

Answer: B) Chaining

Explanation: Chaining stores multiple elements in a bucket using a linked list to resolve collisions.

22. In Quick Sort, which element is chosen as the pivot in the simplest form?

- A) First element
- B) Last element
- C) Random element
- D) Any of the above

Answer: D) Any of the above

Explanation: Pivot selection can be first, last, middle, or random. Choice affects efficiency but not correctness.

23. The adjacency matrix of a graph has size:

- A) $V \times E$
- B) $V \times V$
- C) $E \times E$
- D) $V + E$

Answer: B) $V \times V$

Explanation: For a graph with V vertices, adjacency matrix stores connectivity between each pair, hence size $V \times V$.

24. Which of the following is true about a doubly linked list?

- A) Each node contains data and one pointer
- B) Each node contains data and two pointers
- C) Insertion at the end is $O(n)$ always
- D) Cannot be traversed backward

Answer: B) Each node contains data and two pointers

Explanation: A doubly linked list node has pointers to both **previous** and **next** nodes, allowing forward and backward traversal.

25. Which of the following is the best data structure for implementing BFS?

- A) Stack
- B) Queue
- C) Heap
- D) Priority Queue

Answer: B) Queue

Explanation: BFS visits nodes **level by level**, so a FIFO queue is used to store nodes temporarily.

26. Which of the following is a divide-and-conquer algorithm?

- A) Insertion Sort
- B) Merge Sort
- C) Linear Search
- D) BFS

Answer: B) Merge Sort

Explanation: Merge Sort divides the array into halves, recursively sorts each half, and then merges them. This is the **divide-and-conquer** approach.

27. In a min-heap, the smallest element is located at:

- A) Root
- B) Left child of root
- C) Right child of root
- D) Any leaf

Answer: A) Root

Explanation: Min-heap property ensures that the root always contains the **minimum element**.

28. Which graph traversal algorithm uses a queue?

- A) DFS
- B) BFS
- C) Topological Sort
- D) Kruskal's Algorithm

Answer: B) BFS

Explanation: BFS (Breadth-First Search) explores nodes **level by level**, using a **FIFO queue** to store nodes.

29. In which case is Quick Sort's performance worst?

- A) Already sorted array
- B) Random array
- C) Reverse sorted array
- D) Both A & C

Answer: D) Both A & C

Explanation: Choosing first or last element as pivot in an **already sorted or reverse-sorted array** causes unbalanced partitions, leading to **O(n²)** time complexity.

30. Which of the following is true for circular linked list?

- A) Last node points to NULL
- B) Last node points to head
- C) Only one node can exist
- D) Cannot traverse in circular manner

Answer: B) Last node points to head

Explanation: In a circular linked list, the **last node points to the head**, allowing traversal to continue indefinitely.

31. What is the main advantage of a doubly linked list over a singly linked list?

- A) Uses less memory
- B) Allows backward traversal

- C) Faster insertion at head
- D) Simpler implementation

Answer: B) Allows backward traversal

Explanation: Doubly linked lists store a **previous pointer**, allowing traversal in both directions. Singly linked lists cannot traverse backward.

32. Which of the following is NOT a characteristic of a stack?

- A) Push operation
- B) Pop operation
- C) FIFO order
- D) Top element access

Answer: C) FIFO order

Explanation: Stack uses **LIFO order**, not FIFO. FIFO is used in queues.

33. In hashing, a good hash function should:

- A) Minimize collisions
- B) Maximize collisions
- C) Use sequential keys only
- D) Store only integer keys

Answer: A) Minimize collisions

Explanation: A **good hash function** distributes keys uniformly to minimize collisions, improving performance.

34. Which of the following is a non-comparison-based sorting algorithm?

- A) Quick Sort
- B) Merge Sort
- C) Counting Sort
- D) Bubble Sort

Answer: C) Counting Sort

Explanation: Counting Sort uses **key counts instead of comparisons**, making it non-comparison-based and $O(n + k)$ time complexity.

35. Which of the following operations is most costly in an array?

- A) Accessing an element
- B) Inserting at the end
- C) Inserting at the beginning
- D) Traversing the array

Answer: C) Inserting at the beginning

Explanation: Inserting at the beginning requires **shifting all elements** one position forward → $O(n)$ time. Accessing and appending at the end are $O(1)$.

36. The preorder traversal of a binary tree is:

- A) Left, Root, Right
- B) Root, Left, Right
- C) Left, Right, Root
- D) Root, Right, Left

Answer: B) Root, Left, Right

Explanation: Preorder visits **root first**, then recursively left and right subtrees.

37. Which of the following algorithms is greedy?

- A) Dijkstra's Algorithm
- B) BFS
- C) DFS
- D) Quick Sort

Answer: A) Dijkstra's Algorithm

Explanation: Dijkstra's algorithm **greedily picks the nearest unvisited vertex** to find shortest paths.

38. Which of the following is true about a complete binary tree?

- A) All levels fully filled
- B) All levels except last fully filled, and last filled left to right

- C) All levels half filled
- D) No structure

Answer: B) All levels except last fully filled, and last filled left to right

Explanation: Complete binary tree ensures **compact structure**; last level may not be fully filled but filled left to right.

39. What is the time complexity of searching in a sorted array using binary search?

- A) $O(n)$
- B) $O(\log n)$
- C) $O(n^2)$
- D) $O(1)$

Answer: B) $O(\log n)$

Explanation: Binary search repeatedly divides the search space in half \rightarrow logarithmic time complexity.

40. Which of the following represents a sparse graph?

- A) Number of edges $\approx V^2$
- B) Number of edges $\ll V^2$
- C) Number of edges $\approx V$
- D) Number of edges = 0

Answer: B) Number of edges $\ll V^2$

Explanation: Sparse graph has far fewer edges than maximum possible, i.e., $E \ll V^2$. Dense graph has edges $\approx V^2$.

41. Which of the following is used for dynamic memory allocation?

- A) Array
- B) Stack
- C) Heap
- D) Queue

Answer: C) Heap

Explanation: Heap allows **runtime allocation and deallocation**, unlike stack which has fixed memory scope.

42. What is the maximum number of edges in a simple undirected graph with n vertices?

- A) n
- B) $n(n-1)/2$
- C) n^2
- D) $2n$

Answer: B) $n(n-1)/2$

Explanation: Simple undirected graph has **no loops or multiple edges**, maximum edges = combination of n vertices taken 2 → $n(n-1)/2$.

43. Which data structure is suitable for implementing LRU cache?

- A) Array
- B) Stack
- C) Doubly Linked List + Hash Map
- D) Queue

Answer: C) Doubly Linked List + Hash Map

Explanation: Doubly linked list maintains order, hash map gives **O(1)** access → efficient LRU implementation.

44. In a graph, which algorithm finds the minimum spanning tree?

- A) Dijkstra
- B) Prim & Kruskal
- C) Bellman-Ford
- D) DFS

Answer: B) Prim & Kruskal

Explanation: Both **Prim's** and **Kruskal's** algorithms find MST efficiently. Dijkstra finds shortest path, not MST.

45. Which is better for searching when data is nearly sorted?

- A) Binary Search
- B) Interpolation Search
- C) Linear Search
- D) Hashing

Answer: B) Interpolation Search

Explanation: Interpolation search predicts likely position of target in **uniformly distributed sorted array**, faster than binary search if nearly sorted.

46. Which of the following is used for recursive tree traversal?

- A) Stack
- B) Queue
- C) Heap
- D) Graph

Answer: A) Stack

Explanation: Recursion implicitly uses **function call stack** for traversal.

47. Which of the following is true about a singly linked list?

- A) Requires two pointers per node
- B) Requires one pointer per node
- C) Allows backward traversal
- D) Cannot be used dynamically

Answer: B) Requires one pointer per node

Explanation: Each node stores **data and one pointer** to next node; cannot traverse backward.

48. Which sorting algorithm has best-case complexity $O(n)$?

- A) Quick Sort
- B) Merge Sort
- C) Insertion Sort
- D) Heap Sort

Answer: C) Insertion Sort

Explanation: Insertion Sort is **linear $O(n)$** if array is already sorted. Other sorts remain $O(n \log n)$ or worse.

49. In a circular linked list, deleting a node at the head requires:

- A) Traversing the list
- B) Updating head and tail pointers
- C) Only updating head pointer
- D) $O(1)$ operation always

Answer: B) Updating head and tail pointers

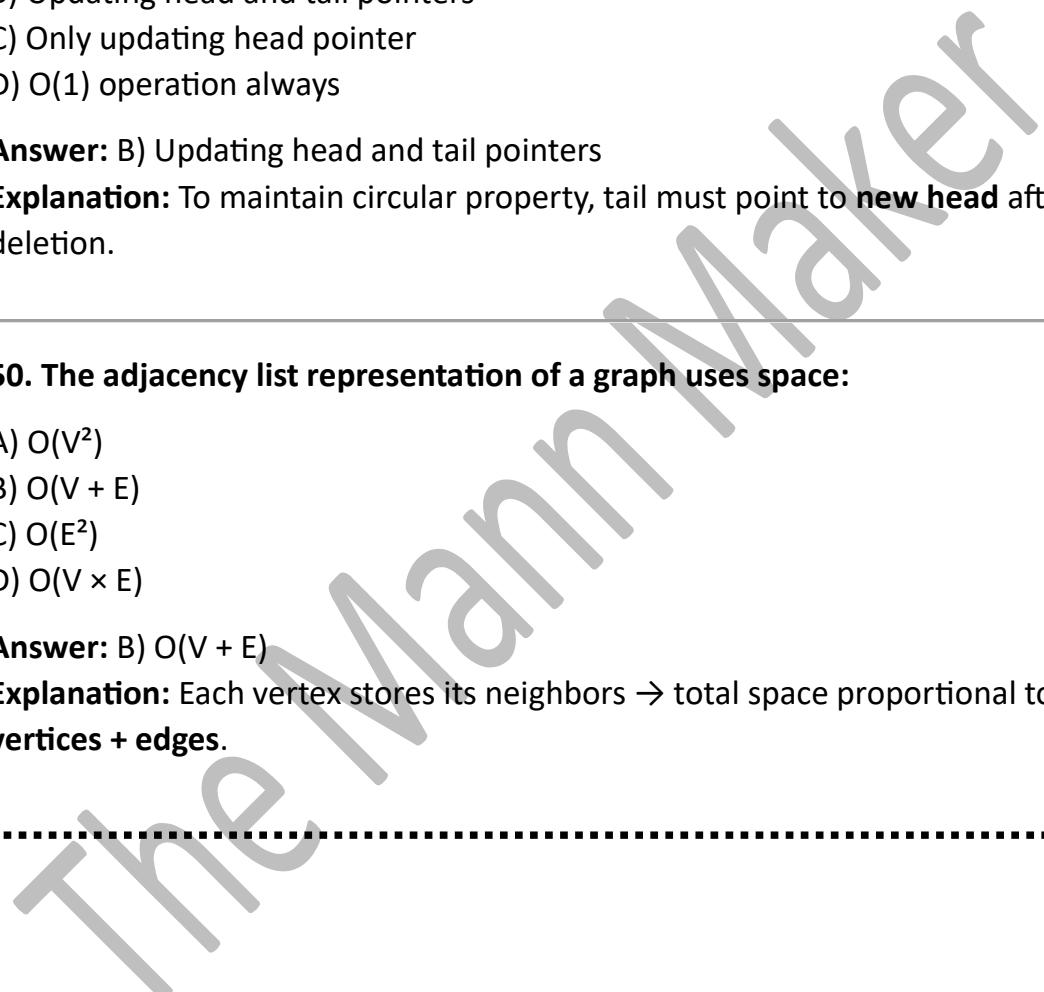
Explanation: To maintain circular property, tail must point to **new head** after deletion.

50. The adjacency list representation of a graph uses space:

- A) $O(V^2)$
- B) $O(V + E)$
- C) $O(E^2)$
- D) $O(V \times E)$

Answer: B) $O(V + E)$

Explanation: Each vertex stores its neighbors → total space proportional to **vertices + edges**.



Digital Electronics & Logic – 50 MCQs

1. What is the 2's complement of binary number 1011?

- A) 0101
- B) 1010
- C) $0101 + 1 = 0110$
- D) 1101

Answer: C) 0110

Explanation: 2's complement = invert all bits ($1011 \rightarrow 0100$) + 1 $\rightarrow 0101 + 1 = 0110$.

****2. Which logic gate produces HIGH output when any one or more inputs are HIGH?**

- A) AND
- B) OR
- C) XOR
- D) NAND

Answer: B) OR

Explanation: OR gate outputs 1 if **at least one input is 1**; outputs 0 only if all inputs are 0.

3. Which Boolean expression represents NAND gate in terms of AND and NOT?

- A) $A + B$
- B) $(A \cdot B)'$
- C) $A \cdot B$
- D) $A' + B'$

Answer: B) $(A \cdot B)'$

Explanation: NAND = NOT of AND; so output = (A AND B) complemented.

4. Which of the following is true about a JK flip-flop when J = K = 1?

- A) Set
- B) Reset
- C) Toggle
- D) No change

Answer: C) Toggle

Explanation: JK flip-flop **toggles output** when both inputs are 1 on clock pulse.

5. A multiplexer (MUX) is used for:

- A) Selecting one input from multiple inputs
- B) Generating pulses
- C) Storing data
- D) Performing addition

Answer: A) Selecting one input from multiple inputs

Explanation: MUX is a **combinational circuit** that selects one input line based on select lines.

6. The decimal number 45 in binary is:

- A) 101101
- B) 101110
- C) 110101
- D) 111001

Answer: A) 101101

Explanation: Convert 45 → binary: $45 \div 2 = 22$ rem 1, $22 \div 2 = 11$ rem 0, $11 \div 2 = 5$ rem 1, $5 \div 2 = 2$ rem 1, $2 \div 2 = 1$ rem 0, $1 \div 2 = 0$ rem 1 $\rightarrow 101101$.

7. Which of the following is a universal gate?

- A) AND
- B) OR
- C) NAND
- D) XOR

Answer: C) NAND

Explanation: NAND and NOR gates can be used to **implement any Boolean function**, hence called universal gates.

8. The output of XOR gate is HIGH when:

- A) Both inputs are 0
- B) Both inputs are 1
- C) Inputs are different
- D) Inputs are same

Answer: C) Inputs are different

Explanation: XOR outputs 1 when exactly **one input is 1**, i.e., inputs are different.

9. A D flip-flop is also called:

- A) Data flip-flop
- B) Toggle flip-flop
- C) JK flip-flop
- D) Reset flip-flop

Answer: A) Data flip-flop

Explanation: D flip-flop stores **data input at clock edge**, hence called data flip-flop.

10. In a 4-bit binary counter, maximum count is:

- A) 8
- B) 15
- C) 16
- D) 31

Answer: B) 15

Explanation: 4-bit binary $\rightarrow 2^4 = 16$ states (0 to 15), maximum count = 15.

11. Which of the following is a sequential circuit?

- A) AND gate
- B) OR gate
- C) Flip-flop
- D) XOR gate

Answer: C) Flip-flop

Explanation: Sequential circuits **depend on present input and past states**, e.g., flip-flops store memory.

12. Half adder has:

- A) 1 XOR, 1 AND
- B) 2 XOR, 1 AND
- C) 1 OR, 1 AND
- D) 2 AND, 1 OR

Answer: A) 1 XOR, 1 AND

Explanation: Half adder sum = XOR, carry = AND.

13. Full adder can be built using:

- A) 1 Half adder
- B) 2 Half adders + 1 OR gate
- C) 2 AND gates
- D) 2 XOR gates

Answer: B) 2 Half adders + 1 OR gate

Explanation: Full adder = sum of two half adders; carry outputs combined using OR gate.

14. Which of the following encoders converts 8 inputs into 3-bit output?

- A) 4-to-2
- B) 8-to-3
- C) 3-to-8
- D) 2-to-4

Answer: B) 8-to-3

Explanation: Encoder compresses 2^n inputs into n-bit output; 8-to-3 encoder:
8 inputs → 3-bit output.

15. In digital circuits, fan-out means:

- A) Voltage range
- B) Maximum input capacitance
- C) Maximum number of inputs a gate can drive
- D) Power consumption

Answer: C) Maximum number of inputs a gate can drive

Explanation: Fan-out = **number of standard inputs a gate can drive without voltage degradation.**

16. Which logic gate output is LOW only when all inputs are HIGH?

- A) AND
- B) OR
- C) NAND
- D) NOR

Answer: C) NAND

Explanation: NAND = NOT(AND); outputs LOW only when all inputs are HIGH.

17. Which counter counts in both directions?

- A) Synchronous counter
- B) Asynchronous counter
- C) Up/down counter
- D) Ring counter

Answer: C) Up/down counter

Explanation: Up/down counter can increment or decrement depending on control input.

18. A 3-bit Gray code sequence has how many distinct codes?

- A) 6
- B) 7
- C) 8
- D) 9

Answer: C) 8

Explanation: n-bit Gray code has 2^n distinct codes; 3-bit $\rightarrow 2^3 = 8$ codes.

19. The main advantage of synchronous counter over asynchronous counter is:

- A) Simplicity
- B) No timing issue
- C) Lower cost
- D) Uses fewer flip-flops

Answer: B) No timing issue

Explanation: Synchronous counters **change state simultaneously** on clock pulse \rightarrow avoids ripple delay in asynchronous counters.

20. Which flip-flop is considered memory element?

- A) SR flip-flop
- B) D flip-flop
- C) JK flip-flop
- D) All of the above

Answer: D) All of the above

Explanation: Flip-flops store **1-bit memory**, all types (SR, D, JK) serve as memory elements.

21. Which of the following is true for a priority encoder?

- A) Outputs multiple 1s for multiple inputs
- B) Outputs binary code of highest-priority input
- C) Outputs 0 if all inputs HIGH
- D) None of the above

Answer: B) Outputs binary code of highest-priority input

Explanation: Priority encoder assigns **binary code of input with highest priority**, even if multiple inputs are 1.

22. The time period of a clock signal is 10 ns. Its frequency is:

- A) 10 MHz
- B) 100 MHz
- C) 1 MHz
- D) 0.1 MHz

Answer: B) 100 MHz

Explanation: $f = 1/T = 1 / 10 \times 10^{-9} \text{ s} = 100 \times 10^6 \text{ Hz} = 100 \text{ MHz}$.

23. A digital-to-analog converter (DAC) converts:

- A) Digital signal → Analog signal
- B) Analog signal → Digital signal
- C) Binary → Hexadecimal
- D) Serial → Parallel

Answer: A) Digital signal → Analog signal

Explanation: DAC converts **binary input to proportional analog output voltage/current**.

24. A 4-to-1 multiplexer requires how many select lines?

- A) 1
- B) 2
- C) 3
- D) 4

Answer: B) 2

Explanation: 2^n inputs → n select lines; 4 inputs → 2 select lines.

25. Half subtractor outputs are:

- A) Difference & Borrow
- B) Sum & Carry
- C) Difference & Carry
- D) Sum & Borrow

Answer: A) Difference & Borrow

Explanation: Half subtractor: difference = XOR, borrow = AND(NOT A, B).

26. Which of the following is a combinational circuit?

- A) Flip-flop
- B) Counter
- C) Decoder
- D) Register

Answer: C) Decoder

Explanation: Combinational circuits output **depends only on current inputs**, e.g., decoder, multiplexer.

27. How many flip-flops are required for 8-state counter?

- A) 2
- B) 3
- C) 4
- D) 8

Answer: B) 3

Explanation: Number of flip-flops required = $\log_2(\text{states}) \rightarrow \log_2 8 = 3$.

28. Which circuit is used for data storage and transfer?

- A) Multiplexer
- B) Register
- C) Counter
- D) Decoder

Answer: B) Register

Explanation: Register is a **group of flip-flops** used for storing and shifting data.

29. A logic gate with truth table: 0 1 1 0 represents:

- A) AND
- B) OR
- C) XOR
- D) NAND

Answer: C) XOR

Explanation: XOR truth table: 0 1 1 0 → output HIGH when inputs differ.

30. How many minterms does a 3-variable Boolean function have?

- A) 3
- B) 6
- C) 7
- D) 8

Answer: D) 8

Explanation: Number of minterms = $2^n \rightarrow 2^3 = 8$.

31. Which type of flip-flop is edge-triggered?

- A) SR
- B) D
- C) JK
- D) All of the above

Answer: D) All of the above

Explanation: Flip-flops can be **edge-triggered** on rising/falling clock edges.

32. Karnaugh map is used for:

- A) Arithmetic operations
- B) Boolean simplification
- C) Storing data
- D) Multiplexing

Answer: B) Boolean simplification

Explanation: K-map is used to minimize Boolean expressions visually.

33. Which of the following is asynchronous sequential circuit?

- A) Flip-flop
- B) Counter
- C) SR latch
- D) Multiplexer

Answer: C) SR latch

Explanation: SR latch is asynchronous; output changes immediately when input changes, no clock required.

34. In a ring counter of n flip-flops, maximum count is:

- A) n
- B) n-1
- C) 2^n
- D) $2^n - 1$

Answer: A) n

Explanation: Ring counter cycles through n states → maximum count = n.

35. Which digital IC is used as a buffer?

- A) 7400
- B) 7407
- C) 7486
- D) 7410

Answer: B) 7407

Explanation: 7407 is hex buffer/driver IC.

36. Which code is self-complementing?

- A) Binary
- B) BCD

- C) 8421 code
- D) 2421 code

Answer: D) 2421 code

Explanation: In 2421 code, **1's complement = 9's complement**, easy for arithmetic operations.

37. Which type of counter can act as a frequency divider?

- A) Synchronous
- B) Asynchronous
- C) Both
- D) None

Answer: C) Both

Explanation: Any **binary counter** divides input clock frequency by 2^n at nth stage.

38. Which sequential circuit output depends only on present input?

- A) Flip-flop
- B) Register
- C) Latch
- D) Combinational circuit

Answer: D) Combinational circuit

Explanation: Combinational circuits **ignore past states**; output depends only on current inputs.

39. Which gate is called “controlled inverter”?

- A) AND
- B) OR
- C) XOR
- D) NAND

Answer: C) XOR

Explanation: XOR acts as **controlled inverter**: output = input when control = 0, inverted when control = 1.

40. The output of NOR gate is HIGH only when:

- A) Both inputs HIGH
- B) Both inputs LOW
- C) Any input HIGH
- D) Any input LOW

Answer: B) Both inputs LOW

Explanation: NOR = NOT(OR); output is 1 **only when all inputs are 0.**

41. What is the main purpose of ADC?

- A) Convert digital to analog
- B) Convert analog to digital
- C) Perform addition
- D) Perform subtraction

Answer: B) Convert analog to digital

Explanation: ADC converts **continuous analog signal** into **digital equivalent**.

42. 7-segment display decoder is an example of:

- A) Sequential circuit
- B) Combinational circuit
- C) Counter
- D) Register

Answer: B) Combinational circuit

Explanation: Output depends **only on input code**; no memory → combinational.

43. Which flip-flop has “no invalid state”?

- A) SR flip-flop
- B) JK flip-flop
- C) D flip-flop
- D) T flip-flop

Answer: B) JK flip-flop

Explanation: SR flip-flop has invalid state ($S=R=1$); JK flip-flop **eliminates invalid state by toggling**.

44. The decimal number 25.75 in binary is:

- A) 11001.11
- B) 11001.101
- C) 11001.1
- D) 11010.11

Answer: A) 11001.11

Explanation: 25 \rightarrow 11001, 0.75 \rightarrow 0.11 \rightarrow combine \rightarrow 11001.11.

45. What is the fan-in of a logic gate?

- A) Maximum inputs it can handle
- B) Maximum outputs it can drive
- C) Input voltage
- D) Output voltage

Answer: A) Maximum inputs it can handle

Explanation: Fan-in = **maximum number of inputs** a gate can accept.

46. Which sequential circuit requires clock signal for operation?

- A) Latch
- B) Flip-flop
- C) Decoder
- D) Multiplexer

Answer: B) Flip-flop

Explanation: Flip-flops are **clocked sequential circuits**, unlike asynchronous latches.

47. Which register shifts data in serial input/output?

- A) Parallel-in parallel-out
- B) Serial-in serial-out
- C) Parallel-in serial-out
- D) Serial-in parallel-out

Answer: B) Serial-in serial-out

Explanation: Data enters and exits one bit at a time → serial-in serial-out register.

48. Which counter is also called modulo-n counter?

- A) Binary counter
- B) Ring counter
- C) Asynchronous counter
- D) Up/down counter

Answer: A) Binary counter

Explanation: Binary counter cycles through n states → modulo-n counter.

49. Karnaugh map with 3 variables has how many cells?

- A) 4
- B) 6
- C) 8
- D) 16

Answer: C) 8

Explanation: 3 variables → $2^3 = 8$ minterms → 8 cells in K-map.

50. Which of the following is used to store temporary data during processing?

- A) Register
- B) Flip-flop
- C) Counter
- D) Decoder

Answer: A) Register

Explanation: Registers store intermediate results or data for immediate processing.

Operating System – 50 MCQs

1. What is the main function of an operating system?

- A) Execute applications
- B) Manage hardware and software resources
- C) Store files
- D) None of the above

Answer: B) Manage hardware and software resources

Explanation:

- An OS is a **system software**.
 - It **manages CPU, memory, I/O devices**.
 - Provides a **platform for applications** to run.
 - Handles **resource allocation, process scheduling, and protection**.
-

2. Which of the following is a type of operating system?

- A) Batch OS
- B) Time-sharing OS
- C) Real-time OS
- D) All of the above

Answer: D) All of the above

Explanation:

- **Batch OS:** Jobs collected and executed in batches; no interaction.
 - **Time-sharing OS:** Multiple users share CPU via time slices.
 - **Real-time OS:** Guarantees response within strict deadlines.
 - Modern OS can combine features of these types.
-

3. What is a process in OS?

- A) Program in execution
- B) CPU instruction
- C) File
- D) Hardware device

Answer: A) Program in execution

Explanation:

- **Process** = instance of a program being executed.
- Includes **program counter, stack, data section, and registers**.
- Can be **active (running) or waiting**.

4. Which of the following is a process state?

- A) New
- B) Ready
- C) Waiting
- D) All of the above

Answer: D) All of the above

Explanation:

- **New:** Process is created.
- **Ready:** Process waits in memory for CPU allocation.
- **Running:** Process currently executes on CPU.
- **Waiting (Blocked):** Process waits for I/O or event.
- **Terminated:** Process execution completed.

5. Which scheduling algorithm gives minimum average waiting time for a set of processes?

- A) FCFS
- B) SJF
- C) Round Robin
- D) Priority

Answer: B) SJF (Shortest Job First)

Explanation:

- **SJF** selects process with shortest burst time next.
 - Minimizes **average waiting time** in queue.
 - Can be **preemptive or non-preemptive**.
 - Limitation: Requires **knowledge of CPU burst in advance**.
-

6. Which scheduling algorithm is used in time-sharing systems?

- A) FCFS
- B) SJF
- C) Round Robin
- D) Priority

Answer: C) Round Robin (RR)

Explanation:

- **Round Robin** assigns **fixed time quantum** to each process.
 - Ensures **fair CPU sharing**.
 - Suitable for **interactive systems**.
 - Handles **multiple users efficiently**.
-

7. What is a context switch?

- A) Switching OS
- B) Switching CPU from one process to another
- C) Switching files
- D) Switching memory

Answer: B) Switching CPU from one process to another

Explanation:

- OS saves the **state of currently running process** (CPU registers, PC, stack pointer).

- Loads the **state of next ready process**.
 - Necessary for **multitasking and time-sharing**.
 - Introduces **overhead** called context-switch time.
-

8. What is a deadlock?

- A) CPU idle
- B) Two processes waiting indefinitely for each other
- C) High CPU utilization
- D) Low memory

Answer: B) Two processes waiting indefinitely

Explanation:

- Deadlock occurs when **each process holds resources and waits for others**.
 - **Necessary conditions:**
 1. Mutual exclusion
 2. Hold and wait
 3. No preemption
 4. Circular wait
 - OS can **avoid, prevent, detect, or recover** from deadlock.
-

9. Which technique is used for deadlock prevention?

- A) Mutual exclusion
- B) Hold and wait avoidance
- C) Circular wait enforcement
- D) Round Robin

Answer: B) Hold and wait avoidance

Explanation:

- OS prevents a process from **holding one resource while waiting for another**.

- Process must **request all resources at once**.
 - Ensures at least one deadlock condition (**hold and wait**) is avoided.
-

10. Which memory allocation technique divides memory into fixed-size partitions?

- A) Paging
- B) Segmentation
- C) Fixed partitioning
- D) Dynamic partitioning

Answer: C) Fixed partitioning

Explanation:

- Memory divided into **fixed-size blocks**.
 - Process assigned to a **partition large enough to fit**.
 - Simple but can cause **internal fragmentation**.
-

11. What is paging?

- A) Dividing memory into segments
- B) Dividing memory into fixed-size pages
- C) Swapping files
- D) Scheduling technique

Answer: B) Dividing memory into fixed-size pages

Explanation:

- Logical memory divided into **pages**.
 - Physical memory divided into **frames**.
 - Pages mapped to frames → **non-contiguous allocation**.
 - Eliminates **external fragmentation**.
-

12. What is virtual memory?

- A) Physical RAM
- B) Secondary storage as extension of main memory
- C) Cache memory
- D) Registers

Answer: B) Secondary storage as extension

Explanation:

- Allows **process to use more memory than physically available.**
 - OS swaps **pages between RAM and disk** (paging or segmentation).
 - Provides **process isolation and multitasking.**
-

13. What is thrashing in OS?

- A) CPU idle
- B) Excessive paging causing low CPU utilization
- C) Process waiting
- D) File corruption

Answer: B) Excessive paging

Explanation:

- Thrashing occurs when **system spends more time swapping pages than executing processes.**
 - Usually happens under **high degree of multiprogramming.**
 - Reduces **system throughput and performance.**
-

14. Which algorithm is used for page replacement in OS?

- A) FIFO
- B) LRU
- C) Optimal
- D) All of the above

Answer: D) All of the above

Explanation:

- **FIFO (First-In-First-Out)**: Replace oldest page.
 - **LRU (Least Recently Used)**: Replace page not used recently.
 - **Optimal**: Replace page that won't be used for longest time.
-

15. What is a semaphore?

- A) Process
- B) Hardware device
- C) Synchronization tool
- D) File system

Answer: C) Synchronization tool

Explanation:

- Semaphore is a **variable or abstract data type** for process synchronization.
 - Prevents **race conditions**.
 - Two types: **Binary (0/1)** and **Counting ($>=0$)**.
-

16. What is a race condition?

- A) Process uses CPU
- B) Two processes access shared resource simultaneously leading to incorrect results
- C) Memory failure
- D) Disk error

Answer: B) Simultaneous access leads to incorrect results

Explanation:

- Occurs when **outcome depends on order/timing** of processes.
 - Can be **prevented using semaphores, mutexes, and monitors**.
-

17. What is the difference between preemptive and non-preemptive scheduling?

Answer:

Preemptive Scheduling:

1. OS can **interrupt a running process** to assign CPU to higher-priority process.
2. Examples: **Round Robin, Priority (preemptive), SJF (preemptive)**.
3. Better response for interactive systems.

Non-preemptive Scheduling:

1. Process **runs to completion** once allocated CPU.
2. Examples: **FCFS, SJF (non-preemptive)**.
3. Simple but may cause **long waiting times** for short processes.

18. What is a critical section?

- A) Code segment for CPU
- B) Code segment accessing shared resources
- C) Memory area
- D) I/O operation

Answer: B) Code segment accessing shared resources

Explanation:

- **Critical section** = section of code **accessing shared variables/resources**.
- Only **one process should execute at a time** in critical section.
- Solved using **mutex, semaphore, or monitor**.

19. Which of the following is a blocking synchronization?

- A) Semaphore
- B) Mutex
- C) Spinlock
- D) Both A & B

Answer: D) Both A & B

Explanation:

- **Blocking synchronization:** process **waits if resource is unavailable.**
 - Mutex and Semaphore **block process until resource is free.**
 - Spinlock is **non-blocking;** CPU busy-waits.
-

20. Which OS component manages file system?

- A) Process management
- B) Memory management
- C) File manager
- D) Device driver

Answer: C) File manager

Explanation:

- Handles **creation, deletion, read/write, access control** of files.
 - Maintains **directory structure.**
 - Provides **security and protection** for files.
-

21. Which scheduling is better for real-time OS?

- A) FCFS
- B) Priority scheduling
- C) Round Robin
- D) SJF

Answer: B) Priority scheduling

Explanation:

- Real-time OS requires **tasks with deadlines** to be executed timely.
 - Priority scheduling allows **high-priority tasks first.**
 - Can be **preemptive or non-preemptive.**
-

22. What is the difference between internal and external fragmentation?

Answer:

Internal Fragmentation:

1. Memory block larger than process needs.
2. **Unused memory inside allocated block.**
3. Example: Fixed partitioning.

External Fragmentation:

1. Free memory scattered in small chunks.
 2. Cannot satisfy process request even if total free memory sufficient.
 3. Example: Dynamic partitioning.
-

23. What is the function of I/O scheduler?

- A) Allocate CPU
- B) Decide order of disk access
- C) Allocate memory
- D) Execute processes

Answer: B) Decide order of disk access

Explanation:

- I/O scheduler determines **sequence of disk read/write requests.**
 - Optimizes **throughput, seek time, and response time.**
 - Examples: **FCFS, SSTF, SCAN, C-SCAN.**
-

24. What is swapping in OS?

- A) Moving data from RAM to CPU
- B) Moving process from memory to disk and back
- C) Process execution
- D) Disk formatting

Answer: B) Moving process from memory to disk and back

Explanation:

- Allows **freeing memory** for other processes.
 - Helps **multitasking when physical memory limited**.
 - Introduces **swapping overhead**.
-

25. Which condition is NOT required for deadlock?

- A) Mutual exclusion
- B) Hold and wait
- C) Preemption
- D) Circular wait

Answer: C) Preemption

Explanation:

- Deadlock occurs when **mutual exclusion, hold and wait, no preemption, circular wait** exist.
- Preemption **allows OS to recover resources**, preventing deadlock.

26. What is a file descriptor in OS?

- A) Pointer to a file in memory
- B) Unique integer to identify open file
- C) File name
- D) File size

Answer: B) Unique integer to identify open file

Explanation:

- File descriptor = **integer handle** assigned by OS when file is opened.
 - Used to **read, write, or close the file**.
 - Standard descriptors: 0 → stdin, 1 → stdout, 2 → stderr.
-

27. What is demand paging?

- A) Load all pages at process start
- B) Load pages only when referenced

- C) Load pages sequentially
- D) Load pages randomly

Answer: B) Load pages only when referenced

Explanation:

- Reduces **memory usage** by loading only **needed pages**.
 - Unreferenced pages **remain on disk**.
 - Uses **page fault mechanism** to bring page into memory.
-

28. Which page replacement algorithm replaces the page that will not be used for the longest time in future?

- A) FIFO
- B) LRU
- C) Optimal
- D) Random

Answer: C) Optimal

Explanation:

- **Optimal algorithm** replaces page with **farthest future use**.
 - Provides **minimum page faults** theoretically.
 - Cannot be implemented in practice because **future knowledge is required**.
-

29. What is thrashing in virtual memory?

- A) Memory idle
- B) Excessive page swapping
- C) Deadlock
- D) CPU idle

Answer: B) Excessive page swapping

Explanation:

- Occurs when **high page fault rate** causes **system spends more time swapping than executing processes**.
 - Symptoms: **low CPU utilization, high disk activity**.
 - Solution: **reduce degree of multiprogramming, increase RAM**.
-

30. Which of the following is a non-preemptive scheduling algorithm?

- A) Round Robin
- B) FCFS
- C) Priority (preemptive)
- D) SJF (preemptive)

Answer: B) FCFS (First-Come, First-Served)

Explanation:

- Process runs **until completion** once CPU is allocated.
 - Simple to implement.
 - Can cause **convoy effect** → long processes delay short ones.
-

31. In which scheduling algorithm does a process with shortest remaining time execute next?

- A) FCFS
- B) SJF (Preemptive)
- C) Round Robin
- D) Priority

Answer: B) SJF (Preemptive)

Explanation:

- Also called **Shortest Remaining Time First (SRTF)**.
 - Preemptive: running process **interrupted if a shorter process arrives**.
 - Minimizes **average waiting time**.
-

32. What is the main function of the OS kernel?

- A) User interface
- B) Process & memory management
- C) Hardware management
- D) All of the above

Answer: D) All of the above

Explanation:

- Kernel = **core part of OS.**
- Manages **CPU scheduling, memory, I/O devices, file system.**
- Provides **interface for user applications.**

33. Which of the following is true for a multi-level queue scheduling?

- A) Processes divided into queues based on priority
- B) Each queue can have different scheduling
- C) No process migration between queues
- D) All of the above

Answer: D) All of the above

Explanation:

- Multi-level queue:
 1. **Queues based on process type** (system, interactive, batch).
 2. Each queue uses **different scheduling algorithm.**
 3. Usually, **no inter-queue migration** allowed.

34. Which of the following is true about preemptive priority scheduling?

- A) Lower priority can preempt higher priority
- B) Higher priority can preempt lower priority
- C) Process runs to completion
- D) Same as FCFS

Answer: B) Higher priority can preempt lower priority

Explanation:

- Preemptive: **running process can be interrupted** by higher priority process.
 - Ensures **critical tasks executed timely**.
 - Can cause **starvation for low-priority processes**.
-

35. What is the main purpose of swap space?

- A) Store permanent files
- B) Temporarily hold process pages
- C) Store device drivers
- D) Store cache

Answer: B) Temporarily hold process pages

Explanation:

- Swap space = **disk area used for paging/swapping**.
 - Frees up **RAM for active processes**.
 - Helps in **multitasking** when memory is limited.
-

36. Which of the following is true about LRU page replacement?

- A) Replace oldest loaded page
- B) Replace page least recently used
- C) Replace page never used
- D) Replace random page

Answer: B) Replace page least recently used

Explanation:

- LRU = **Least Recently Used** page replaced.
 - Approximates **optimal replacement**.
 - Can be implemented using **stack or counter per page**.
-

37. What is the purpose of the File Allocation Table (FAT)?

- A) CPU scheduling
- B) Memory allocation
- C) Track files in storage
- D) Synchronization

Answer: C) Track files in storage

Explanation:

- FAT keeps **mapping of files to disk blocks**.
- Helps OS locate **which blocks belong to a file**.
- Used in **FAT12, FAT16, FAT32 file systems**.

38. Which of the following describes a process control block (PCB)?

- A) Data about file
- B) Data about process
- C) Hardware info
- D) Scheduling info only

Answer: B) Data about process

Explanation:

- PCB contains:
 1. **Process ID**
 2. CPU registers & program counter
 3. Scheduling information
 4. Memory management info
 5. I/O status info
- Essential for **process management**.

39. Which I/O method allows CPU and I/O to work concurrently?

- A) Programmed I/O
- B) Interrupt-driven I/O

- C) DMA
- D) Polling

Answer: C) DMA (Direct Memory Access)

Explanation:

- DMA allows **I/O device to transfer data to/from memory directly.**
 - CPU **not involved in transfer**, can perform other tasks.
 - Reduces **CPU idle time and increases throughput.**
-

40. Which of the following is true about multithreading?

- A) Multiple processes
- B) Multiple threads within a process
- C) Single thread execution
- D) None of the above

Answer: B) Multiple threads within a process

Explanation:

- Threads share **code, data, and resources** of a process.
 - Each thread has **own program counter, stack, and registers.**
 - Improves **CPU utilization and responsiveness.**
-

41. Which of the following is a disadvantage of FCFS scheduling?

- A) Simple to implement
- B) Starvation of processes
- C) Convoy effect
- D) Preemptive

Answer: C) Convoy effect

Explanation:

- **Convoy effect:** small processes wait behind large ones.
- Leads to **high average waiting time.**

- FCFS is **non-preemptive**, so long jobs block CPU.
-

42. Which of the following is used to avoid race conditions?

- A) Semaphore
- B) Mutex
- C) Monitor
- D) All of the above

Answer: D) All of the above

Explanation:

- **Race condition:** concurrent access leads to inconsistent data.
 - **Synchronization tools:**
 1. **Semaphore:** signal mechanism.
 2. **Mutex:** mutual exclusion lock.
 3. **Monitor:** high-level abstraction for synchronization.
-

43. Which of the following is true for real-time OS?

- A) Response time is critical
- B) High throughput is critical
- C) Only batch jobs
- D) No multitasking

Answer: A) Response time is critical

Explanation:

- Real-time OS must **meet deadlines**.
 - Examples: **aircraft control, medical systems**.
 - Throughput may be secondary to **timely response**.
-

44. Which of the following is true about multilevel feedback queue scheduling?

- A) Allows processes to move between queues
- B) Uses same scheduling for all queues
- C) Prevents starvation
- D) Non-preemptive

Answer: A) Allows processes to move between queues

Explanation:

- Process can **move to higher/lower priority queue** based on behavior.
 - Improves **response time for interactive processes**.
 - Helps **prevent starvation** for low-priority jobs.
-

45. Which of the following is an advantage of virtual memory?

- A) Less memory utilization
- B) Process isolation
- C) Faster execution always
- D) No page faults

Answer: B) Process isolation

Explanation:

- Virtual memory allows **processes to have separate address spaces**.
 - Prevents **one process from accessing another's memory**.
 - Enables **multiprogramming**.
 - Can cause **page faults**, so not always faster.
-

46. What is a monitor in OS?

- A) Hardware device
- B) High-level synchronization construct
- C) CPU scheduler
- D) Disk manager

Answer: B) High-level synchronization construct

Explanation:

- Monitor = **data structure + procedures + synchronization.**
 - Only **one process executes monitor at a time.**
 - Provides **mutual exclusion** automatically.
-

47. Which of the following scheduling algorithms is starvation-prone?

- A) FCFS
- B) Round Robin
- C) Priority scheduling
- D) SJF

Answer: C) Priority scheduling

Explanation:

- Low-priority processes may **never get CPU** if high-priority processes keep arriving.
 - Solution: **aging** → gradually increase priority of waiting processes.
-

48. Which method is used for interprocess communication (IPC)?

- A) Shared memory
- B) Message passing
- C) Pipes
- D) All of the above

Answer: D) All of the above

Explanation:

- IPC allows processes to **exchange data**.
 - Methods:
 1. **Shared memory:** common memory region.
 2. **Message passing:** send/receive messages.
 3. **Pipes:** unidirectional communication channel.
-

49. Which of the following is a disadvantage of polling?

- A) CPU idle
- B) Wastes CPU cycles
- C) Faster than interrupts
- D) None

Answer: B) Wastes CPU cycles

Explanation:

- Polling: CPU **continuously checks device status.**
- Wastes **CPU time** when device not ready.
- Interrupt-driven I/O is **more efficient.**

50. What is a zombie process?

- A) Process running forever
- B) Process waiting for I/O
- C) Process terminated but PCB not cleared
- D) Process in memory swap

Answer: C) Process terminated but PCB not cleared

Explanation:

- Child process completes execution, but **parent has not read exit status.**
- PCB remains → called **zombie.**
- Cleared after **parent calls wait().**

Computer Networking – 50 MCQs

1. What is the main function of a network?

- A) Execute programs
- B) Share resources and information
- C) Store data only
- D) Process images

Answer: B) Share resources and information

Explanation:

- Networks **connect multiple devices** to communicate.
 - Enable **sharing of files, printers, and Internet**.
 - Provide **centralized data management and security**.
-

2. Which topology has a central hub and all nodes connected to it?

- A) Bus
- B) Ring
- C) Star
- D) Mesh

Answer: C) Star

Explanation:

- **Star topology:** central hub/switch connects all nodes.
 - Advantages: easy to **add/remove nodes**, failure in one link does not affect others.
 - Disadvantage: **hub failure affects all nodes**.
-

3. Which of the following is a physical layer device?

- A) Switch
- B) Hub
- C) Router
- D) Firewall

Answer: B) Hub

Explanation:

- Hub works at **Layer 1 (Physical layer)**.
 - **Repeats incoming signals** to all ports.
 - Does not **filter or route traffic** like switch or router.
-

4. What is the main purpose of a router?

- A) Connect multiple LANs
- B) Amplify signals
- C) Store files
- D) Block viruses

Answer: A) Connect multiple LANs

Explanation:

- Router operates at **Network layer (Layer 3)**.
 - Routes packets between **different networks**.
 - Determines **best path using IP addresses**.
-

5. Which layer of OSI model provides end-to-end delivery?

- A) Physical
- B) Data Link
- C) Transport
- D) Application

Answer: C) Transport

Explanation:

- Transport layer ensures **reliable data delivery**.
 - Uses **TCP for connection-oriented communication**.
 - Provides **error detection, flow control, segmentation**.
-

6. Which protocol is used for email sending?

- A) HTTP
- B) SMTP
- C) FTP
- D) DNS

Answer: B) SMTP (Simple Mail Transfer Protocol)

Explanation:

- SMTP sends emails from **client to server or server-to-server**.
 - Works over **TCP port 25**.
 - For receiving emails: **POP3 or IMAP**.
-

7. Which protocol provides reliable, connection-oriented service?

- A) UDP
- B) TCP
- C) IP
- D) ICMP

Answer: B) TCP (Transmission Control Protocol)

Explanation:

- TCP ensures **delivery of all packets in order**.
 - Uses **acknowledgments, retransmissions, flow control**.
 - UDP is **connectionless, unreliable**, used for streaming.
-

8. What is an IP address?

- A) Physical address of NIC
- B) Logical address assigned to device
- C) MAC address
- D) Hostname

Answer: B) Logical address assigned to device

Explanation:

- IP address identifies device **in a network**.
 - IPv4: 32-bit, IPv6: 128-bit.
 - Logical, can be **changed or assigned dynamically (DHCP)**.
-

9. Which protocol resolves domain names to IP addresses?

- A) HTTP
- B) FTP
- C) DNS
- D) SMTP

Answer: C) DNS (Domain Name System)

Explanation:

- Converts **human-readable domain** (example.com) to **IP address**.
 - Uses **hierarchical distributed database**.
 - Critical for **Internet communication**.
-

10. What is the function of ARP?

- A) Map IP to MAC address
- B) Encrypt data
- C) Route packets
- D) Resolve domain name

Answer: A) Map IP to MAC address

Explanation:

- ARP = **Address Resolution Protocol**.
 - Resolves **Layer 3 IP addresses to Layer 2 MAC addresses**.
 - Used in **local network communication**.
-

11. Which protocol is used for secure communication over the Internet?

- A) HTTP
- B) HTTPS
- C) FTP
- D) Telnet

Answer: B) HTTPS

Explanation:

- HTTPS = **HTTP over SSL/TLS**.
- Encrypts data to ensure **confidentiality and integrity**.
- Uses **port 443**.

12. What is the main difference between TCP and UDP?

Answer:

TCP (Transmission Control Protocol):

1. Connection-oriented
2. Reliable delivery
3. Packet ordering
4. Error checking & correction

UDP (User Datagram Protocol):

1. Connectionless
2. Unreliable delivery
3. No packet ordering
4. Faster, used in **streaming, VoIP**

13. What is the subnet mask for a Class C IP address by default?

- A) 255.0.0.0
- B) 255.255.0.0
- C) 255.255.255.0
- D) 255.255.255.255

Answer: C) 255.255.255.0

Explanation:

- Class C IP: **192.0.0.0 – 223.255.255.255**
 - Default subnet mask = **first 24 bits network, last 8 bits host.**
-

14. Which device operates at both Layer 2 and Layer 3?

- A) Hub
- B) Switch
- C) Layer 3 Switch
- D) Repeater

Answer: C) Layer 3 Switch

Explanation:

- Performs **switching (MAC-based)** at Layer 2.
 - Performs **routing (IP-based)** at Layer 3.
 - Ideal for large enterprise networks.
-

15. What is the purpose of ICMP?

- A) Error reporting & diagnostics
- B) File transfer
- C) Email sending
- D) Encrypting packets

Answer: A) Error reporting & diagnostics

Explanation:

- ICMP = **Internet Control Message Protocol.**
 - Used for **ping, traceroute.**
 - Reports errors like **destination unreachable.**
-

16. Which of the following is true about IPv6?

- A) 32-bit address
- B) Supports 4.3 billion addresses
- C) 128-bit address, hierarchical addressing
- D) No built-in security

Answer: C) 128-bit address, hierarchical addressing

Explanation:

- IPv6 = 128-bit, provides **enormous address space**.
- Hierarchical addressing reduces **routing table size**.
- Built-in support for **IPSec security**.

17. What is the purpose of DHCP?

- A) Assign static IPs
- B) Assign dynamic IPs automatically
- C) Map IP to MAC
- D) Encrypt network data

Answer: B) Assign dynamic IPs automatically

Explanation:

- DHCP = **Dynamic Host Configuration Protocol**
- Assigns **IP address, subnet mask, default gateway** automatically.
- Reduces **manual configuration** errors.

18. What is a VPN?

- A) Public network
- B) Secure private network over Internet
- C) File transfer protocol
- D) Virus protection

Answer: B) Secure private network over Internet

Explanation:

- VPN = **Virtual Private Network**.

- Uses **encryption and tunneling** to connect remote users securely.
 - Protects **data confidentiality over public networks**.
-

19. What is collision domain?

- A) Area with data collision possibility in network
- B) Area with no data transfer
- C) Device memory area
- D) None

Answer: A) Area with data collision possibility

Explanation:

- Collision domain = set of devices where **simultaneous transmission can collide**.
 - Switches reduce collision domain (each port = 1 domain).
 - Hubs **extend collision domain**.
-

20. What is broadcast domain?

- A) Devices that share same IP subnet
- B) Devices sharing CPU
- C) Devices sharing memory
- D) None

Answer: A) Devices that share same IP subnet

Explanation:

- Broadcast domain = group of devices **that receive broadcast frames**.
 - Routers **divide broadcast domains**.
 - Switches do not by default.
-

21. Which of the following is a transport layer protocol?

- A) IP
- B) TCP

- C) ARP
- D) HTTP

Answer: B) TCP

Explanation:

- Transport layer provides **end-to-end communication**.
 - Protocols: **TCP (reliable), UDP (unreliable)**.
 - IP = Network layer, HTTP = Application layer.
-

22. Which layer handles MAC addressing?

- A) Physical
- B) Data Link
- C) Network
- D) Transport

Answer: B) Data Link

Explanation:

- MAC = **unique hardware address** of NIC.
 - Data link layer handles **framing, error detection** using MAC addresses.
 - Example: Ethernet frames.
-

23. What is the main advantage of star topology over bus topology?

- A) Less cabling
- B) Failure of one link does not affect others
- C) Easy to expand
- D) Both B & C

Answer: D) Both B & C

Explanation:

- Star topology uses **central hub/switch**.
- Single link failure **does not affect network**.

- Adding/removing devices is **simple**.
-

24. Which protocol is used to transfer files?

- A) FTP
- B) SMTP
- C) HTTP
- D) DNS

Answer: A) FTP (File Transfer Protocol)

Explanation:

- FTP transfers files **between client and server**.
 - Uses **port 21**.
 - Supports **authentication and directory management**.
-

25. Which of the following is true about UDP?

- A) Reliable
- B) Connectionless
- C) Ordered delivery
- D) Error correction

Answer: B) Connectionless

Explanation:

- UDP is **lightweight, fast, connectionless**.
 - No guarantees for **delivery, order, or error correction**.
 - Suitable for **streaming, VoIP, DNS queries**.
-

26. Which protocol is used to translate IP addresses to MAC addresses?

- A) DNS
- B) ARP

- C) DHCP
- D) ICMP

Answer: B) ARP (Address Resolution Protocol)

Explanation:

- ARP resolves **Layer 3 IP addresses to Layer 2 MAC addresses.**
 - Used for **local area network communication.**
 - Essential for **Ethernet networks.**
-

27. Which protocol is used to resolve MAC addresses from IP addresses in IPv6?

- A) ARP
- B) NDP
- C) DHCPv6
- D) ICMPv6

Answer: B) NDP (Neighbor Discovery Protocol)

Explanation:

- IPv6 replaces ARP with **NDP.**
 - Uses **ICMPv6 messages** to discover MAC addresses.
 - Helps with **address resolution and router discovery.**
-

28. Which layer of OSI handles encryption and compression?

- A) Physical
- B) Data Link
- C) Presentation
- D) Session

Answer: C) Presentation

Explanation:

- Presentation layer ensures **data is in proper format.**
- Handles **encryption, decryption, compression, translation.**

- Acts as translator between application and network.
-

29. Which layer establishes, manages, and terminates connections between applications?

- A) Transport
- B) Session
- C) Network
- D) Application

Answer: B) Session

Explanation:

- Session layer manages **dialog control** between applications.
 - Functions:
 1. Establish session
 2. Maintain session
 3. Terminate session
 - Example: **RPC, NetBIOS sessions.**
-

30. Which device divides a network into multiple collision domains but one broadcast domain?

- A) Hub
- B) Switch
- C) Router
- D) Repeater

Answer: B) Switch

Explanation:

- Each port on a switch is **a separate collision domain.**
- Switch **forwards broadcast frames to all ports**, so one broadcast domain.
- Reduces **collisions, improves efficiency.**

31. What is the main difference between a hub and a switch?

Answer:

Hub:

- Layer 1 device
- **Broadcasts all incoming data** to every port
- Leads to **collisions**

Switch:

- Layer 2 device (MAC-based)
 - **Forwards data to intended port only**
 - Reduces **collision domains**
 - More efficient than hub
-

32. Which layer ensures error-free transfer of data frames over a physical link?

- A) Transport
- B) Network
- C) Data Link
- D) Application

Answer: C) Data Link

Explanation:

- Data link layer adds **frame headers and trailers**.
 - Performs **error detection (CRC)** and retransmission.
 - Divides network into **frames** for reliable link-level delivery.
-

33. Which protocol provides error reporting in IP networks?

- A) TCP
- B) ICMP

- C) UDP
- D) HTTP

Answer: B) ICMP

Explanation:

- ICMP = Internet Control Message Protocol
 - Sends **messages like host unreachable, TTL exceeded**
 - Works with IP to **report network errors**
-

34. What is the maximum length of a Cat5e cable segment?

- A) 50 meters
- B) 100 meters
- C) 500 meters
- D) 1000 meters

Answer: B) 100 meters

Explanation:

- Cat5e supports **up to 100 meters (328 ft)** per segment.
 - Speeds: **1 Gbps at 100 meters.**
 - Longer lengths require **repeaters or switches.**
-

35. Which wireless standard supports 5 GHz frequency band?

- A) 802.11b
- B) 802.11g
- C) 802.11n
- D) 802.11a

Answer: D) 802.11a

Explanation:

- 802.11a operates at **5 GHz**, max speed 54 Mbps.
- 802.11b/g: 2.4 GHz

- 802.11n: dual-band (2.4 & 5 GHz)
-

36. Which layer is responsible for logical addressing in a network?

- A) Physical
- B) Data Link
- C) Network
- D) Transport

Answer: C) Network

Explanation:

- Network layer assigns **logical addresses (IP addresses)**
 - Routes packets across **different networks**
 - Examples: IP, ICMP, IGMP
-

37. What is the function of a firewall?

- A) Route packets
- B) Block unauthorized access
- C) Encrypt data
- D) Assign IP addresses

Answer: B) Block unauthorized access

Explanation:

- Firewall monitors and **controls incoming/outgoing traffic**
 - Enforces **security policies**
 - Types: **Hardware firewall, software firewall**
-

38. Which of the following is a connectionless protocol?

- A) TCP
- B) UDP
- C) FTP
- D) SMTP

Answer: B) UDP

Explanation:

- UDP transmits data **without establishing connection**
 - No acknowledgment or retransmission
 - Suitable for **streaming, VoIP, gaming**
-

39. Which of the following is true about TCP/IP model?

- A) Has 7 layers like OSI
- B) Has 4 layers
- C) No transport layer
- D) No network layer

Answer: B) Has 4 layers

Explanation:

- TCP/IP model layers:
 1. Application
 2. Transport
 3. Internet
 4. Network Access
 - Simplified compared to **7-layer OSI model**
-

40. What is the main difference between IPv4 and IPv6?

Answer:

IPv4:

- 32-bit address, 4.3 billion addresses
- Written in **dotted decimal**
- Header smaller, simpler

IPv6:

- 128-bit address, massive address space
 - Written in **hexadecimal**
 - Built-in security (IPSec), auto-configuration
-

41. Which topology provides maximum redundancy?

- A) Bus
- B) Ring
- C) Star
- D) Mesh

Answer: D) Mesh

Explanation:

- Mesh topology: **every node connected to every other node**
 - Failure of one link **does not disrupt network**
 - High reliability but **expensive and complex**
-

42. What is the main purpose of NAT?

- A) Translate MAC addresses
- B) Translate private IP to public IP
- C) Assign domain names
- D) Encrypt traffic

Answer: B) Translate private IP to public IP

Explanation:

- NAT = Network Address Translation
 - Allows **multiple devices in private network to access Internet**
 - Conserves **public IP addresses**
-

43. Which of the following is an advantage of UDP?

- A) Reliable delivery
- B) Low latency
- C) Congestion control
- D) Connection-oriented

Answer: B) Low latency

Explanation:

- UDP is **faster, connectionless**
- No handshaking or acknowledgment
- Ideal for **real-time applications**

44. What is the function of a proxy server?

- A) Forward requests to other servers
- B) Cache content
- C) Filter requests
- D) All of the above

Answer: D) All of the above

Explanation:

- Proxy server acts as **intermediary between client and Internet**
- Improves **performance (caching)**
- Provides **security, filtering, and anonymity**

45. Which protocol is used for secure file transfer?

- A) FTP
- B) SFTP
- C) HTTP
- D) SMTP

Answer: B) SFTP (Secure File Transfer Protocol)

Explanation:

- SFTP uses **SSH for encryption**

- Provides **confidentiality and integrity**
 - Preferred over FTP for **secure transfers**
-

46. What is the maximum transmission unit (MTU)?

- A) Minimum packet size
- B) Maximum packet size that can be transmitted
- C) Maximum network speed
- D) Minimum network speed

Answer: B) Maximum packet size

Explanation:

- MTU = **largest data unit** transmitted in a single frame
 - Ethernet MTU = **1500 bytes**
 - Helps avoid **fragmentation**
-

47. Which protocol resolves hostnames to IP addresses on the Internet?

- A) FTP
- B) HTTP
- C) DNS
- D) ARP

Answer: C) DNS

Explanation:

- DNS = Domain Name System
 - Converts **human-friendly domain to IP address**
 - Hierarchical and distributed for **scalability**
-

48. Which device connects two different networks with different protocols?

- A) Switch
- B) Hub

- C) Gateway
- D) Repeater

Answer: C) Gateway

Explanation:

- Gateway translates **data between networks with different protocols**
 - Operates at **application layer**
 - Example: connecting corporate LAN to Internet
-

49. What is the main purpose of SSL/TLS?

- A) File transfer
- B) Encrypt data for secure communication
- C) Assign IP addresses
- D) Route packets

Answer: B) Encrypt data for secure communication

Explanation:

- SSL/TLS encrypts **data transmitted over network**
 - Ensures **confidentiality, integrity, authentication**
 - Used in **HTTPS, email encryption**
-

50. Which layer in OSI model is responsible for establishing logical connections between devices?

- A) Physical
- B) Data Link
- C) Network
- D) Transport

Answer: D) Transport

Explanation:

- Transport layer provides **end-to-end communication**
- Ensures **reliable delivery using TCP**

- Segments data and performs **error detection, flow control**
-
-

DBMS – 50 MCQs

1. What is a database?

- A) Collection of programs
- B) Collection of related data
- C) Collection of computers
- D) Collection of networks

Answer: B) Collection of related data

Explanation:

- Database = **organized collection of related information.**
 - Stored for **easy retrieval and management.**
 - Supports **data integrity, security, and concurrency.**
-

2. Which of the following is a DBMS?

- A) MySQL
- B) Oracle
- C) Microsoft SQL Server
- D) All of the above

Answer: D) All of the above

Explanation:

- DBMS = software to **store, retrieve, and manage data.**
- Examples: **MySQL, Oracle, SQL Server, PostgreSQL.**
- Provides **data abstraction and manipulation facilities.**

3. What is a primary key?

- A) Column that stores null values
- B) Column that uniquely identifies a row
- C) Column that stores foreign data
- D) Column with duplicate values

Answer: B) Column that uniquely identifies a row

Explanation:

- Ensures **uniqueness of each record**.
 - Cannot contain **NULL values**.
 - Example: Student_ID in student table.
-

4. Which key establishes relationship between tables?

- A) Primary key
- B) Foreign key
- C) Candidate key
- D) Alternate key

Answer: B) Foreign key

Explanation:

- Foreign key = column in **child table** referencing **primary key of parent table**.
 - Maintains **referential integrity**.
 - Example: Student_ID in Enrollment table referencing Student table.
-

5. Which of the following is an advantage of DBMS?

- A) Data redundancy
- B) Data consistency
- C) Data isolation
- D) Inconsistency

Answer: B) Data consistency

Explanation:

- DBMS **reduces redundancy** by storing data centrally.
 - Ensures **consistency and integrity** using constraints.
 - Provides **backup, security, concurrency control**.
-

6. What is normalization?

- A) Process to store duplicates
- B) Process to remove redundancy
- C) Process to encrypt data
- D) Process to create indexes

Answer: B) Process to remove redundancy

Explanation:

- Normalization organizes data into **tables**.
 - Eliminates **duplicate data** and improves **data integrity**.
 - Forms: **1NF, 2NF, 3NF, BCNF**.
-

7. What is denormalization?

- A) Adding redundancy to improve performance
- B) Removing redundancy
- C) Encrypting database
- D) Creating views

Answer: A) Adding redundancy to improve performance

Explanation:

- Denormalization **combines tables** for faster queries.
 - Redundant data may exist.
 - Trade-off between **speed and storage efficiency**.
-

8. Which SQL command is used to retrieve data?

- A) INSERT
- B) UPDATE
- C) DELETE
- D) SELECT

Answer: D) SELECT

Explanation:

- SELECT queries **data from one or more tables.**
 - Supports **WHERE, JOIN, GROUP BY, ORDER BY clauses.**
 - Read-only operation unless combined with **modifying queries.**
-

9. What is the difference between DELETE and TRUNCATE?

Answer:

DELETE:

- Removes **specific rows** using WHERE clause.
- **Transaction log** maintained → can be rolled back.
- Slower for large tables.

TRUNCATE:

- Removes **all rows** in table.
 - Faster, minimal logging.
 - Cannot use WHERE clause.
-

10. What is an index in DBMS?

- A) Column in table
- B) Structure to improve search speed
- C) Database schema
- D) Backup file

Answer: B) Structure to improve search speed

Explanation:

- Index = **data structure (B-Tree, Hash)**
 - Improves **query performance** by reducing table scan.
 - Trade-off: **extra storage and update overhead.**
-

11. Which of the following is a type of relationship in DBMS?

- A) One-to-One
- B) One-to-Many
- C) Many-to-Many
- D) All of the above

Answer: D) All of the above

Explanation:

- **One-to-One:** one row in table A → one row in table B
 - **One-to-Many:** one row in table A → multiple rows in table B
 - **Many-to-Many:** multiple rows in table A → multiple rows in table B
(needs **junction table**)
-

12. What is a candidate key?

- A) Column that can uniquely identify a record
- B) Column used for foreign reference
- C) Column with duplicate values
- D) Column used only for indexing

Answer: A) Column that can uniquely identify a record

Explanation:

- Candidate key = **set of attributes** that can serve as primary key.
 - One candidate key is chosen as **primary key**, others are **alternate keys**.
-

13. Which normal form removes partial dependency?

- A) 1NF
- B) 2NF
- C) 3NF
- D) BCNF

Answer: B) 2NF

Explanation:

- 2NF requires table in **1NF** and no **partial dependency**
 - Partial dependency = **non-prime attribute depends on part of composite key**
 - Improves **data integrity**
-

14. Which normal form removes transitive dependency?

- A) 1NF
- B) 2NF
- C) 3NF
- D) BCNF

Answer: C) 3NF

Explanation:

- 3NF requires table in **2NF** and no **transitive dependency**
 - Non-key attributes should depend **only on primary key**
-

15. Which SQL clause is used to filter rows?

- A) FROM
- B) WHERE
- C) GROUP BY
- D) ORDER BY

Answer: B) WHERE

Explanation:

- WHERE filters **rows satisfying condition**

- Syntax: SELECT * FROM table WHERE condition
 - Can use =, <, >, IN, BETWEEN, LIKE
-

16. Which SQL clause is used to group rows?

- A) FROM
- B) WHERE
- C) GROUP BY
- D) ORDER BY

Answer: C) GROUP BY

Explanation:

- GROUP BY groups rows with **same column values**
 - Often used with **aggregate functions**: SUM, COUNT, AVG, MAX, MIN
-

17. What is a view in DBMS?

- A) Permanent table
- B) Virtual table derived from query
- C) Physical backup
- D) Index

Answer: B) Virtual table derived from query

Explanation:

- View = **result of SELECT query**
 - Acts like a **table but does not store data physically**
 - Can **simplify complex queries, enforce security**
-

18. What is a transaction in DBMS?

- A) Query execution
- B) Sequence of operations on database treated as single unit
- C) Backup operation
- D) File operation

Answer: B) Sequence of operations on database

Explanation:

- Transaction = **atomic unit of work**
- Must satisfy **ACID properties**:
 1. **Atomicity** – all or nothing
 2. **Consistency** – preserves database rules
 3. **Isolation** – concurrent transactions do not interfere
 4. **Durability** – changes persist after commit

19. What is the difference between COMMIT and ROLLBACK?

Answer:

COMMIT:

- Makes **all changes permanent**
- Ends transaction
- Ensures **durability**

ROLLBACK:

- **Undoes all changes** since last commit
- Maintains **atomicity and consistency**

20. Which of the following is a concurrency control technique?

- A) Locking
- B) Timestamps
- C) Optimistic control
- D) All of the above

Answer: D) All of the above

Explanation:

- Ensures **simultaneous transactions do not conflict**

- Techniques:
 1. **Locking:** prevents concurrent access
 2. **Timestamp ordering:** schedules transactions based on time
 3. **Optimistic control:** assumes no conflict, validates before commit
-

21. What is a stored procedure?

- A) SQL query executed once
- B) Precompiled SQL code stored in database
- C) Backup command
- D) Table creation command

Answer: B) Precompiled SQL code

Explanation:

- Stored procedure = **predefined SQL operations**
 - Improves **performance and security**
 - Can accept **parameters and return results**
-

22. What is a trigger in DBMS?

- A) Automatic response to table event
- B) Backup script
- C) Index creation
- D) Data type

Answer: A) Automatic response

Explanation:

- Trigger executes **automatically when INSERT, UPDATE, DELETE occurs**
 - Used for **enforcing rules, logging, auditing**
-

23. Which type of join returns all rows from both tables?

- A) INNER JOIN
- B) LEFT JOIN
- C) RIGHT JOIN
- D) FULL OUTER JOIN

Answer: D) FULL OUTER JOIN

Explanation:

- Returns **all rows** from both tables
- Missing matches filled with **NULL**
- Useful for **complete dataset merging**

24. Which SQL command is used to modify table structure?

- A) ALTER TABLE
- B) UPDATE
- C) INSERT
- D) DROP TABLE

Answer: A) ALTER TABLE

Explanation:

- ALTER TABLE allows:
 1. Add/modify/drop columns
 2. Add/drop constraints
- Does not affect table data unless column dropped

25. Which isolation level allows maximum concurrency but can lead to dirty reads?

- A) READ UNCOMMITTED
- B) READ COMMITTED
- C) REPEATABLE READ
- D) SERIALIZABLE

Answer: A) READ UNCOMMITTED

Explanation:

- Allows transactions to **read uncommitted changes of others**
- High concurrency
- May cause **dirty reads**

26. Which SQL keyword is used to remove a table and all its data?

- A) DELETE
- B) TRUNCATE
- C) DROP
- D) REMOVE

Answer: C) DROP

Explanation:

- DROP TABLE **deletes table structure and data permanently**
- Cannot be rolled back
- TRUNCATE removes data **but keeps table structure**
- DELETE removes **selected rows**

27. Which SQL constraint ensures no duplicate values in a column?

- A) PRIMARY KEY
- B) UNIQUE
- C) FOREIGN KEY
- D) CHECK

Answer: B) UNIQUE

Explanation:

- UNIQUE constraint **prevents duplicate values**
- Can allow **NULL values** (except in some DBMS)
- PRIMARY KEY also ensures uniqueness but **cannot be NULL**

28. Which SQL constraint is used to enforce a condition on a column?

- A) PRIMARY KEY
- B) UNIQUE
- C) CHECK
- D) FOREIGN KEY

Answer: C) CHECK

Explanation:

- CHECK constraint **validates data before insertion**
 - Example: CHECK (age >= 18)
 - Ensures **data integrity** at column level
-

29. What is a composite key?

- A) Single column key
- B) Key with multiple columns
- C) Foreign key
- D) Alternate key

Answer: B) Key with multiple columns

Explanation:

- Composite key = **combination of two or more columns**
 - Together, they **uniquely identify a row**
 - Example: (Student_ID, Course_ID) in enrollment table
-

30. What is a surrogate key?

- A) User-assigned key
- B) System-generated unique key
- C) Foreign key
- D) Composite key

Answer: B) System-generated unique key

Explanation:

- Surrogate key = **artificial key**
 - Typically **auto-increment integer**
 - Used when **natural key is complex or changes frequently**
-

31. Which type of join returns only matching rows from two tables?

- A) INNER JOIN
- B) LEFT JOIN
- C) RIGHT JOIN
- D) FULL OUTER JOIN

Answer: A) INNER JOIN

Explanation:

- INNER JOIN returns **rows that satisfy join condition**
 - Non-matching rows are **excluded**
 - Syntax: `SELECT * FROM A INNER JOIN B ON A.id = B.id`
-

32. Which SQL clause is used to sort query results?

- A) WHERE
- B) GROUP BY
- C) ORDER BY
- D) HAVING

Answer: C) ORDER BY

Explanation:

- ORDER BY sorts **rows in ascending (ASC) or descending (DESC) order**
 - Can sort by **one or multiple columns**
 - Example: `ORDER BY age DESC`
-

33. Which SQL clause is used to filter groups?

- A) WHERE
- B) GROUP BY
- C) HAVING
- D) ORDER BY

Answer: C) HAVING

Explanation:

- HAVING filters **aggregated groups**
- WHERE filters **individual rows** before aggregation
- Example: HAVING COUNT(*) > 5

34. Which DBMS architecture is most commonly used?

- A) 1-tier
- B) 2-tier
- C) 3-tier
- D) 4-tier

Answer: C) 3-tier

Explanation:

- 3-tier architecture:
 1. **Presentation layer (UI)**
 2. **Application layer (business logic)**
 3. **Database layer (DBMS)**
- Provides **scalability, security, and modularity**

35. Which of the following is true about ACID properties?

- A) Ensures database performance
- B) Ensures database reliability
- C) Ensures database concurrency
- D) None of the above

Answer: B) Ensures database reliability

Explanation:

- ACID properties:
 1. **Atomicity:** all or nothing
 2. **Consistency:** maintains valid state
 3. **Isolation:** concurrent transactions do not interfere
 4. **Durability:** committed changes persist
-

36. Which index type automatically maintains sorting order?

- A) Hash index
- B) B-Tree index
- C) Bitmap index
- D) Clustered index

Answer: B) B-Tree index

Explanation:

- B-Tree index is **balanced tree**
 - Maintains **sorted order of keys**
 - Efficient for **range queries and search**
-

37. Which SQL command is used to add a column to a table?

- A) ALTER TABLE ADD
- B) INSERT COLUMN
- C) UPDATE TABLE
- D) MODIFY TABLE

Answer: A) ALTER TABLE ADD

Explanation:

- Syntax: ALTER TABLE table_name ADD column_name datatype
 - Adds **new column** without affecting existing data
-

38. What is referential integrity?

- A) Data stored in multiple tables
- B) Foreign key values must exist in primary key table
- C) Unique primary keys
- D) Data encryption

Answer: B) Foreign key values must exist in primary key table

Explanation:

- Ensures **relationships between tables remain consistent**
 - Prevents **orphan records in child table**
 - Enforced via **FOREIGN KEY constraints**
-

39. Which of the following is a DDL command?

- A) SELECT
- B) INSERT
- C) CREATE TABLE
- D) UPDATE

Answer: C) CREATE TABLE

Explanation:

- DDL = Data Definition Language
 - Commands: **CREATE, ALTER, DROP, TRUNCATE**
 - Defines **database schema**
-

40. Which of the following is a DML command?

- A) CREATE TABLE
- B) ALTER TABLE
- C) INSERT
- D) DROP TABLE

Answer: C) INSERT

Explanation:

- DML = Data Manipulation Language
 - Commands: **INSERT, UPDATE, DELETE, SELECT**
 - Used to **manipulate data in tables**
-

41. What is a deadlock in DBMS?

- A) Slow query execution
- B) Two or more transactions waiting indefinitely for each other
- C) Table corruption
- D) Index failure

Answer: B) Two or more transactions waiting indefinitely

Explanation:

- Deadlock occurs when **two transactions hold locks the other needs**
 - Solution:
 1. Deadlock detection & rollback
 2. Avoidance via resource ordering
 3. Timeout mechanisms
-

42. Which isolation level prevents dirty reads but allows non-repeatable reads?

- A) READ UNCOMMITTED
- B) READ COMMITTED
- C) REPEATABLE READ
- D) SERIALIZABLE

Answer: B) READ COMMITTED

Explanation:

- **READ COMMITTED:**
 - Cannot read **uncommitted changes**
 - Non-repeatable reads possible if another transaction **modifies data after first read**

43. Which DBMS type stores data in key-value pairs?

- A) Relational
- B) NoSQL
- C) Hierarchical
- D) Network

Answer: B) NoSQL

Explanation:

- NoSQL DBMS: **flexible schema**
 - Types: **key-value, document, columnar, graph**
 - Suitable for **big data, high scalability**
-

44. Which SQL function returns number of rows?

- A) SUM
- B) COUNT
- C) AVG
- D) MAX

Answer: B) COUNT

Explanation:

- COUNT(*) = returns **total number of rows**
 - COUNT(column_name) = counts **non-null values**
-

45. Which SQL function returns largest value in column?

- A) MIN
- B) MAX
- C) SUM
- D) AVG

Answer: B) MAX

Explanation:

- MAX(column) returns **maximum value**
 - Often used with **GROUP BY** to find top value per group
-

46. Which DBMS type allows complex many-to-many relationships?

- A) Hierarchical
- B) Relational
- C) Network
- D) Key-value

Answer: C) Network

Explanation:

- Network DBMS supports **multiple parent-child relationships**
 - Uses **pointers to connect records**
 - More flexible than hierarchical
-

47. What is a materialized view?

- A) Virtual table
- B) Stored physical copy of query result
- C) Index
- D) Temporary table

Answer: B) Stored physical copy

Explanation:

- Materialized view stores **query result physically**
 - Improves **query performance**
 - Needs **refresh to stay updated**
-

48. Which of the following is used for backup in DBMS?

- A) DDL
- B) DML

- C) Utilities like mysqldump, RMAN
- D) Trigger

Answer: C) Utilities like mysqldump, RMAN

Explanation:

- Backup tools **extract and store database data**
 - Ensures **data recovery in case of failure**
 - DBMS may have **hot and cold backup options**
-

49. What is the difference between clustered and non-clustered index?

Answer:

Clustered index:

- Table rows **sorted according to key**
- One per table
- Faster for **range queries**

Non-clustered index:

- Separate index structure
 - Table rows **physical order independent**
 - Multiple indexes possible
-

50. What is a dead tuple in DBMS (used in PostgreSQL)?

- A) Deleted row that still occupies space
- B) Active row
- C) Foreign key
- D) Index entry

Answer: A) Deleted row that still occupies space

Explanation:

- Dead tuple exists due to **MVCC (Multi-Version Concurrency Control)**

- Space reclaimed via **VACUUM command**
 - Helps in **transaction isolation** without blocking reads
-

Computer Organization & Architecture – 50 MCQs

1. What is the main function of the CPU?

- A) Store data
- B) Perform arithmetic and logical operations
- C) Control peripherals only
- D) Display output

Answer: B) Perform arithmetic and logical operations

Explanation:

- CPU = **Central Processing Unit**
 - Executes **instructions from programs**
 - Consists of:
 1. **ALU (Arithmetic Logic Unit)**: performs arithmetic & logic operations
 2. **CU (Control Unit)**: controls instruction execution
 3. **Registers**: temporary storage for processing
-

2. Which register holds the address of the next instruction to be executed?

- A) MAR
- B) MDR
- C) PC
- D) IR

Answer: C) PC (Program Counter)

Explanation:

- PC stores **address of next instruction**
 - Updated after **each instruction fetch**
 - Ensures **sequential execution** of instructions
-

3. What does MAR stand for?

- A) Memory Address Register
- B) Memory Access Register
- C) Main Address Register
- D) Main Access Register

Answer: A) Memory Address Register

Explanation:

- MAR stores **address of memory location to read/write**
 - Works with **MDR** for data transfer
-

4. Which unit performs arithmetic and logical operations in CPU?

- A) CU
- B) ALU
- C) Register
- D) Cache

Answer: B) ALU (Arithmetic Logic Unit)

Explanation:

- ALU performs:
 1. **Arithmetic:** addition, subtraction, multiplication, division
 2. **Logic:** AND, OR, NOT, XOR
 - Works with **registers for operands and results**
-

5. What is the function of the Control Unit (CU)?

- A) Perform arithmetic operations
- B) Execute instructions and control CPU operations
- C) Store data permanently
- D) Manage cache only

Answer: B) Execute instructions and control CPU operations

Explanation:

- CU **fetches, decodes, and executes instructions**
- Generates **control signals** for ALU, memory, and I/O
- Ensures **correct sequencing of operations**

6. Which memory is fastest?

- A) RAM
- B) Cache
- C) Hard disk
- D) ROM

Answer: B) Cache

Explanation:

- Cache memory is **small, high-speed memory** inside/near CPU
- Stores **frequently used data and instructions**
- Reduces **CPU waiting time**

7. Which of the following is a non-volatile memory?

- A) RAM
- B) ROM
- C) Cache
- D) Register

Answer: B) ROM

Explanation:

- ROM = Read-Only Memory

- Stores **permanent data/programs**
 - Retains data **even when power is off**
-

8. What is the function of the stack pointer (SP)?

- A) Points to program memory
- B) Points to top of the stack
- C) Points to CPU registers
- D) Points to ALU

Answer: B) Points to top of the stack

Explanation:

- Stack stores **temporary data, return addresses**
 - SP keeps **address of top element**
 - Supports **LIFO (Last In First Out)** operations
-

9. Which addressing mode uses the operand itself in the instruction?

- A) Immediate
- B) Direct
- C) Indirect
- D) Register

Answer: A) Immediate

Explanation:

- Operand value **provided directly in instruction**
 - Example: MOV A, #5 → moves 5 into register A
 - Fastest mode, no memory access required
-

10. Which addressing mode specifies the memory location of the operand?

- A) Immediate
- B) Direct

- C) Indirect
- D) Register

Answer: B) Direct

Explanation:

- Instruction contains **memory address of operand**
 - Example: MOV A, 2000H → moves value from memory address 2000H
 - Slower than immediate mode due to **memory access**
-

11. Which CPU instruction fetch cycle step reads instruction from memory?

- A) Decode
- B) Execute
- C) Fetch
- D) Write-back

Answer: C) Fetch

Explanation:

- Fetch cycle steps:
 1. PC gives address to MAR
 2. Read instruction from memory into MDR
 3. Move instruction to IR for decoding
-

12. Which instruction type performs data transfer?

- A) Arithmetic
- B) Logical
- C) Data transfer (MOV, LOAD, STORE)
- D) Branch

Answer: C) Data transfer

Explanation:

- Data transfer instructions move data between:

1. Registers
 2. Memory
 3. I/O devices
- Examples: MOV, LOAD, STORE
-

13. Which instruction type changes sequence of execution?

- A) Arithmetic
- B) Branching
- C) Logical
- D) Data transfer

Answer: B) Branching

Explanation:

- Branch instructions **alter PC value**
 - Types:
 1. **Unconditional** – always branch
 2. **Conditional** – branch if condition is true
 - Example: JMP, JZ, JNZ
-

14. Which instruction type performs AND, OR, NOT operations?

- A) Arithmetic
- B) Logical
- C) Data transfer
- D) Branch

Answer: B) Logical

Explanation:

- Logical instructions **operate on bits**
- Example: AND, OR, XOR, NOT
- Used for **bit masking, comparison, decision making**

15. Which register temporarily holds data read from memory?

- A) MAR
- B) MDR
- C) IR
- D) PC

Answer: B) MDR (Memory Data Register)

Explanation:

- MDR holds **data read from or written to memory**
 - Works with MAR to **transfer data between CPU and memory**
-

16. What is pipelining in CPU?

- A) Single instruction execution at a time
- B) Overlapping execution of multiple instructions
- C) Data storage technique
- D) Memory access method

Answer: B) Overlapping execution

Explanation:

- Pipelining splits instruction execution into **stages**
 - Each stage handles **different instruction simultaneously**
 - Improves **CPU throughput, but may have hazards**
-

17. Which of the following is a hazard in pipelining?

- A) Structural
- B) Data
- C) Control
- D) All of the above

Answer: D) All of the above

Explanation:

- Structural hazard: hardware resource conflict
 - Data hazard: instruction depends on previous instruction result
 - Control hazard: branch instruction changes execution flow
-

18. Which memory is closest to CPU?

- A) RAM
- B) Cache
- C) Registers
- D) Hard disk

Answer: C) Registers

Explanation:

- Registers are **inside CPU**
 - Access time **few nanoseconds**
 - Store **operands, results, addresses, flags**
-

19. What is a bus in computer architecture?

- A) Path for CPU only
- B) Shared communication path for data, address, and control signals
- C) Storage device
- D) None of the above

Answer: B) Shared communication path

Explanation:

- Bus types:
 1. **Data bus:** carries data
 2. **Address bus:** carries memory addresses
 3. **Control bus:** carries control signals (read/write, clock)
 - Connects **CPU, memory, I/O devices**
-

20. Which architecture separates memory for instructions and data?

- A) Von Neumann
- B) Harvard
- C) SISD
- D) SIMD

Answer: B) Harvard

Explanation:

- Harvard architecture: **separate instruction and data memory**
 - Allows **simultaneous access**
 - Von Neumann: single memory → instructions & data share bus
-

21. What is the advantage of Harvard over Von Neumann architecture?

- A) Simpler
- B) Cheaper
- C) Higher performance due to separate buses
- D) Less memory required

Answer: C) Higher performance

Explanation:

- Separate buses for **instructions and data**
 - Reduces **fetch bottleneck**
 - Improves **CPU throughput**
-

22. Which of the following is a type of CPU organization?

- A) SISD (Single Instruction Single Data)
- B) SIMD (Single Instruction Multiple Data)
- C) MIMD (Multiple Instruction Multiple Data)
- D) All of the above

Answer: D) All of the above

Explanation:

- CPU organization based on **Flynn's taxonomy**:
 1. SISD – traditional sequential CPU
 2. SIMD – vector processors
 3. MISD – rare, redundant computation
 4. MIMD – multicore / multiprocessor
-

23. Which addressing mode uses register content as address?

- A) Immediate
- B) Register
- C) Register indirect
- D) Direct

Answer: C) Register indirect

Explanation:

- Operand address is **stored in register**
 - CPU fetches data from **address specified in register**
-

24. Which instruction type is used to compare two values?

- A) Arithmetic
- B) Logical
- C) Compare (CMP)
- D) Branch

Answer: C) Compare (CMP)

Explanation:

- CMP subtracts **operands but does not store result**
 - Sets **flags (zero, carry, sign)** for conditional branching
-

25. What is the function of accumulator register?

- A) Store memory addresses
- B) Store intermediate arithmetic and logic results
- C) Store program counter
- D) Store instruction

Answer: B) Store intermediate results

Explanation:

- Accumulator = primary ALU register
- Holds **operands and results temporarily**
- Used in **arithmetic and logic operations**

26. What is a word in computer architecture?

- A) Single bit
- B) Group of bits processed together
- C) CPU instruction
- D) Memory address

Answer: B) Group of bits processed together

Explanation:

- Word size depends on **CPU architecture** (e.g., 16-bit, 32-bit, 64-bit)
- Determines **amount of data CPU can process at once**
- Larger word size → **higher processing capability**

27. Which register stores the currently executing instruction?

- A) MAR
- B) MDR
- C) IR
- D) PC

Answer: C) IR (Instruction Register)

Explanation:

- IR holds **fetched instruction from memory**
 - CU decodes instruction from IR
 - Essential for **instruction execution cycle**
-

28. Which CPU component generates timing and control signals?

- A) ALU
- B) CU
- C) Register
- D) Cache

Answer: B) CU (Control Unit)

Explanation:

- CU generates signals for:
 1. **Memory read/write**
 2. **I/O operations**
 3. **ALU operations**
 - Ensures **proper sequencing**
-

29. Which type of memory is both fast and volatile?

- A) ROM
- B) RAM
- C) Cache
- D) Hard Disk

Answer: C) Cache

Explanation:

- Cache is **fast, temporary storage near CPU**
 - Volatile → loses data on **power off**
 - Stores **frequently used instructions/data**
-

30. Which CPU architecture uses a single bus for instructions and data?

- A) Harvard
- B) Von Neumann
- C) SISD
- D) SIMD

Answer: B) Von Neumann

Explanation:

- Von Neumann architecture shares **single memory and bus**
- Fetching instructions and data uses **same path**
- Simpler, but may cause **bottleneck (Von Neumann bottleneck)**

31. Which is the smallest unit of data in computer memory?

- A) Byte
- B) Nibble
- C) Bit
- D) Word

Answer: C) Bit

Explanation:

- Bit = **binary digit (0 or 1)**
- 1 byte = 8 bits
- CPU processes data in **words (multiple bits)**

32. What is the function of a cache controller?

- A) Execute instructions
- B) Manage cache memory access
- C) Decode instructions
- D) Transfer data to disk

Answer: B) Manage cache memory access

Explanation:

- Cache controller handles:
 1. Data fetch from cache or main memory
 2. Replacement policy (LRU, FIFO)
 3. Write-through / write-back strategies
-

33. What does CPI stand for in CPU performance?

- A) Clock per instruction
- B) Cycle per instruction
- C) Control process instruction
- D) Central processing indicator

Answer: B) Cycle per instruction

Explanation:

- CPI = average **clock cycles needed per instruction**
- Used to calculate **CPU performance**:

$$CPU T = \frac{\text{Instruction C} \cdot \text{ime}}{\text{Clock F} \cdot \text{ount} \times \text{CPI}}$$

34. Which of the following reduces average memory access time?

- A) Larger RAM
- B) Cache memory
- C) Faster hard disk
- D) None of the above

Answer: B) Cache memory

Explanation:

- Cache stores **frequently used instructions/data**
- CPU accesses **cache faster than main memory**
- Reduces **average memory latency**

35. Which pipeline stage performs arithmetic operation?

- A) Fetch
- B) Decode
- C) Execute
- D) Write-back

Answer: C) Execute

Explanation:

- Execute stage:
 - ALU performs **arithmetic/logical operations**
 - May access **memory addresses calculated**
 - Result sent to **register or memory**
-

36. Which register holds flags or status bits?

- A) IR
- B) MAR
- C) Program Status Word (PSW)
- D) PC

Answer: C) Program Status Word (PSW)

Explanation:

- PSW stores:
 1. **Carry, zero, overflow flags**
 2. **Interrupt enable/disable**
 3. **Condition codes for branching**
-

37. Which memory unit stores data permanently?

- A) RAM
- B) Cache

- C) ROM
- D) Register

Answer: C) ROM

Explanation:

- ROM is **non-volatile**
 - Stores **firmware, boot programs**
 - Cannot be modified (or modified slowly in some types like EEPROM)
-

38. Which unit converts high-level instructions into micro-operations?

- A) CU
- B) ALU
- C) Registers
- D) Cache

Answer: A) CU

Explanation:

- Control Unit **decodes instructions into micro-operations**
 - Generates **control signals** for ALU, memory, I/O
 - Ensures **proper sequencing**
-

39. Which instruction type performs I/O operations?

- A) Data transfer
- B) Control
- C) Input/Output
- D) Arithmetic

Answer: C) Input/Output

Explanation:

- I/O instructions **transfer data between CPU and peripherals**
- Examples: IN, OUT, READ, WRITE

40. What is the main disadvantage of Von Neumann architecture?

- A) Expensive
- B) Single bus causes bottleneck
- C) Cannot execute instructions
- D) Complex design

Answer: B) Single bus causes bottleneck

Explanation:

- Instruction and data share **same bus**
 - CPU waits for memory access → **Von Neumann bottleneck**
 - Solved by **cache or Harvard architecture**
-

41. Which type of CPU organization is used in supercomputers?

- A) SISD
- B) SIMD
- C) MIMD
- D) MISD

Answer: C) MIMD

Explanation:

- MIMD = Multiple Instruction, Multiple Data
 - Multiple processors execute **different instructions on different data**
 - Suitable for **parallel computing, supercomputers**
-

42. Which register stores address for memory access?

- A) PC
- B) MAR
- C) MDR
- D) IR

Answer: B) MAR (Memory Address Register)

Explanation:

- MAR holds **address for read/write operations**
 - Works with MDR for **data transfer**
-

43. What is a bus width?

- A) Number of buses in CPU
- B) Number of bits transmitted simultaneously
- C) Memory size
- D) Number of instructions executed

Answer: B) Number of bits transmitted simultaneously

Explanation:

- Bus width = **number of parallel lines in bus**
 - Determines **data transfer capability**
 - Example: 32-bit bus transfers **32 bits at a time**
-

44. Which unit converts data from I/O devices into CPU-understandable format?

- A) ALU
- B) CU
- C) Interface/Controller
- D) Cache

Answer: C) Interface/Controller

Explanation:

- I/O controllers handle **data format conversion**
 - Provide **buffering and synchronization**
 - CPU interacts **indirectly via controller**
-

45. Which pipeline technique executes multiple instructions in a single clock cycle?

- A) Scalar pipeline
- B) Superscalar pipeline
- C) Vector pipeline
- D) RISC pipeline

Answer: B) Superscalar pipeline

Explanation:

- Superscalar CPU fetches **multiple instructions per cycle**
- Multiple ALUs execute in **parallel**
- Improves **instruction throughput**

46. Which instruction set architecture focuses on simple, fast instructions?

- A) CISC
- B) RISC
- C) SISD
- D) SIMD

Answer: B) RISC (Reduced Instruction Set Computer)

Explanation:

- RISC has **simple, fixed-length instructions**
- Faster execution, easier pipelining
- Fewer addressing modes than CISC

47. Which instruction set allows complex multi-step instructions?

- A) RISC
- B) CISC
- C) Harvard
- D) Von Neumann

Answer: B) CISC (Complex Instruction Set Computer)

Explanation:

- CISC: **rich instruction set**

- Each instruction may **perform multiple operations**
 - Reduces program size but **slower per instruction**
-

48. Which component holds frequently used instructions in CPU?

- A) RAM
- B) Register
- C) Cache
- D) Hard Disk

Answer: C) Cache

Explanation:

- Cache stores **recently or frequently used instructions/data**
 - Reduces **CPU wait time for memory**
 - Levels: L1, L2, L3 (L1 fastest, smallest)
-

49. What is meant by clock cycle in CPU?

- A) Time for memory access
- B) Time for single CPU operation
- C) Time between two clock pulses
- D) Time for program execution

Answer: C) Time between two clock pulses

Explanation:

- Clock cycle = **basic time unit** for CPU operation
 - Determines **speed of instruction execution**
 - Faster clock → more instructions per second
-

50. Which instruction type moves data between CPU and memory or I/O?

- A) Arithmetic
- B) Logical

- C) Data transfer
- D) Branch

Answer: C) Data transfer

Explanation:

- Examples: MOV, LOAD, STORE, IN, OUT
 - Essential for **communication between CPU and memory/peripherals**
-

Theory of Computation – 50 MCQs

1. What is a formal language?

- A) Natural language
- B) Set of strings over an alphabet
- C) Programming language only
- D) Grammar rules

Answer: B) Set of strings over an alphabet

Explanation:

- Formal language = **collection of strings formed from a finite set of symbols (alphabet)**
 - Example: {a, ab, aa} over alphabet {a, b}
 - Used in **automata, compiler design, and language theory**
-

2. What is an alphabet in formal language?

- A) Set of all strings
- B) Set of symbols
- C) Grammar rules
- D) Syntax tree

Answer: B) Set of symbols

Explanation:

- Alphabet = finite set of symbols used to **construct strings**
 - Example: $\Sigma = \{0,1\}$ for binary strings
 - Strings = sequences of symbols from alphabet
-

3. Which of the following is a regular language?

- A) $\{a^n b^n \mid n \geq 0\}$
 B) {a, aa, aaa}
 C) $\{a^n b^n c^n \mid n \geq 0\}$
 D) $\{a^n b^m c^p \mid n \neq m \neq p\}$

Answer: B) {a, aa, aaa}

Explanation:

- Regular language = can be **represented by regular expressions or finite automata**
 - {a, aa, aaa} can be expressed as $a(a^*)$
 - $\{a^n b^n\}$ is **context-free, not regular**
-

4. Which automaton recognizes regular languages?

- A) DFA
 B) NFA
 C) Both DFA and NFA
 D) Turing Machine

Answer: C) Both DFA and NFA

Explanation:

- DFA = Deterministic Finite Automaton
- NFA = Nondeterministic Finite Automaton
- Both accept **exactly regular languages**
- NFA can be converted to **equivalent DFA**

5. What is the difference between DFA and NFA?

Answer:

DFA:

- Deterministic → **one transition per symbol per state**
- Always knows **next state**

NFA:

- Nondeterministic → **multiple or zero transitions**
 - Can move without input (ϵ -moves)
 - Can be converted to **DFA** using subset construction
-

6. What is a regular expression?

- A) Mathematical expression
- B) Symbolic representation of a regular language
- C) Automaton diagram
- D) Parsing tree

Answer: B) Symbolic representation

Explanation:

- Regular expressions describe **sets of strings using operators:**
 1. Union (+ or |)
 2. Concatenation (AB)
 3. Kleene star (A^*) → zero or more repetitions
 - Example: $a(b|c)^*$
-

7. Which language is context-free?

- A) $\{a^n b^n \mid n \geq 0\}$
- B) $\{a^n b^n c^n \mid n \geq 0\}$

- C) {a, aa, aaa}
- D) { $0^n1^m \mid n \neq m$ }

Answer: A) { $a^n b^n \mid n \geq 0$ }

Explanation:

- Context-free languages (CFL) = **generated by context-free grammars**
 - Recognized by **pushdown automata (PDA)**
 - { $a^n b^n$ } requires **stack memory** → CFL
-

8. What type of automaton recognizes context-free languages?

- A) DFA
- B) NFA
- C) PDA (Pushdown Automaton)
- D) Turing Machine

Answer: C) PDA

Explanation:

- PDA = Finite automaton with **stack memory**
 - Stack allows **matching nested patterns**
 - Example: Balanced parentheses ((())())
-

9. Which is true about Turing Machines?

- A) Recognize only regular languages
- B) Can recognize any computable language
- C) Same as PDA
- D) Only finite computation

Answer: B) Can recognize any computable language

Explanation:

- Turing Machine = **most powerful computational model**
- Recognizes **recursively enumerable languages**

- Forms basis of **computability theory**
-

10. What is a context-free grammar (CFG)?

- A) Grammar with no rules
- B) Grammar where each production has a single non-terminal on LHS
- C) Grammar where multiple terminals on LHS
- D) Grammar for regular languages only

Answer: B) Single non-terminal on LHS

Explanation:

- CFG: $A \rightarrow \alpha$ where A = non-terminal, α = string of terminals/non-terminals
 - Used to define **programming languages syntax**
-

11. Which of the following is a context-sensitive language?

- A) $\{a^n b^n \mid n \geq 0\}$
- B) $\{a^n b^n c^n \mid n \geq 0\}$
- C) {a, aa, aaa}
- D) {0,1}

Answer: B) $\{a^n b^n c^n \mid n \geq 0\}$

Explanation:

- Context-sensitive grammar allows **productions with context**: $\alpha A \beta \rightarrow \alpha \gamma \beta$
 - Needs **linear-bounded automaton**
 - Example: $a^n b^n c^n$ cannot be generated by CFG
-

12. What does the Pumping Lemma for regular languages show?

- A) All languages are regular
- B) Some languages are not regular
- C) DFA can be converted to PDA
- D) CFG is more powerful than regular expressions

Answer: B) Some languages are not regular

Explanation:

- Pumping Lemma provides **necessary property of regular languages**
 - If a language **fails lemma**, it is **not regular**
 - Useful for proving **non-regularity**
-

13. What is a recursive language?

- A) Language accepted by DFA
- B) Language decided by a Turing Machine that **halts for all inputs**
- C) Language accepted by PDA
- D) Language with infinite strings

Answer: B) Decided by Turing Machine that halts

Explanation:

- TM halts for **all inputs** → decides recursive language
 - Recursively enumerable (RE) may **not halt** for some inputs
-

14. What is the difference between RE and recursive languages?

Answer:

- RE (Recursively Enumerable):
 - Accepted by TM
 - TM may **not halt** for some inputs
 - Recursive:
 - TM **halts for all inputs**
 - Decidable languages
-

15. Which language class is recognized by linear bounded automaton (LBA)?

- A) Regular
- B) Context-free
- C) Context-sensitive
- D) Recursively enumerable

Answer: C) Context-sensitive

Explanation:

- LBA = Turing Machine with **tape bounded by input length**
- Recognizes **context-sensitive languages**

16. Which of the following is an example of a non-regular language?

- A) a^*
- B) $\{a^n b^n \mid n \geq 0\}$
- C) ab^*
- D) $\{0,1\}$

Answer: B) $\{a^n b^n \mid n \geq 0\}$

Explanation:

- Cannot be recognized by **finite automaton**
- Requires **stack memory** → PDA

17. Which of the following is the most powerful model of computation?

- A) DFA
- B) PDA
- C) Turing Machine
- D) LBA

Answer: C) Turing Machine

Explanation:

- TM can compute **all computable functions**
- DFA, PDA, LBA are **restricted computational models**

18. What is the difference between DFA and PDA in terms of memory?

- A) DFA has stack, PDA has none
- B) DFA has finite memory, PDA has stack
- C) Both have infinite memory
- D) PDA has registers only

Answer: B) DFA = finite memory, PDA = stack

Explanation:

- DFA → limited to **current state**
- PDA → **stack memory** allows **context-free language recognition**

19. What is meant by “closure property” of languages?

- A) Language cannot be extended
- B) Language closed under operations (union, concatenation, etc.)
- C) Language is empty
- D) Language is finite

Answer: B) Closed under operations

Explanation:

- Regular languages: closed under **union, concatenation, Kleene star, intersection**
- CFL: closed under **union, concatenation**, but not intersection

20. Which of the following operations may not preserve context-free property?

- A) Union
- B) Concatenation
- C) Intersection
- D) Kleene star

Answer: C) Intersection

Explanation:

- CFLs closed under **union, concatenation, Kleene star**

- Not closed under **intersection and complement**
-

21. What is an epsilon transition in NFA?

- A) Moves on input 0
- B) Moves without consuming input
- C) Stops execution
- D) Moves on input 1

Answer: B) Moves without consuming input

Explanation:

- ϵ -transition allows NFA to **change state freely**
 - Important in **ϵ -NFA to DFA conversion**
-

22. Which of the following is true for minimization of DFA?

- A) Reduces number of states
- B) Increases number of transitions
- C) Removes alphabet
- D) Converts DFA to NFA

Answer: A) Reduces number of states

Explanation:

- Minimized DFA has **fewest states accepting same language**
 - Reduces **memory and computational cost**
-

23. What is the language accepted by a TM if it halts for all strings?

- A) RE
- B) Recursive
- C) Context-free
- D) Regular

Answer: B) Recursive

Explanation:

- Halts for **all strings** → recursive
 - TM may loop for some inputs → only RE
-

24. Which of the following is undecidable?

- A) DFA membership
- B) Halting problem
- C) PDA membership
- D) Regular expression equivalence

Answer: B) Halting problem

Explanation:

- Halting problem: **cannot determine if arbitrary TM halts on input**
 - Proven **undecidable by Turing**
-

25. Which is the simplest type of grammar in Chomsky hierarchy?

- A) Type-0
- B) Type-1
- C) Type-2
- D) Type-3

Answer: D) Type-3 (Regular grammar)

Explanation:

- Type-3 = regular grammar → generates **regular languages**
- Type-2 = context-free
- Type-1 = context-sensitive
- Type-0 = recursively enumerable

26. Which of the following is true about context-free grammars (CFG)?

- A) Can generate regular languages only
- B) LHS of production has single non-terminal

- C) RHS must have only terminals
- D) Cannot generate balanced parentheses

Answer: B) LHS of production has single non-terminal

Explanation:

- CFG production: $A \rightarrow \alpha$
 - LHS = **single non-terminal**, RHS = **string of terminals and/or non-terminals**
 - Can generate **nested structures** like balanced parentheses
-

27. What is the Chomsky hierarchy in order of increasing power?

- A) Type-0 \rightarrow Type-1 \rightarrow Type-2 \rightarrow Type-3
- B) Type-3 \rightarrow Type-2 \rightarrow Type-1 \rightarrow Type-0
- C) Type-2 \rightarrow Type-3 \rightarrow Type-1 \rightarrow Type-0
- D) Type-1 \rightarrow Type-0 \rightarrow Type-3 \rightarrow Type-2

Answer: B) Type-3 \rightarrow Type-2 \rightarrow Type-1 \rightarrow Type-0

Explanation:

- Hierarchy:
 1. **Type-3:** Regular
 2. **Type-2:** Context-free
 3. **Type-1:** Context-sensitive
 4. **Type-0:** Recursively enumerable
 - **Power increases** from Type-3 to Type-0
-

28. What is a pushdown automaton (PDA) used for?

- A) Recognize regular languages
- B) Recognize context-free languages
- C) Recognize context-sensitive languages
- D) Recognize recursively enumerable languages

Answer: B) Recognize context-free languages

Explanation:

- PDA = Finite automaton with **stack memory**
 - Can handle **nested structures**, e.g., $a^n b^n$
 - Stack provides **memory beyond finite states**
-

29. What is the significance of ϵ -moves in NFA?

- A) Reduce states
- B) Allow transition without input
- C) Increase alphabet size
- D) Perform arithmetic operations

Answer: B) Allow transition without input

Explanation:

- ϵ -moves allow **state changes without consuming symbol**
 - Used in **ϵ -NFA**
 - Important for **NFA to DFA conversion**
-

30. Which class of languages is closed under union, concatenation, and Kleene star?

- A) Regular
- B) Context-free
- C) Context-sensitive
- D) RE

Answer: A) Regular

Explanation:

- Regular languages are **closed under these operations**
 - Means combining regular languages **produces another regular language**
-

31. Which of the following is true for deterministic PDA (DPDA)?

- A) Accepts all CFLs
- B) Can accept subset of CFLs
- C) Equivalent to DFA
- D) Accepts all RE languages

Answer: B) Can accept subset of CFLs

Explanation:

- DPDA = deterministic pushdown automaton
 - Cannot accept **all CFLs** (e.g., $a^n b^n c^n$)
 - Nondeterministic PDA is **more powerful**
-

32. What is a linear bounded automaton (LBA)?

- A) DFA with infinite tape
- B) Turing Machine with tape bounded by input length
- C) PDA with stack
- D) NFA with ϵ -moves

Answer: B) TM with tape bounded by input length

Explanation:

- LBA recognizes **context-sensitive languages**
 - Memory is **limited to a linear function of input size**
 - Example: $a^n b^n c^n$
-

33. Which of the following is undecidable?

- A) DFA membership
- B) CFG membership
- C) TM halting problem
- D) PDA acceptance

Answer: C) TM halting problem

Explanation:

- Halting problem: cannot **decide if arbitrary TM halts**

- Fundamental in **computability theory**
 - DFA, CFG, PDA membership **decidable**
-

34. Which of the following operations may lead to non-closure for CFLs?

- A) Union
- B) Intersection
- C) Concatenation
- D) Kleene star

Answer: B) Intersection

Explanation:

- CFLs are **not closed under intersection or complement**
 - Union, concatenation, Kleene star **preserve CFL property**
-

35. Which language can be recognized by a DFA but not by a PDA?

- A) Regular language
- B) Context-free language
- C) Context-sensitive language
- D) Recursively enumerable language

Answer: A) Regular language

Explanation:

- DFA is **sufficient for regular languages**
 - PDA is **more powerful** but can also recognize regular languages
 - Example: a^*
-

36. What is the purpose of the Pumping Lemma for CFLs?

- A) Generate strings
- B) Prove non-context-freeness
- C) Construct DFA
- D) Construct Turing Machine

Answer: B) Prove non-context-freeness

Explanation:

- CFL Pumping Lemma provides **property all CFLs must satisfy**
 - Used to **prove a language is not context-free**
-

37. Which of the following is a recursive enumerable (RE) language?

- A) Accepted by TM that may not halt
- B) Accepted by DFA
- C) Accepted by LBA only
- D) Accepted by PDA only

Answer: A) Accepted by TM that may not halt

Explanation:

- RE languages: **TM may not halt for non-members**
 - Decidable languages = recursive, TM **halts for all inputs**
-

38. Which language is an example of a context-sensitive language?

- A) a^*
- B) $a^n b^n c^n$
- C) {ab, aab, aaab}
- D) $\{\epsilon\}$

Answer: B) $a^n b^n c^n$

Explanation:

- Needs **linear bounded automaton (LBA)**
 - Cannot be generated by CFG
 - Requires **context-sensitive rules**
-

39. Which of the following is true about Turing Machines?

- A) Can recognize only regular languages
- B) Can simulate any algorithm
- C) Can recognize only CFLs
- D) Cannot store infinite memory

Answer: B) Can simulate any algorithm

Explanation:

- TM = **universal model of computation**
 - Can simulate **any algorithm**
 - Basis of **computability and undecidability theory**
-

40. What is the difference between recursive and recursively enumerable languages?

Answer:

- Recursive: TM **halts on all inputs** → decidable
 - RE: TM **accepts members** but may **loop on non-members** → semi-decidable
-

41. Which of the following is an example of a Type-3 grammar?

- A) $S \rightarrow aS \mid b$
- B) $S \rightarrow aSb$
- C) $S \rightarrow aSb \mid \epsilon$
- D) $S \rightarrow a^n b^n c^n$

Answer: A) $S \rightarrow aS \mid b$

Explanation:

- Type-3 = **regular grammar**
 - RHS: **single terminal followed optionally by non-terminal**
 - Generates **regular languages**
-

42. What does the term “computable function” mean?

- A) Function not computable by any machine
- B) Function calculated by TM
- C) Function with finite alphabet
- D) Function with infinite input

Answer: B) Function calculated by TM

Explanation:

- Computable function = **TM halts and outputs result**
- Basis of **algorithmic computation**

43. What is the key difference between deterministic and nondeterministic TM?

- A) Deterministic has multiple transitions
- B) Nondeterministic can explore multiple paths simultaneously
- C) Deterministic accepts RE languages
- D) Nondeterministic cannot halt

Answer: B) Nondeterministic can explore multiple paths

Explanation:

- NTM = may have **multiple choices for next move**
- Useful in **complexity theory**
- Equivalent to TM in **language recognition**

44. Which of the following is true for recursive languages?

- A) TM may not halt for some inputs
- B) Decidable
- C) Not closed under union
- D) Not accepted by TM

Answer: B) Decidable

Explanation:

- Recursive languages are **decidable**

- TM halts for **all inputs**
 - Closed under union, intersection, complement
-

45. What does the halting problem state?

- A) DFA can accept all strings
- B) No algorithm can decide if arbitrary TM halts
- C) PDA can accept all CFLs
- D) TM cannot simulate algorithms

Answer: B) No algorithm can decide halting

Explanation:

- Halting problem is **undecidable**
 - Proven by **Turing**
 - Fundamental in **computability theory**
-

46. Which of the following languages is infinite but regular?

- A) $\{a^n b^n\}$
- B) $\{a^n \mid n \geq 0\}$
- C) $\{a^n b^n c^n\}$
- D) $\{a^n b^m c^p \mid n \neq m \neq p\}$

Answer: B) $\{a^n \mid n \geq 0\}$

Explanation:

- Can be represented by **regular expression a^***
 - Infinite number of strings, but **regular**
-

47. Which of the following is not closed under complement?

- A) Regular languages
- B) Context-free languages
- C) Context-sensitive languages
- D) Recursive languages

Answer: B) Context-free languages

Explanation:

- CFLs **not closed under complement**
 - Regular, context-sensitive, recursive → closed under complement
-

48. Which of the following recognizes exactly the regular languages?

- A) PDA
- B) DFA/NFA
- C) LBA
- D) TM

Answer: B) DFA/NFA

Explanation:

- DFA/NFA = finite automata
 - Recognizes **all regular languages**
 - Cannot recognize **non-regular languages**
-

49. Which type of grammar generates recursively enumerable languages?

- A) Type-0
- B) Type-1
- C) Type-2
- D) Type-3

Answer: A) Type-0

Explanation:

- Type-0 = unrestricted grammar
 - Generates **recursively enumerable languages**
 - Recognized by **Turing Machine**
-

50. What is the main purpose of Theory of Computation?

- A) Study computer networks
- B) Study algorithms, language recognition, and computability
- C) Study hardware architecture
- D) Study operating systems

Answer: B) Study algorithms, language recognition, and computability

Explanation:

- ToC explores:
 1. **Formal languages and grammars**
 2. **Automata theory**
 3. **Computability and decidability**
 4. **Complexity and algorithmic limits**
-
-

Compiler Design – 50 MCQs

1. What is the main purpose of a compiler?

- A) Execute code directly
- B) Translate high-level code to machine code
- C) Debug programs
- D) Store data

Answer: B) Translate high-level code to machine code

Explanation:

- Compiler = **translator program**
- Converts **source code (high-level)** → **target code (machine/assembly)**

- Steps include: **lexical analysis, syntax analysis, semantic analysis, code generation**
-

2. Which phase of compiler removes comments and blanks?

- A) Lexical analysis
- B) Syntax analysis
- C) Semantic analysis
- D) Optimization

Answer: A) Lexical analysis

Explanation:

- Lexical analyzer = **scanner**
 - Removes **whitespaces, comments**
 - Produces **tokens** for parser
-

3. Which compiler phase checks the structure of the code?

- A) Lexical analysis
- B) Syntax analysis
- C) Semantic analysis
- D) Code generation

Answer: B) Syntax analysis

Explanation:

- Syntax analysis = **parsing**
 - Checks code against **grammar of programming language**
 - Builds **parse tree / syntax tree**
-

4. Which data structure is used in syntax analysis?

- A) Stack
- B) Queue

C) Linked list

D) Tree

Answer: A) Stack

Explanation:

- Stack is used in **parsing algorithms** (e.g., LL, LR parsers)
 - Helps in **tracking non-terminals and rules**
 - Also builds **parse tree gradually**
-

5. What is a token in compiler design?

A) Single character

B) Sequence of characters forming a unit

C) Entire program

D) Error message

Answer: B) Sequence forming a unit

Explanation:

- Token = **basic unit** produced by lexical analysis
 - Example: identifier, keyword, operator, literal
 - Each token has **lexeme and token type**
-

6. Which component detects semantic errors?

A) Lexical analyzer

B) Parser

C) Semantic analyzer

D) Code optimizer

Answer: C) Semantic analyzer

Explanation:

- Semantic analysis ensures **meaning of statements is correct**
- Checks:

1. Type checking
 2. Variable declaration
 3. Function calls correctness
-

7. What is intermediate code in compiler?

- A) High-level source code
- B) Machine code
- C) Representation between source and target code
- D) Syntax tree

Answer: C) Representation between source and target

Explanation:

- Intermediate code = **machine-independent representation**
 - Examples: **Three-address code, quadruples, syntax tree**
 - Makes **optimization easier**
-

8. Which is a type of syntax-directed translation?

- A) Top-down parsing
- B) Bottom-up parsing
- C) Attribute grammar
- D) Code generation

Answer: C) Attribute grammar

Explanation:

- Each grammar rule is **associated with attributes**
 - Semantic actions are **performed during parsing**
 - Helps in **translation and semantic analysis**
-

9. What is the main purpose of code optimization?

- A) Check syntax
- B) Reduce execution time or memory usage
- C) Generate tokens
- D) Detect semantic errors

Answer: B) Reduce execution time or memory

Explanation:

- Code optimization improves **efficiency** of generated code
- Types:
 1. **Machine-independent** → before target code generation
 2. **Machine-dependent** → after target code generation

10. Which parser uses recursive function calls?

- A) LR parser
- B) LL parser
- C) SLR parser
- D) LALR parser

Answer: B) LL parser

Explanation:

- LL parser = **top-down parser**
- Uses **recursive descent functions**
- Processes **Left-to-right, Leftmost derivation**

11. Which parser uses stack and shift-reduce operations?

- A) LL parser
- B) LR parser
- C) Recursive descent parser
- D) Predictive parser

Answer: B) LR parser

Explanation:

- LR parser = **bottom-up parser**
 - Stack stores **states and symbols**
 - Performs **shift (read input)** and **reduce (apply grammar)** operations
-

12. Which symbol is used in context-free grammar to denote ϵ ?

- A) Empty string
- B) Space
- C) Null pointer
- D) None

Answer: A) Empty string

Explanation:

- ϵ represents **empty string** in grammar
 - Used in **optional productions and nullable rules**
-

13. What is FIRST set in parsing?

- A) Set of tokens that can appear at start of a string
- B) Set of tokens at the end
- C) Set of variables
- D) Set of errors

Answer: A) Tokens at start

Explanation:

- **FIRST(X) = set of terminals that can appear at the beginning of strings derived from X**
 - Helps **predict which production to use** in LL parser
-

14. What is FOLLOW set in parsing?

- A) Set of tokens at start
- B) Set of tokens that can appear immediately after non-terminal

- C) Set of terminals
- D) Set of errors

Answer: B) Tokens after non-terminal

Explanation:

- FOLLOW(A) = **terminals that can appear immediately after non-terminal A**
 - Helps in **predictive parsing table construction**
-

15. Which of the following is a bottom-up parser?

- A) LL(1)
- B) SLR
- C) Recursive descent
- D) Predictive parser

Answer: B) SLR

Explanation:

- SLR = Simple LR parser
 - Bottom-up parser → **constructs parse tree from leaves to root**
 - Uses **shift-reduce method**
-

16. Which of the following is an advantage of intermediate code?

- A) Hardware independent
- B) Faster than machine code
- C) Reduces program size
- D) Detects syntax errors

Answer: A) Hardware independent

Explanation:

- Intermediate code allows **compiler to be retargeted**
- Example: **Three-address code** can be optimized **before generating target code**

17. Which of the following is an example of three-address code?

- A) $x = y + z$
- B) $t1 = y + z; x = t1$
- C) if $a < b$ goto L1
- D) All of the above

Answer: D) All of the above

Explanation:

- Three-address code: **at most 3 addresses per statement**
 - Used in **intermediate code representation**
-

18. What does backpatching handle?

- A) Lexical errors
- B) Undefined jumps in code generation
- C) Syntax errors
- D) Semantic checks

Answer: B) Undefined jumps

Explanation:

- Backpatching fills **jump addresses** during intermediate code generation
 - Used in **if, while, goto statements**
-

19. Which phase performs register allocation?

- A) Lexical analysis
- B) Code generation
- C) Syntax analysis
- D) Semantic analysis

Answer: B) Code generation

Explanation:

- Code generator assigns **variables to registers**

- Optimizes **memory access**
-

20. What type of errors does lexical analyzer detect?

- A) Missing semicolon
- B) Invalid token, identifier
- C) Type mismatch
- D) Uninitialized variable

Answer: B) Invalid token, identifier

Explanation:

- Lexical analyzer checks for **illegal characters, invalid identifiers, number formats**
-

21. Which parser is suitable for LL(1) grammar?

- A) Recursive descent parser
- B) SLR parser
- C) LR parser
- D) LALR parser

Answer: A) Recursive descent parser

Explanation:

- LL(1) grammar = **predictive parser grammar**
 - Can implement **top-down parser using recursion**
-

22. What is the role of symbol table?

- A) Store tokens
- B) Store variable/function information
- C) Generate code
- D) Optimize code

Answer: B) Store variable/function info

Explanation:

- Symbol table stores:
 1. Name of identifiers
 2. Type
 3. Scope
 4. Memory location
 - Accessed during **semantic analysis and code generation**
-

23. Which of the following is an example of code optimization?

- A) Constant folding
- B) Loop unrolling
- C) Dead code elimination
- D) All of the above

Answer: D) All of the above

Explanation:

- Optimizations reduce **runtime or memory**:
 1. Constant folding → compute constants at compile time
 2. Loop unrolling → reduce loop overhead
 3. Dead code elimination → remove unused code
-

24. Which phase detects type mismatches?

- A) Lexical analysis
- B) Syntax analysis
- C) Semantic analysis
- D) Code generation

Answer: C) Semantic analysis

Explanation:

- Ensures **type correctness** in operations
- Example: assigning int to float may require **type conversion**

25. Which parser resolves shift-reduce conflicts?

- A) LL parser
- B) SLR parser
- C) Recursive descent
- D) Predictive parser

Answer: B) SLR parser

Explanation:

- Shift-reduce conflict occurs when parser **cannot decide to shift or reduce**
- SLR resolves using **lookahead and parsing table**

26. What is the main difference between SLR and LALR parsers?

- A) SLR uses more states than LALR
- B) LALR uses lookahead symbols to reduce states
- C) SLR cannot parse LL(1) grammar
- D) LALR is top-down parser

Answer: B) LALR uses lookahead symbols to reduce states

Explanation:

- LALR (Look-Ahead LR) parser = optimized version of SLR
- Reduces **number of states while using lookahead** for conflict resolution
- Commonly used in **modern compiler tools like YACC**

27. Which intermediate code form is closest to machine code?

- A) Syntax tree
- B) Three-address code
- C) Quadruples
- D) Assembly code

Answer: D) Assembly code

Explanation:

- Assembly code = **low-level representation**
 - Can be **easily translated to machine code**
 - Intermediate forms (TAC, quadruples) are **machine-independent**
-

28. What is peephole optimization?

- A) Global optimization
- B) Local optimization on small instruction window
- C) Loop optimization
- D) Semantic check

Answer: B) Local optimization on small instruction window

Explanation:

- Peephole optimization examines **small sequences of target code instructions**
 - Replaces with **more efficient sequences**
 - Example: $x = x + 0 \rightarrow$ remove instruction
-

29. Which parser is based on bottom-up parsing?

- A) LL(1)
- B) LR(1)
- C) Recursive descent
- D) Predictive parser

Answer: B) LR(1)

Explanation:

- LR(1) parser = **shift-reduce, bottom-up parsing**
 - L = Left-to-right scanning, R = rightmost derivation
 - Uses **lookahead of 1 symbol** to resolve conflicts
-

30. Which of the following is true about ambiguous grammar?

- A) Has more than one parse tree for a string
- B) Cannot be parsed
- C) Only regular grammar
- D) Does not require parentheses

Answer: A) Has more than one parse tree

Explanation:

- Ambiguous grammar allows **multiple derivations** for same string
- Causes **parsing conflicts**
- Example: $E \rightarrow E + E \mid E * E \mid id$

31. What is a lexical error?

- A) Missing semicolon
- B) Typo in variable name
- C) Invalid token or symbol
- D) Type mismatch

Answer: C) Invalid token or symbol

Explanation:

- Detected in **lexical analysis**
- Examples: @variable, 12a
- Corrected before **syntax analysis**

32. Which type of code generation strategy reduces memory access?

- A) Stack-based
- B) Register allocation
- C) Immediate values
- D) Peephole optimization

Answer: B) Register allocation

Explanation:

- Assigns **frequently used variables to CPU registers**

- Reduces **load/store instructions** → faster execution
-

33. What is a syntax tree?

- A) List of tokens
- B) Graph of variables
- C) Hierarchical representation of program structure
- D) Machine code

Answer: C) Hierarchical representation

Explanation:

- Syntax tree = **parse tree without redundant nodes**
 - Represents **program structure** for semantic analysis and code generation
-

34. Which is true about LL(1) grammar?

- A) Can have left recursion
- B) Predictive parsing table is single entry per cell
- C) Uses shift-reduce
- D) Cannot be parsed top-down

Answer: B) Predictive parsing table is single entry

Explanation:

- LL(1) grammar = suitable for **predictive top-down parser**
 - Each table entry **unique** → no conflict
 - Cannot have **left recursion**
-

35. Which of the following is a type of syntax-directed translation?

- A) Top-down parsing
- B) Bottom-up parsing
- C) Attribute grammar
- D) Code optimization

Answer: C) Attribute grammar

Explanation:

- Attribute grammar associates **attributes with grammar symbols**
 - Semantic actions are **performed along with parsing**
-

36. What is the main task of the semantic analyzer?

- A) Remove comments
- B) Check syntax rules
- C) Ensure meaning is correct
- D) Generate machine code

Answer: C) Ensure meaning is correct

Explanation:

- Checks:
 1. Type compatibility
 2. Scope of identifiers
 3. Function call arguments
 - Builds **symbol table and type information**
-

37. Which intermediate code representation uses operators, arguments, and result?

- A) Syntax tree
- B) Quadruples
- C) Parse table
- D) Assembly code

Answer: B) Quadruples

Explanation:

- Quadruples = (operator, arg1, arg2, result)
- Example: $t1 = a + b \rightarrow (+, a, b, t1)$
- Easy for **optimization and code generation**

38. Which compiler phase performs dead code elimination?

- A) Lexical analysis
- B) Syntax analysis
- C) Semantic analysis
- D) Optimization

Answer: D) Optimization

Explanation:

- Dead code = instructions never executed
 - Optimization phase removes **unnecessary instructions**
 - Improves **runtime efficiency**
-

39. Which phase converts parse tree to intermediate code?

- A) Lexical analysis
- B) Syntax analysis
- C) Semantic analysis
- D) Code generation

Answer: D) Code generation

Explanation:

- Converts **syntax/semantic representation → intermediate code**
 - Helps in **target code generation and optimization**
-

40. Which parsing technique uses lookahead symbol to decide production?

- A) LL(1)
- B) LR(0)
- C) Recursive descent
- D) None

Answer: A) LL(1)

Explanation:

- LL(1) parser uses **one symbol lookahead**
 - Predicts **correct production without backtracking**
-

41. Which of the following is true about shift-reduce parser?

- A) Top-down parser
- B) Bottom-up parser
- C) Uses recursive calls
- D) Eliminates semantic errors

Answer: B) Bottom-up parser

Explanation:

- Constructs **parse tree from leaves to root**
 - Uses **shift (read input) and reduce (apply rule)**
 - Example: SLR, LALR
-

42. What is the role of symbol table in compiler?

- A) Store token list
- B) Store identifiers, types, scopes, memory info
- C) Generate machine code
- D) Optimize code

Answer: B) Store identifiers, types, scopes

Explanation:

- Symbol table used in **semantic analysis and code generation**
 - Helps in **type checking and memory allocation**
-

43. Which is true about recursive descent parser?

- A) Bottom-up parser
- B) Cannot handle LL(1) grammar
- C) Top-down parser using recursion
- D) Uses shift-reduce

Answer: C) Top-down parser using recursion

Explanation:

- Implements each **non-terminal as a function**
 - Suitable for **LL(1) grammars**
-

44. Which optimization technique replaces expressions with constants at compile time?

- A) Loop unrolling
- B) Constant folding
- C) Peephole optimization
- D) Dead code elimination

Answer: B) Constant folding

Explanation:

- Evaluates **constant expressions at compile time**
 - Reduces **runtime computation**
-

45. What is the difference between top-down and bottom-up parsing?

Answer:

- Top-down:
 - Start from **start symbol**
 - Expand productions → match input
 - Example: LL parser
 - Bottom-up:
 - Start from **input symbols**
 - Reduce to start symbol
 - Example: LR parser
-

46. Which parser uses predictive parsing table?

- A) LL(1)
- B) SLR
- C) LR
- D) LALR

Answer: A) LL(1)

Explanation:

- Table entries = **unique mapping of non-terminal and lookahead terminal → production**
 - Ensures **no backtracking**
-

47. Which is a major advantage of LALR parser?

- A) Uses recursion
- B) Reduces number of states compared to canonical LR
- C) Parses all CFLs
- D) Only top-down parsing

Answer: B) Reduces number of states

Explanation:

- LALR parser = optimized SLR/LR
 - Same power but **smaller parsing table**
 - Widely used in **compiler tools**
-

48. Which intermediate code is machine independent and easy to optimize?

- A) Assembly code
- B) Three-address code
- C) Machine code
- D) Bytecode

Answer: B) Three-address code

Explanation:

- TAC = simple, **independent of hardware**
 - Easier for **optimization and translation**
 - Example: $t1 = a + b$
-

49. What is loop unrolling?

- A) Removing loops
- B) Replacing loop with repeated statements to reduce iterations
- C) Constant folding
- D) Semantic analysis

Answer: B) Replace loop with repeated statements

Explanation:

- Loop unrolling reduces **loop overhead**
 - Improves **runtime performance**
-

50. Which phase of compiler assigns memory locations to variables?

- A) Lexical analysis
- B) Syntax analysis
- C) Semantic analysis / Symbol table management
- D) Optimization

Answer: C) Semantic analysis / Symbol table management

Explanation:

- Assign memory addresses **during semantic analysis or early code generation**
 - Symbol table contains **address, type, and scope information**
-

Software Engineering – 50 MCQs

1. What is the main purpose of software engineering?

- A) Writing code only
- B) Systematic development, operation, and maintenance of software
- C) Hardware design
- D) Networking

Answer: B) Systematic development, operation, and maintenance of software

Explanation:

- Software engineering = **application of engineering principles** to software
 - Ensures:
 1. Correctness
 2. Reliability
 3. Maintainability
 4. Efficiency
-

2. Which of the following is a software process model?

- A) Waterfall model
- B) Incremental model
- C) Spiral model
- D) All of the above

Answer: D) All of the above

Explanation:

- Software process models define **sequence of activities**
 - Examples:
 1. **Waterfall:** Sequential phases
 2. **Incremental:** Develop in increments
 3. **Spiral:** Risk-driven iterative model
-

3. What is the first phase of the Waterfall model?

- A) Implementation
- B) Maintenance
- C) Requirements analysis
- D) Testing

Answer: C) Requirements analysis

Explanation:

- Requirements analysis → **gather and document user needs**
 - Followed by: Design → Implementation → Testing → Maintenance
-

4. Which model is best suited for high-risk projects?

- A) Waterfall
- B) Spiral
- C) Incremental
- D) Prototype

Answer: B) Spiral

Explanation:

- Spiral model = **risk-driven approach**
 - Combines **iterative development + risk analysis**
 - Each iteration evaluates **risks and refines requirements**
-

5. Which model allows early delivery of functional software?

- A) Waterfall
- B) Incremental
- C) V-model
- D) Spiral

Answer: B) Incremental

Explanation:

- Incremental model = develop software in **small increments**

- Each increment = **partially functional system**
 - Users can **use early modules**
-

6. Which of the following is a prototyping model advantage?

- A) Reduces user involvement
- B) Helps clarify requirements
- C) High initial cost
- D) Hard to implement

Answer: B) Helps clarify requirements

Explanation:

- Prototyping = **builds a prototype** before final system
 - Users **validate requirements**
 - Reduces **misunderstandings**
-

7. What is a major disadvantage of the Waterfall model?

- A) Easy to understand
- B) Late delivery of working software
- C) Low documentation
- D) High user involvement

Answer: B) Late delivery of working software

Explanation:

- Waterfall is **sequential**
 - Users **see final product late**
 - Difficult to accommodate **requirement changes**
-

8. Which activity comes under software design?

- A) Requirement gathering
- B) Architectural design

- C) Testing
- D) Maintenance

Answer: B) Architectural design

Explanation:

- Software design = **plan solution**
- Levels:
 1. **Architectural design:** overall structure
 2. **Detailed design:** modules, data structures

9. What is software testing?

- A) Writing code
- B) Process to identify defects
- C) Maintenance
- D) Requirement analysis

Answer: B) Process to identify defects

Explanation:

- Testing ensures **software behaves as expected**
- Types:
 1. **Unit testing:** individual modules
 2. **Integration testing:** module interaction
 3. **System testing:** complete system
 4. **Acceptance testing:** user validation

10. Which is a type of black-box testing?

- A) Unit testing
- B) Integration testing
- C) Functional testing
- D) Code coverage testing

Answer: C) Functional testing

Explanation:

- Black-box testing = **test without knowledge of internal code**
 - Focuses on **input-output behavior**
 - Functional testing = verify **software functions as per requirements**
-

11. Which is a type of white-box testing?

- A) Boundary value testing
- B) Path testing
- C) Equivalence partitioning
- D) Functional testing

Answer: B) Path testing

Explanation:

- White-box testing = **knowledge of code structure**
 - Path testing = **cover all possible execution paths**
 - Ensures **code logic correctness**
-

12. Which document describes system requirements in detail?

- A) Design document
- B) SRS (Software Requirements Specification)
- C) Test plan
- D) User manual

Answer: B) SRS

Explanation:

- SRS = **Software Requirements Specification**
- Includes:
 1. Functional requirements
 2. Non-functional requirements

3. Constraints
 4. Interfaces
-

13. Which metric measures the complexity of code?

- A) LOC (Lines of Code)
- B) Cyclomatic complexity
- C) Function points
- D) Coupling metric

Answer: B) Cyclomatic complexity

Explanation:

- Cyclomatic complexity = **number of independent paths**
 - Helps in **estimating testing effort**
-

14. Which design principle reduces inter-module dependency?

- A) Coupling
- B) Cohesion
- C) Encapsulation
- D) Abstraction

Answer: A) Coupling

Explanation:

- Low coupling → modules **independent**
 - High cohesion → module **single responsibility**
 - Good design = **low coupling, high cohesion**
-

15. Which software maintenance type is for correcting errors after delivery?

- A) Adaptive
- B) Corrective
- C) Perfective
- D) Preventive

Answer: B) Corrective

Explanation:

- Corrective maintenance → **fixing bugs**
 - Adaptive → adapt to **new environment**
 - Perfective → **enhance functionality**
 - Preventive → **improve maintainability**
-

16. What is CASE tool in software engineering?

- A) Coding tool
- B) Computer-Aided Software Engineering tool
- C) Compiler
- D) Testing framework

Answer: B) Computer-Aided Software Engineering tool

Explanation:

- CASE tool helps in **design, analysis, documentation, and testing**
 - Examples: Rational Rose, Visual Paradigm
-

17. Which diagram represents objects and their relationships?

- A) DFD
- B) Class diagram
- C) Use case diagram
- D) Flowchart

Answer: B) Class diagram

Explanation:

- Class diagram = **UML diagram**
- Shows:
 1. Classes
 2. Attributes

3. Methods
 4. Relationships
-

18. Which diagram shows dynamic behavior of a system?

- A) Class diagram
- B) Sequence diagram
- C) ER diagram
- D) Use case diagram

Answer: B) Sequence diagram

Explanation:

- Sequence diagram = **interaction of objects over time**
 - Shows **messages and order**
-

19. Which software model is iterative and risk-driven?

- A) Waterfall
- B) Spiral
- C) Incremental
- D) Prototyping

Answer: B) Spiral

Explanation:

- Spiral = **risk-driven, iterative development**
 - Helps manage **complex, high-risk projects**
-

20. What is software reliability?

- A) Time taken to develop software
- B) Probability that software functions correctly under given conditions
- C) Number of lines of code
- D) Performance metric

Answer: B) Probability software functions correctly

Explanation:

- Reliability = **measure of failure-free operation**
 - Evaluated using: **MTBF (Mean Time Between Failures)**
-

21. What is software quality assurance (SQA)?

- A) Writing code
- B) Process to ensure software meets quality standards
- C) Debugging
- D) Deployment

Answer: B) Process to ensure quality

Explanation:

- SQA = **systematic monitoring of software development**
 - Ensures **standards, processes, and procedures** are followed
-

22. Which of the following is a software metric?

- A) LOC
- B) Cyclomatic complexity
- C) Function points
- D) All of the above

Answer: D) All of the above

Explanation:

- Metrics measure **software attributes**
 - LOC = size
 - Cyclomatic complexity = logic complexity
 - Function points = functionality delivered
-

23. Which is an example of functional requirement?

- A) System shall respond within 2 sec
- B) System shall allow user login
- C) System shall run on Windows
- D) System shall be maintainable

Answer: B) Allow user login

Explanation:

- Functional requirement = **what system should do**
 - Non-functional = **performance, usability, reliability**
-

24. Which is an example of non-functional requirement?

- A) User login
- B) Password validation
- C) System response time < 2 sec
- D) Data storage requirement

Answer: C) System response time < 2 sec

Explanation:

- Non-functional = **how system should perform**
 - Includes: performance, reliability, security, maintainability
-

25. Which software testing ensures all modules work together?

- A) Unit testing
- B) Integration testing
- C) System testing
- D) Acceptance testing

Answer: B) Integration testing

Explanation:

- Integration testing = **test module interactions**
 - Detects **interface errors between modules**
-

26. What is the main purpose of a use case diagram?

- A) Show class relationships
- B) Represent system functionalities and interactions with users
- C) Show data flow
- D) Represent code structure

Answer: B) Represent system functionalities and interactions with users

Explanation:

- Use case diagram = **UML diagram**
- Shows:
 1. Actors (users or external systems)
 2. Use cases (system functions)
 3. Relationships (association, include, extend)
- Helps in **requirements gathering and analysis**

27. Which model is most suitable for projects with evolving requirements?

- A) Waterfall
- B) Incremental
- C) Spiral
- D) Prototype

Answer: D) Prototype

Explanation:

- Prototyping allows **early model creation**
- Users can **review and modify requirements**
- Reduces **misunderstanding between developers and clients**

28. What is coupling in software design?

- A) Degree of interaction between modules
- B) Number of lines of code

- C) Number of functions in a module
- D) Degree of similarity within a module

Answer: A) Degree of interaction between modules

Explanation:

- Low coupling → modules **independent**
 - High coupling → modules **heavily dependent**
 - Low coupling = better maintainability
-

29. What is cohesion in software design?

- A) Measure of module independence
- B) Measure of module's single responsibility
- C) Interaction between modules
- D) Number of functions in a module

Answer: B) Measure of module's single responsibility

Explanation:

- High cohesion → module performs a **single well-defined task**
 - Improves **understandability, maintainability, and reliability**
-

30. Which maintenance type is done to adapt software to new environments?

- A) Corrective
- B) Adaptive
- C) Perfective
- D) Preventive

Answer: B) Adaptive

Explanation:

- Adaptive maintenance = **update software for new OS, hardware, or environment**
 - Ensures **software continues to function correctly**
-

31. Which type of maintenance improves performance or usability?

- A) Corrective
- B) Adaptive
- C) Perfective
- D) Preventive

Answer: C) Perfective

Explanation:

- Perfective maintenance → **enhance software functionality, performance, or user interface**
-

32. Which maintenance aims to prevent future problems?

- A) Corrective
- B) Adaptive
- C) Preventive
- D) Perfective

Answer: C) Preventive

Explanation:

- Preventive maintenance → **refactoring, code cleanup, documentation updates**
 - Reduces **future defects and maintenance costs**
-

33. Which diagram is used to show sequence of operations for a function?

- A) Use case diagram
- B) Sequence diagram
- C) Class diagram
- D) Activity diagram

Answer: D) Activity diagram

Explanation:

- Activity diagram = **UML diagram**
- Represents **workflow and operation sequence**

- Helps in visualizing logic and business processes
-

34. Which diagram represents dynamic behavior of objects?

- A) Class diagram
- B) Sequence diagram
- C) ER diagram
- D) Component diagram

Answer: B) Sequence diagram

Explanation:

- Shows interaction between objects over time
 - Includes lifelines, messages, and sequence order
-

35. Which software metric measures functionality delivered to user?

- A) LOC
- B) Cyclomatic complexity
- C) Function points
- D) Defect density

Answer: C) Function points

Explanation:

- Function points = functional size metric
 - Measures features and complexity from user perspective
 - Independent of implementation technology
-

36. Which software model emphasizes iterative development and user feedback?

- A) Waterfall
- B) Spiral
- C) Incremental
- D) Prototype

Answer: D) Prototype

Explanation:

- Prototyping allows **quick iterations**
 - Users **interact with prototype** → refine requirements
 - Reduces **requirement ambiguity**
-

37. Which testing type is performed by end users to accept the software?

- A) Unit testing
- B) Integration testing
- C) System testing
- D) Acceptance testing

Answer: D) Acceptance testing

Explanation:

- Performed **before deployment**
 - Ensures software meets **business and user requirements**
-

38. Which testing ensures the complete system works as intended?

- A) Unit testing
- B) Integration testing
- C) System testing
- D) Acceptance testing

Answer: C) System testing

Explanation:

- System testing = **end-to-end testing of complete system**
 - Validates **functionality, performance, and compliance**
-

39. Which is a characteristic of good software?

- A) Functionality
- B) Reliability
- C) Maintainability
- D) All of the above

Answer: D) All of the above

Explanation:

- Good software should be:
 1. **Functional:** meets requirements
 2. **Reliable:** works correctly under conditions
 3. **Maintainable:** easy to update and modify

40. Which model is also called verification and validation model?

- A) Waterfall
- B) V-model
- C) Spiral
- D) Prototype

Answer: B) V-model

Explanation:

- V-model = **extension of waterfall**
- Verification (left side) → requirement/design validation
- Validation (right side) → corresponding testing phase

41. Which design principle emphasizes hiding module details?

- A) Coupling
- B) Cohesion
- C) Abstraction
- D) Modularity

Answer: C) Abstraction

Explanation:

- Abstraction = **hide unnecessary details**
 - Focus on **essential features**
 - Supports **modular design and maintainability**
-

42. Which UML diagram shows static structure of classes?

- A) Class diagram
- B) Sequence diagram
- C) Activity diagram
- D) Use case diagram

Answer: A) Class diagram

Explanation:

- Class diagram = **static structure**
 - Shows:
 1. Classes
 2. Attributes & methods
 3. Relationships (association, inheritance)
-

43. Which diagram represents relationships between entities in a database?

- A) Class diagram
- B) Sequence diagram
- C) ER diagram
- D) Use case diagram

Answer: C) ER diagram

Explanation:

- Entity-Relationship (ER) diagram
- Shows:
 1. Entities
 2. Attributes

3. Relationships

- Used for **database design**
-

44. Which model combines prototyping and risk assessment?

- A) Waterfall
- B) Spiral
- C) Incremental
- D) Agile

Answer: B) Spiral

Explanation:

- Spiral model = **risk-driven**
 - Combines **prototyping, iterative development, and risk management**
-

45. Which software metric measures number of defects per thousand lines of code?

- A) LOC
- B) Cyclomatic complexity
- C) Defect density
- D) Function points

Answer: C) Defect density

Explanation:

- Defect density = **number of defects / size of code (KLOC)**
 - Helps **assess software quality**
-

46. Which model is highly structured and sequential?

- A) Waterfall
- B) Spiral
- C) Incremental
- D) Prototype

Answer: A) Waterfall

Explanation:

- Waterfall = **strict sequential phases**
 - Each phase **depends on previous**
 - Hard to **accommodate requirement changes**
-

47. Which diagram shows system functionality from user perspective?

- A) Class diagram
- B) Sequence diagram
- C) Use case diagram
- D) Activity diagram

Answer: C) Use case diagram

Explanation:

- Represents **actors and use cases**
 - Focuses on **what system should do, not how**
-

48. Which type of software testing covers all program paths?

- A) Unit testing
- B) Integration testing
- C) White-box testing
- D) Black-box testing

Answer: C) White-box testing

Explanation:

- White-box testing = **knowledge of code**
 - Ensures **all paths, conditions, and branches are tested**
-

49. Which model allows software delivery in small, usable pieces?

- A) Waterfall
- B) Incremental
- C) Spiral
- D) V-model

Answer: B) Incremental

Explanation:

- Incremental → **deliver partial functionality in increments**
 - Users can **start using system early**
-

50. Which activity is part of software configuration management (SCM)?

- A) Code version control
- B) Requirement gathering
- C) Testing
- D) Design

Answer: A) Code version control

Explanation:

- SCM ensures:
 1. **Versioning of code and documents**
 2. **Tracking changes**
 3. **Collaboration among team members**
 - Important for **Maintainability and coordination**
-

Artificial Intelligence & Machine Learning – 50 MCQs

1. What is Artificial Intelligence (AI)?

- A) Hardware design
- B) Programming languages
- C) Simulation of human intelligence by machines
- D) Network protocols

Answer: C) Simulation of human intelligence by machines

Explanation:

- AI = **field of computer science**
 - Goal: enable machines to **think, reason, learn, and solve problems**
 - Applications: **chatbots, self-driving cars, game playing**
-

2. Which of the following is a type of AI?

- A) Narrow AI
- B) General AI
- C) Super AI
- D) All of the above

Answer: D) All of the above

Explanation:

- **Narrow AI:** Performs **specific task** (e.g., Siri)
 - **General AI:** Performs **any intellectual task** like humans
 - **Super AI:** Surpasses human intelligence
-

3. What is Machine Learning (ML)?

- A) Manual programming
- B) Technique for machines to learn from data
- C) Database management
- D) Operating system

Answer: B) Technique for machines to learn from data

Explanation:

- ML = **subset of AI**
 - Machine **learns patterns from data** without explicit programming
 - Tasks: classification, regression, clustering
-

4. Which is a type of ML based on labeled data?

- A) Supervised learning
- B) Unsupervised learning
- C) Reinforcement learning
- D) Deep learning

Answer: A) Supervised learning

Explanation:

- Supervised learning:
 1. Data has **input-output pairs**
 2. Model **learns mapping** from input to output
 - Examples: **Linear regression, Decision trees**
-

5. Which ML type finds hidden patterns in unlabeled data?

- A) Supervised learning
- B) Unsupervised learning
- C) Reinforcement learning
- D) Semi-supervised learning

Answer: B) Unsupervised learning

Explanation:

- Unsupervised learning: **no labels provided**
 - Finds **clusters, associations, anomalies**
 - Examples: **K-means clustering, PCA**
-

6. Which ML type learns by interacting with environment?

- A) Supervised learning
- B) Unsupervised learning
- C) Reinforcement learning
- D) Deep learning

Answer: C) Reinforcement learning

Explanation:

- RL agent learns via **trial and error**
 - Receives **rewards or penalties**
 - Examples: **self-driving cars, game AI**
-

7. Which algorithm is used for classification?

- A) Linear regression
- B) Logistic regression
- C) K-means
- D) PCA

Answer: B) Logistic regression

Explanation:

- Logistic regression = **supervised algorithm**
 - Predicts **categorical outcome (0/1)**
 - Uses **sigmoid function** for probability output
-

8. Which algorithm is used for predicting continuous values?

- A) Linear regression
- B) Logistic regression
- C) KNN (classification)
- D) Decision tree classifier

Answer: A) Linear regression

Explanation:

- Linear regression = **predicts numeric values**
 - Equation: $y = mx + c$
 - Example: Predicting **house prices**
-

9. Which algorithm is used for clustering?

- A) Decision tree
- B) K-means
- C) Naive Bayes
- D) Linear regression

Answer: B) K-means

Explanation:

- K-means = **unsupervised learning**
 - Groups data into **k clusters based on similarity**
 - Iteratively minimizes **distance within clusters**
-

10. Which algorithm uses reward signal to improve policy?

- A) Supervised learning
- B) Unsupervised learning
- C) Reinforcement learning
- D) Decision trees

Answer: C) Reinforcement learning

Explanation:

- RL agent **maximizes cumulative reward**
 - Learns **optimal policy for actions**
 - Example: **Q-learning, Deep Q Network**
-

11. Which is a deep learning architecture?

- A) Linear regression
- B) Convolutional Neural Network (CNN)
- C) Decision tree
- D) K-means

Answer: B) Convolutional Neural Network

Explanation:

- CNN = **deep neural network**
 - Used for **image recognition, object detection**
 - Layers: **convolution, pooling, fully connected**
-

12. What is overfitting in ML?

- A) Model performs well on unseen data
- B) Model performs poorly on training data
- C) Model performs well on training data but poorly on unseen data
- D) Model ignores data

Answer: C) Performs well on training but poorly on unseen

Explanation:

- Overfitting = **model too complex**
 - Captures **noise in training data**
 - Solution: **regularization, cross-validation**
-

13. Which technique prevents overfitting?

- A) Increase layers
- B) Cross-validation
- C) Reduce training data
- D) Remove test set

Answer: B) Cross-validation

Explanation:

- Cross-validation = **split data into training and validation sets**

- Ensures **model generalizes well**
 - Other techniques: **regularization, pruning, dropout**
-

14. Which is a feature selection technique?

- A) PCA
- B) Linear regression
- C) Decision tree
- D) K-means

Answer: A) PCA

Explanation:

- Principal Component Analysis (PCA) = **dimensionality reduction**
 - Selects **most important features**
 - Reduces **noise and computational cost**
-

15. Which is a common activation function in neural networks?

- A) Linear function
- B) Sigmoid function
- C) Exponential function
- D) Square function

Answer: B) Sigmoid function

Explanation:

- Sigmoid maps input → **0 to 1**
 - Used for **probabilistic outputs in classification**
 - Other functions: **ReLU, Tanh**
-

16. Which loss function is used in regression?

- A) Mean Squared Error (MSE)
- B) Cross-entropy

- C) Hinge loss
- D) Log loss

Answer: A) Mean Squared Error

Explanation:

- MSE = average of **squared differences between predicted and actual values**
 - Common in **linear regression and neural networks**
-

17. Which loss function is used in classification?

- A) MSE
- B) Cross-entropy
- C) Mean absolute error
- D) Huber loss

Answer: B) Cross-entropy

Explanation:

- Cross-entropy measures **difference between predicted and true probability distributions**
 - Suitable for **binary and multi-class classification**
-

18. Which ML algorithm is probabilistic?

- A) Decision tree
- B) KNN
- C) Naive Bayes
- D) K-means

Answer: C) Naive Bayes

Explanation:

- Naive Bayes = **Bayes theorem-based classifier**
- Assumes **feature independence**
- Examples: **spam detection, text classification**

19. Which algorithm finds decision boundaries?

- A) Linear regression
- B) Support Vector Machine (SVM)
- C) K-means
- D) PCA

Answer: B) SVM

Explanation:

- SVM finds **hyperplane that separates classes**
 - Maximizes **margin between classes**
 - Can use **kernel trick for non-linear boundaries**
-

20. Which ML algorithm is lazy learning?

- A) Decision tree
- B) K-Nearest Neighbor (KNN)
- C) Logistic regression
- D) Naive Bayes

Answer: B) KNN

Explanation:

- Lazy learning = **no explicit training phase**
 - Stores **training data**
 - Predicts output based on **nearest neighbors**
-

21. Which learning type is semi-supervised?

- A) Uses only labeled data
- B) Uses only unlabeled data
- C) Uses both labeled and unlabeled data
- D) Uses reward signals

Answer: C) Uses both labeled and unlabeled data

Explanation:

- Semi-supervised learning = **limited labeled + abundant unlabeled data**
 - Reduces **labeling effort**
-

22. Which optimization algorithm is commonly used in neural networks?

- A) Gradient Descent
- B) K-means
- C) PCA
- D) Naive Bayes

Answer: A) Gradient Descent

Explanation:

- Iteratively updates **weights to minimize loss function**
 - Variants: **SGD, Adam, RMSprop**
-

23. Which metric is used for classification evaluation?

- A) Mean Squared Error
- B) Accuracy, Precision, Recall, F1-score
- C) Covariance
- D) Loss function

Answer: B) Accuracy, Precision, Recall, F1-score

Explanation:

- Accuracy = correct predictions / total
 - Precision = correct positive / predicted positive
 - Recall = correct positive / actual positive
 - F1 = harmonic mean of precision & recall
-

24. Which metric is used for regression evaluation?

- A) Accuracy
- B) Precision
- C) Mean Squared Error
- D) Recall

Answer: C) Mean Squared Error

Explanation:

- Measures **difference between predicted and actual values**
 - Lower MSE → better model performance
-

25. Which algorithm reduces dimensionality of data?

- A) PCA
- B) SVM
- C) Logistic regression
- D) KNN

Answer: A) PCA

Explanation:

- Principal Component Analysis = **projects data onto fewer dimensions**
- Preserves **maximum variance**

26. Which type of neural network is used for image recognition?

- A) Recurrent Neural Network (RNN)
- B) Convolutional Neural Network (CNN)
- C) Feedforward Neural Network
- D) Boltzmann Machine

Answer: B) Convolutional Neural Network

Explanation:

- CNN = **specialized neural network for spatial data**
- Layers:
 1. Convolution → feature extraction

2. Pooling → downsampling
 3. Fully connected → classification
- Common in **image and video recognition**
-

27. Which neural network is used for sequential data like text or time series?

- A) CNN
- B) RNN
- C) Feedforward NN
- D) Autoencoder

Answer: B) Recurrent Neural Network

Explanation:

- RNN = **recurrent connections** for sequence information
 - Can **remember previous inputs** (short-term memory)
 - Applications: **speech recognition, language modeling**
-

28. Which technique prevents overfitting in deep learning?

- A) Dropout
- B) Increase learning rate
- C) Reduce data size
- D) Use fewer layers

Answer: A) Dropout

Explanation:

- Dropout = **randomly deactivate neurons during training**
 - Prevents **over-reliance on specific neurons**
 - Improves **generalization**
-

29. Which activation function avoids vanishing gradient problem?

- A) Sigmoid
- B) Tanh
- C) ReLU
- D) Linear

Answer: C) ReLU (Rectified Linear Unit)

Explanation:

- $\text{ReLU} = \max(0, x)$
 - Keeps **positive gradients intact**
 - Common in **hidden layers of deep networks**
-

30. What is batch gradient descent?

- A) Updates weights after each sample
- B) Updates weights after the whole dataset
- C) Updates weights randomly
- D) Updates weights partially

Answer: B) Updates weights after the whole dataset

Explanation:

- Batch gradient descent = **compute gradient using all training samples**
 - Pros: stable convergence
 - Cons: **slow for large datasets**
-

31. Which gradient descent variant updates weights after each sample?

- A) Batch GD
- B) Stochastic GD (SGD)
- C) Mini-batch GD
- D) Momentum

Answer: B) Stochastic Gradient Descent

Explanation:

- SGD = **update weights after each training example**

- Pros: faster convergence
 - Cons: noisy updates
-

32. What is reinforcement learning reward?

- A) Penalty for error
- B) Signal to guide agent toward desired behavior
- C) Random number
- D) Input feature

Answer: B) Signal to guide agent

Explanation:

- Reward = **feedback for action taken**
 - Goal: **maximize cumulative reward**
 - Example: game score, successful navigation
-

33. Which type of learning uses exploration and exploitation?

- A) Supervised learning
- B) Unsupervised learning
- C) Reinforcement learning
- D) Semi-supervised learning

Answer: C) Reinforcement learning

Explanation:

- Exploration → try new actions
 - Exploitation → use known actions for reward
 - Balancing **exploration vs. exploitation** is key in RL
-

34. Which ML algorithm is tree-based and interpretable?

- A) Linear regression
- B) Decision tree

- C) Neural network
- D) KNN

Answer: B) Decision tree

Explanation:

- Decision tree splits data using **features and thresholds**
 - Provides **human-readable rules**
 - Can be used for **classification and regression**
-

35. Which ensemble method combines weak learners sequentially?

- A) Bagging
- B) Boosting
- C) Random Forest
- D) K-means

Answer: B) Boosting

Explanation:

- Boosting = **combine weak learners sequentially**
 - Each learner focuses on **errors of previous**
 - Example: AdaBoost, Gradient Boosting
-

36. Which ensemble method reduces variance by parallel combination?

- A) Bagging
- B) Boosting
- C) Gradient Descent
- D) PCA

Answer: A) Bagging

Explanation:

- Bagging = **train multiple models in parallel on random subsets**
- Reduces **variance and overfitting**

- Example: Random Forest
-

37. Which type of neural network compresses and reconstructs data?

- A) CNN
- B) Autoencoder
- C) RNN
- D) GAN

Answer: B) Autoencoder

Explanation:

- Autoencoder = **encoder + decoder**
 - Learns **compressed latent representation**
 - Applications: **dimensionality reduction, anomaly detection**
-

38. Which ML algorithm is used for anomaly detection?

- A) K-means
- B) Isolation Forest
- C) Decision tree
- D) Linear regression

Answer: B) Isolation Forest

Explanation:

- Isolation Forest = **unsupervised anomaly detection**
 - Isolates anomalies based on **few splits required**
 - Efficient for **large datasets**
-

39. Which GAN component generates data?

- A) Discriminator
- B) Generator
- C) Encoder
- D) Decoder

Answer: B) Generator

Explanation:

- GAN = Generative Adversarial Network
 - Generator → **produces fake samples**
 - Discriminator → **distinguishes real vs fake**
 - Trains **adversarially**
-

40. Which GAN component classifies real vs fake data?

- A) Generator
- B) Discriminator
- C) Encoder
- D) Decoder

Answer: B) Discriminator

Explanation:

- Discriminator = **binary classifier**
 - Provides **feedback to generator** to improve generation
-

41. Which ML algorithm is sensitive to feature scaling?

- A) Decision tree
- B) KNN
- C) Naive Bayes
- D) Random Forest

Answer: B) KNN

Explanation:

- KNN uses **distance metrics** (Euclidean, Manhattan)
 - Features must be **normalized/scaled** to prevent dominance
-

42. Which ML algorithm assumes feature independence?

- A) Naive Bayes
- B) SVM
- C) KNN
- D) Decision tree

Answer: A) Naive Bayes

Explanation:

- Assumes **all features are independent given the class**
- Simplifies **probability calculation**
- Effective for **text classification**

43. Which ML algorithm maximizes margin between classes?

- A) Decision tree
- B) SVM
- C) K-means
- D) Linear regression

Answer: B) SVM

Explanation:

- Finds **optimal hyperplane**
- Maximizes **distance between closest points of classes (support vectors)**

44. Which ML technique reduces overfitting by adding penalty to large weights?

- A) Dropout
- B) Regularization (L1/L2)
- C) Early stopping
- D) PCA

Answer: B) Regularization

Explanation:

- Regularization adds **penalty term** to loss

- L1 → sparsity
 - L2 → small weights
 - Reduces **overfitting**
-

45. Which deep learning model is used for sequence-to-sequence tasks?

- A) CNN
- B) RNN / LSTM
- C) Autoencoder
- D) SVM

Answer: B) RNN / LSTM

Explanation:

- LSTM = **Long Short-Term Memory**
 - Handles **long-term dependencies** in sequences
 - Applications: **translation, chatbots**
-

46. Which ML algorithm is suitable for imbalanced classification?

- A) Linear regression
- B) Random Forest with class weighting
- C) K-means
- D) PCA

Answer: B) Random Forest with class weighting

Explanation:

- Imbalanced data → class with fewer samples may be ignored
 - Solutions:
 1. Class weighting
 2. Oversampling (SMOTE)
 3. Undersampling
-

47. Which deep learning model generates realistic images?

- A) Autoencoder
- B) GAN
- C) RNN
- D) CNN classifier

Answer: B) GAN

Explanation:

- GANs produce **high-quality synthetic images**
- Applications: art, data augmentation, deepfakes

48. Which metric is suitable for multi-class classification?

- A) Precision
- B) Recall
- C) F1-score (macro / weighted)
- D) MSE

Answer: C) F1-score (macro / weighted)

Explanation:

- F1-score balances **precision and recall**
- Macro → average over classes
- Weighted → weighted by class size

49. Which algorithm can perform both classification and regression?

- A) Linear regression
- B) Decision tree
- C) K-means
- D) Naive Bayes

Answer: B) Decision tree

Explanation:

- Decision tree:

- Classification tree → categorical output
 - Regression tree → continuous output
-

50. Which type of learning involves feedback but no explicit labels?

- A) Supervised
- B) Unsupervised
- C) Reinforcement
- D) Semi-supervised

Answer: C) Reinforcement learning

Explanation:

- Agent receives **reward or penalty**
 - Learns **optimal strategy without labeled input-output pairs**
-

Programming in C/C++/Java – 50 MCQs

1. Which of the following is a correct syntax to declare an integer variable in C?

- A) int a;
- B) integer a;
- C) float a;
- D) var a;

Answer: A) int a;

Explanation:

- int keyword → declares integer variable
- Other options:
 - integer → invalid in C

- float → declares floating-point
 - var → not used in C
-

2. What is the default value of an uninitialized local variable in C?

- A) 0
- B) NULL
- C) Garbage value
- D) 1

Answer: C) Garbage value

Explanation:

- Local variables are **not automatically initialized**
 - They contain **random (garbage) data**
 - Global/static variables default to **0**
-

3. Which operator is used to access members of a structure through a pointer in C/C++?

- A) .
- B) ->
- C) *
- D) &

Answer: B) ->

Explanation:

- -> = **dereference pointer to structure and access member**
 - Example: ptr->member
 - . = access member directly from object
-

4. Which of the following is a loop in C/C++?

- A) for
- B) while

- C) do-while
- D) All of the above

Answer: D) All of the above

Explanation:

- C/C++ supports **three types of loops**
 1. for → counted iteration
 2. while → condition checked before loop
 3. do-while → condition checked after loop
-

5. What is the size of int in 32-bit system in C?

- A) 2 bytes
- B) 4 bytes
- C) 8 bytes
- D) 1 byte

Answer: B) 4 bytes

Explanation:

- Typical 32-bit system:
 - int = 4 bytes
 - char = 1 byte
 - float = 4 bytes
 - double = 8 bytes
-

6. Which of the following is used to allocate memory dynamically in C?

- A) malloc()
- B) calloc()
- C) realloc()
- D) All of the above

Answer: D) All of the above

Explanation:

- `malloc()` → allocates memory without initialization
 - `calloc()` → allocates and **initializes to zero**
 - `realloc()` → **resizes previously allocated memory**
-

7. Which of the following is used for exception handling in C++?

- A) try-catch
- B) if-else
- C) switch-case
- D) throw-catch

Answer: A) try-catch

Explanation:

- C++ supports **exception handling**
 - Structure:
 - `try { /* code */ }`
 - `catch(ExceptionType e) { /* handle */ }`
 - `throw` is used to **raise exceptions**
-

8. What is polymorphism in C++?

- A) Code reuse
- B) Ability to take multiple forms
- C) Data hiding
- D) Inheritance

Answer: B) Ability to take multiple forms

Explanation:

- Polymorphism types:
 1. **Compile-time (Function/Operator overloading)**
 2. **Run-time (Virtual functions)**

- Allows same interface, different behavior
-

9. Which is an example of compile-time polymorphism?

- A) Function overloading
- B) Virtual function
- C) Pure virtual function
- D) Exception handling

Answer: A) Function overloading

Explanation:

- Compile-time polymorphism = **resolved during compilation**
 - Examples: **function overloading, operator overloading**
-

10. Which is an example of run-time polymorphism?

- A) Operator overloading
- B) Function overloading
- C) Virtual function
- D) Constructor overloading

Answer: C) Virtual function

Explanation:

- Run-time polymorphism = **resolved during execution**
 - Achieved by **inheritance + virtual functions**
-

11. What is the output of System.out.println(5 + "5"); in Java?

- A) 10
- B) 55
- C) 5
- D) Error

Answer: B) 55

Explanation:

- "5" is a string
 - + operator → **concatenation** when string involved
 - Result: "5" + "5" = "55"
-

12. Which keyword is used to inherit a class in Java?

- A) implements
- B) extends
- C) inherit
- D) super

Answer: B) extends

Explanation:

- extends → used for **class inheritance**
 - Example: class B extends A { }
-

13. Which keyword is used to implement an interface in Java?

- A) extends
- B) implements
- C) interface
- D) super

Answer: B) implements

Explanation:

- implements → class implements **interface methods**
 - Example:
 - class A implements MyInterface { }
-

14. Which is a primitive data type in Java?

- A) String
- B) int

- C) ArrayList
- D) Scanner

Answer: B) int

Explanation:

- Java primitive types: byte, short, int, long, float, double, char, boolean
 - String, ArrayList → objects
-

15. Which of the following is correct for Java main method?

- A) public static void main(String[] args)
- B) private static void main(String args)
- C) public void main(String args)
- D) static void main()

Answer: A) public static void main(String[] args)

Explanation:

- Correct signature required by JVM to start execution
 - Must be **public, static, void, accept String array**
-

16. Which operator is used for scope resolution in C++?

- A) :
- B) ::
- C) .
- D) ->

Answer: B) ::

Explanation:

- Scope resolution :: → access **global variable or class static members**
 - Example: ClassName::staticMember
-

17. What is encapsulation in OOP?

- A) Hiding internal data
- B) Inheritance
- C) Polymorphism
- D) Operator overloading

Answer: A) Hiding internal data

Explanation:

- Encapsulation → **wrap data and methods in class**
 - Access controlled using **private, protected, public**
 - Ensures **data security and integrity**
-

18. Which of the following is a constructor in C++?

- A) Function with return type
- B) Function with same name as class
- C) Function with void return type
- D) Any function in class

Answer: B) Function with same name as class

Explanation:

- Constructor → **special function called during object creation**
 - Does **not have return type**
 - Can be **default, parameterized, copy constructor**
-

19. What is the purpose of super keyword in Java?

- A) Call parent class constructor or method
- B) Call child class constructor
- C) Access private member
- D) Handle exceptions

Answer: A) Call parent class constructor or method

Explanation:

- **super** → reference to **parent class**

- Used for:
 1. Call parent **constructor**
 2. Access parent **method or variable**
-

20. Which C++ feature allows same function name but different parameters?

- A) Polymorphism
- B) Encapsulation
- C) Function overloading
- D) Inheritance

Answer: C) Function overloading

Explanation:

- Same function name → **different parameter list**
 - Compiler **resolves correct function during compile-time**
-

21. Which of the following is correct syntax to create an object in C++?

- A) `ClassName obj;`
- B) `ClassName* obj = new ClassName();`
- C) Both A and B
- D) `new ClassName obj;`

Answer: C) Both A and B

Explanation:

- Object can be **stack-allocated**: `ClassName obj;`
 - Or **heap-allocated**: `ClassName* obj = new ClassName();`
-

22. Which operator is used for pointer dereferencing in C/C++?

- A) *
- B) &
- C) ->
- D) .

Answer: A) *

Explanation:

- *ptr → access value at pointer address
 - &var → get address
 - ptr->member → pointer to struct/class member
-

23. Which Java keyword is used for defining constants?

- A) static
- B) final
- C) const
- D) constant

Answer: B) final

Explanation:

- final → makes variable value **immutable**
 - Also used for **methods (cannot override)** and **classes (cannot inherit)**
-

24. Which of the following is not a valid Java identifier?

- A) _myVar
- B) \$myVar
- C) 1myVar
- D) myVar1

Answer: C) 1myVar

Explanation:

- Java identifiers **cannot start with a digit**
 - Can start with **letter, _ or \$**
-

25. Which method is called automatically when an object is garbage collected in Java?

- A) finalize()
- B) destructor()
- C) main()
- D) free()

Answer: A) finalize()

Explanation:

- finalize() → called **before object is destroyed** by JVM
- Can be used to **release resources**

26. What is the size of a pointer in 64-bit system in C/C++?

- A) 2 bytes
- B) 4 bytes
- C) 8 bytes
- D) Depends on data type

Answer: C) 8 bytes

Explanation:

- Pointer stores **memory address**
- On **64-bit system**, address = 8 bytes
- Size is **independent of data type it points to**

27. Which of the following is used to handle multiple exceptions in Java?

- A) Multiple try blocks
- B) Multi-catch block
- C) Nested loops
- D) Throws keyword

Answer: B) Multi-catch block

Explanation:

- Java 7+ allows **catching multiple exceptions in one block**
- Syntax: catch (IOException | SQLException e)

- Reduces **code duplication**
-

28. Which operator is used for address-of in C/C++?

- A) *
- B) &
- C) ->
- D) %

Answer: B) &

Explanation:

- &variable → gives **memory address**
 - * → dereference pointer to get value
-

29. Which of the following is true for Java strings?

- A) Strings are mutable
- B) Strings are objects
- C) Strings cannot be compared
- D) Strings are primitive types

Answer: B) Strings are objects

Explanation:

- Java String = **class object**
 - Immutable → content cannot be changed
 - Compared using **equals()** method
-

30. What is the default access modifier for class members in C++?

- A) private
- B) protected
- C) public
- D) default

Answer: A) private

Explanation:

- Class members **private by default** in C++
 - Struct members **public by default**
-

31. Which Java keyword is used to inherit an interface?

- A) extends
- B) implements
- C) inherits
- D) super

Answer: A) extends (for interfaces)

Explanation:

- Interface → interface inheritance uses extends
 - Class implements interface using implements
-

32. What is the purpose of const keyword in C++?

- A) Declare constant variable
- B) Prevent object modification
- C) Both A & B
- D) None of the above

Answer: C) Both A & B

Explanation:

- `const int x = 10;` → x cannot change
 - Can also declare **constant pointers or function parameters**
-

33. Which operator is used for member access in C++ object?

- A) .
- B) ->
- C) *
- D) &

Answer: A) .

Explanation:

- . → access **object's member directly**
 - -> → access member through pointer
-

34. Which loop executes at least once even if condition is false?

- A) for
- B) while
- C) do-while
- D) None

Answer: C) do-while

Explanation:

- Condition checked **after execution**
 - Ensures **loop body executes at least once**
-

35. Which of the following is not an OOP feature in C++/Java?

- A) Encapsulation
- B) Inheritance
- C) Polymorphism
- D) Goto statements

Answer: D) Goto statements

Explanation:

- OOP features:
 1. Encapsulation → hide data
 2. Inheritance → reuse code
 3. Polymorphism → multiple forms
 - goto → procedural programming feature
-

36. Which C++ feature allows dynamic binding?

- A) Function overloading
- B) Virtual function
- C) Inline function
- D) Friend function

Answer: B) Virtual function

Explanation:

- Virtual function → **enables run-time polymorphism**
 - Function call **resolved at runtime**
-

37. What is the default value of boolean in Java?

- A) true
- B) false
- C) 0
- D) null

Answer: B) false

Explanation:

- Instance boolean variable → **false**
 - Local boolean variable → **undefined until initialized**
-

38. Which of the following is correct syntax for template in C++?

- A) template <class T>
- B) template [class T]
- C) template {class T}
- D) template (class T)

Answer: A) template <class T>

Explanation:

- Templates → **generic programming**
- Syntax:

- template <class T>
 - T add(T a, T b) { return a + b; }
-

39. Which C++ feature allows one class to access private members of another class?

- A) Friend function/class
- B) Virtual function
- C) Inheritance
- D) Constructor

Answer: A) Friend function/class

Explanation:

- Friend → **special function/class with access to private/protected members**
 - Declared with friend keyword
-

40. Which method in Java is used to get object's hash code?

- A) hashCode()
- B) toString()
- C) equals()
- D) getCode()

Answer: A) hashCode()

Explanation:

- hashCode() → returns **integer hash for object**
 - Used in **hash-based collections** like HashMap
-

41. Which of the following is correct way to handle multiple inheritance in Java?

- A) A class can extend multiple classes
- B) A class can implement multiple interfaces

- C) Java does not support any inheritance
- D) Java supports multiple class inheritance

Answer: B) A class can implement multiple interfaces

Explanation:

- Java → **no multiple class inheritance**
 - Can implement **multiple interfaces**
-

42. Which exception is thrown when array index is invalid in Java?

- A) ArrayIndexOutOfBoundsException
- B) NullPointerException
- C) IOException
- D) IllegalArgumentException

Answer: A) ArrayIndexOutOfBoundsException

Explanation:

- Accessing index outside **0 to length-1** → exception
 - Example: int arr[5]; arr[6];
-

43. Which of the following is true about static keyword in C++/Java?

- A) Static variables are shared across objects
- B) Static methods can access non-static members
- C) Static methods cannot exist
- D) Static variable created on stack

Answer: A) Static variables are shared across objects

Explanation:

- Static → **single copy for all objects**
 - Can be used for **methods or variables**
 - Stored in **class memory, not heap/stack**
-

44. Which data type is default for floating-point literals in Java?

- A) float
- B) double
- C) long
- D) int

Answer: B) double

Explanation:

- Java **floating literals** → default double
 - Add f suffix → float
 - float x = 5.5f;
-

45. Which C++ operator is used to call constructor explicitly?

- A) ()
- B) ::
- C) new
- D) delete

Answer: C) new

Explanation:

- new ClassName() → allocates memory and **calls constructor**
 - Example: MyClass* obj = new MyClass();
-

46. Which keyword in Java is used to prevent method overriding?

- A) final
- B) static
- C) abstract
- D) synchronized

Answer: A) final

Explanation:

- final → cannot override method in subclass

- Also used to declare **constants and final classes**
-

47. Which is true about destructors in C++?

- A) Called automatically when object goes out of scope
- B) Can be overloaded
- C) Must return void
- D) Both A and C

Answer: D) Both A and C

Explanation:

- Destructor → ~ClassName()
 - Called **automatically**
 - Cannot have return type**
-

48. Which Java access modifier allows access within same package only?

- A) public
- B) private
- C) protected
- D) default (no modifier)

Answer: D) default (no modifier)

Explanation:

- Default → accessible **within package**
 - public → everywhere
 - protected → package + subclasses
 - private → within class only
-

49. Which is true for abstract class in Java?

- A) Cannot have constructor
- B) Can have abstract and concrete methods

- C) Cannot have fields
- D) Can be instantiated

Answer: B) Can have abstract and concrete methods

Explanation:

- Abstract class → cannot instantiate
- Can have:
 - Abstract methods → must override
 - Concrete methods → implemented
- Can have fields, constructors

50. Which C++ feature allows defining same operator for user-defined types?

- A) Operator overloading
- B) Function overloading
- C) Polymorphism
- D) Encapsulation

Answer: A) Operator overloading

Explanation:

- Allows **custom behavior for operators**
- Example: + for complex numbers

Complex operator+(Complex c1, Complex c2);
