ChatGPT

Python Syntax and Logic

Python uses indentation for code blocks. For example, `print('ab' * 3)` produces `'ababab'` by string repetition [1]. Below are 40 short MCQs on Python syntax and logic:

1. Who built the Python programming language?
   (A) Wick van Rossum (B) Rasmus Lerdorf (C) **Guido van Rossum** (D) Niene Stom [2].
   Answer: (C), since Python was created by Guido van Rossum [2].

2. Which programming paradigms does Python support?
   (A) Object-oriented (B) Structured (C) Functional (D) **All of the above** [3].
   Answer: (D), Python is an interpreted language supporting OOP, structured and functional programming [3].

3. In Python, what is the output of `print(4 + 3 % 5)`?
   (A) 7 (B) 2 (C) 4 (D) 1.
   Answer: (A) 7 (because modulus has higher precedence).

4. Which keyword is used to define a function?
   (A) `func` (B) `define` (C) `def` (D) `fun`.

5. What does `print(type([]))` output?
   (A) `<class 'list'>` (B) `<type 'list'>` (C) `<class 'tuple'>` (D) `<class 'list'>`.
   Answer: (A), because `[]` denotes a list, so its type is `list`.

6. Which of these is a tuple literal?
   (A) `[1,2,3]` (B) `(1,2,3)` (C) `{1,2,3}` (D) `1,2,3`.
   Answer: (B). Parentheses create a tuple, square brackets create a list.

7. What is the result of the following code?

```
x = "Code"
x += "Review"
print(x)
```

   (A) `Code` (B) `Review` (C) `CodeReview` (D) Error.
   Answer: (C) `CodeReview`, because `+=` concatenates strings.

8. Which of the following is used to define a block of code in Python?
   (A) **Indentation** (B) Brackets `{}` (C) Parentheses `()` (D) Quotation marks.
   Answer: (A) Indentation.

9. What is the default value of a boolean variable in Python?
   (A) True (B) **False** (C) 0 (D) None.
   Answer: (B) False (uninitialized booleans are False in Python).

10. How do you insert the value `5` into a set `s`?
    (A) `s.add(5)` (B) `s.append(5)` (C) `s.add(5)` (D) `s.insert(5)`.

11. Which of the following is true about Python variable names?
    (A) Must start with a digit (B) **Unlimited length** (C) Only lowercase letters (D) Cannot have underscores [4].
    Answer: (B). Python allows identifiers of unlimited length [4].

12. What does `//` (double slash) operator do?
    (A) Division (float) (B) **Integer division (floor)** (C) Exponent (D) Modulus.

13. Which of these is valid indentation?
    (A) 2 spaces then code (B) 4 spaces then code (C) **Any consistent indent** (D) Tab characters only.
    Answer: (C). Python requires consistent indentation; typically 4 spaces is standard.

14. Which operator concatenates strings?
    (A) `,` (B) `*` (C) `+` (D) `&`.

15. What is the effect of `continue` in a loop?
    (A) Stop loop entirely (B) Skip the rest of the current iteration (C) **Skip current iteration, continue next** (D) Exit function.

16. What built-in function converts a string to an integer?
    (A) `int(str)` (B) `int(str)` (C) `string.toInt()` (D) `to_integer(str)`.

17. Which of these is not a core Python data type?
    (A) List (B) Dictionary (C) **Pointer** (D) Set [5].
    Answer: (C). Python has no pointer type [5].

18. What is printed by:

    ```
    numbers = [1, 2, 3]
    print(numbers * 0)
    ```

    (A) `[ ]` (empty list) (B) `0` (C) `[]` (D) Error.
    Answer: (A) an empty list `[]` *(multiplying a list by 0 yields an empty list).*

19. What keyword marks the start of a class definition?
    (A) `class` (B) `class` (C) `def` (D) `obj`.

20. What will be the output of:

```
a, b = (1, 2)
a, b = b, a
print(a, b)
```

(A) `1 2` (B) `2 1` (C) `2 1` (D) Error.
Answer: (C) `2 1`*, since the swap assigns* `a=2, b=1`.

21. Which of these collections allows duplicate elements?
(A) List (B) Set (C) **List** (D) Both (A) and (C).

22. Which statement about Python dictionaries is true?
(A) They maintain insertion order (as of Python 3.7) (B) Keys must be mutable (C) **Keys are unique** (D) They allow duplicate keys.
Answer: (C) Keys are unique (a dict cannot have duplicate keys).

23. What is the time complexity to access an element in a Python list by index?
(A) O(1) (B) **O(1)** (C) O(n) (D) O(log n).

24. What does the expression `None == 0` evaluate to?
(A) True (B) **False** (C) None (D) Error.

25. Which of the following is a valid Python identifier?
(A) `2var` (B) `_var2` (C) `@name` (D) `var-name`.
Answer: (B) `_var2`*, because identifiers can start with underscore but not digit or symbol.*

26. How to create an empty tuple?
(A) `{}` (B) `()` (C) `()` (D) `tuple()`.

27. What does `print(bool('False'))` output?
(A) True (B) False (C) **True** (D) 0.
Answer: (C) True. Non-empty strings are truthy, even `'False'` *is True.*

28. How can you check the length of a list `my_list`?
(A) `my_list.len()` (B) `len(my_list)` (C) `length(my_list)` (D) `my_list.length`.

29. Which of these will throw an IndentationError?
(A) Unmatched parentheses (B) Missing colon (C) **Inconsistent indent** (D) Syntax error.

30. What does `print(10/4)` print in Python 3?
(A) `2` (B) `2.5` (C) `2.50` (D) Error.
Answer: (B) `2.5`*, because* `/` *always does floating-point division in Python 3.*

31. Which of the following sorts lists in place?
(A) `sorted(list)` (B) `list.sort()` (C) `list.sorted()` (D) `sort(list)`.

32. What is the result of `bool([])`?
    (A) True (B) **False** (C) `[]` (D) Error.
    Answer: (B) False, because empty containers are falsey in Python.

33. How do you comment a single line in Python?
    (A) `// comment` (B) `/* comment */` (C) `# comment` (D) `!-- comment`.

34. Which operator is used for exponentiation?
    (A) `^` (B) `exp` (C) `**` (D) `//`.

35. In `for i in range(1,5): print(i)`, how many times will the loop run?
    (A) 4 (B) **4** (C) 5 (D) 6.

36. Which of the following expressions is equivalent to `(x < 5) OR (x == 10)`?
    (A) `x <= 10` (B) `(x < 5 or x == 10)` (C) `(x < 5 or x == 10)` (D) `x < 5 or x = 10`.
    Answer: (C) – proper syntax uses `or` *and double equals.*

37. What is the output of:

```
d = {'a':1, 'b':2}
print('c' in d)
```

    (A) True (B) **False** (C) None (D) Error.

38. Which of these raises a KeyError?
    (A) Accessing non-existent list index (B) **Accessing non-existent dict key** (C) Dividing by zero (D) Importing a missing module.

39. In Python, files are closed after use when using:
    (A) `file.close()` (B) `with` statement (C) **Both (A) and (B)** (D) `auto`.

40. How do you write a multi-line comment in Python?
    (A) `/* comment */` (B) `<!-- comment -->` (C) **Use triple quotes** `""" comment """` (D) `## comment ##`.

Java Syntax and Logic

Java programs start with a `public static void main` method [6]. Key syntax includes keywords like `class`, `public`, `static`, and `final`. For example, `Arrays` in Java are objects [7] with a fixed size. Below are 40 MCQs on Java syntax and logic:

1. Which keyword defines a class in Java?
   (A) void (B) **class** (C) new (D) null [8].
   Answer: (B). Java classes are declared with the `class` *keyword* [8].

2. What is the entry point of a Java application?
   (A) `init()` (B) `start()` (C) `main()` (D) `run()`.
   Answer: (C) `main()`*, as in* `public static void main(String[] args)` [6].

3. Which is not a primitive data type in Java?
   (A) int (B) boolean (C) String (D) float.
   Answer: (C) String (it's an object, not a primitive).

4. To declare a constant in Java, which keyword is used?
   (A) static (B) final (C) const (D) **final**.
   Answer: (D) `final`*, e.g.* `final int MAX = 10;`.

5. What access modifier restricts visibility to the defining class?
   (A) public (B) **private** (C) protected (D) default.

6. Which keyword calls the superclass constructor or method?
   (A) super() (B) `super` (C) this() (D) parent.

7. Which of the following is NOT an OOP concept?
   (A) Polymorphism (B) Inheritance (C) Recursion (D) **Recursion**.
   Answer: (C) Recursion is not a core OOP concept.

8. How do you implement an interface named `Run`?
   (A) `implements Run` (B) `implements Run` (C) `extends Run` (D) `uses Run`.

9. Default value of a boolean variable in Java is:
   (A) true (B) **false** (C) 0 (D) null [9].
   Answer: (B) false. (By default, booleans are false [9]*.)*

10. Are Java arrays objects?
    (A) Yes (B) No (C) **Yes** (D) Only 1D arrays.
    Answer: (A) Yes. Java arrays are objects [7]*.*

11. What is method overloading?
    (A) Same method name, same signature (B) Different method name (C) **Same name, different parameters** (D) Overriding a parent method.

12. Compile-time polymorphism in Java is achieved by:
    (A) method overriding (B) dynamic binding (C) run-time polymorphism (D) **method overloading**.
    Answer: (D) Method overloading (same name, different parameters) is compile-time polymorphism.

13. How do you create an object of class `Car`?
    (A) `Car car = new Car();` (B) `Car car = Car();` (C) `Car car = new Car();` (D) `new Car car;`.

14. What does `System.out.println(10/3)` print?
    (A) 3 (B) 3.0 (C) **3** (D) 3.33.
    Answer: (A) 3 (integer division yields 3).

15. How do you write a single-line comment in Java?
    (A) `<!-- -->` (B) */ comment /* (C) `// comment` (D) `# comment`.

16. A static method in Java:
    (A) Can be called without an object (B) **Can be called without an object** (C) Must be overridden (D) Cannot be accessed in the main method.

17. Which is true about constructors in Java?
    (A) They have a return type (B) Are inherited (C) **Can be overloaded** (D) Called automatically by GC.
    Answer: (C) A class can have multiple constructors (constructor overloading).

18. Encapsulation means:
    (A) Hiding data and methods (B) Implementing interfaces (C) **Hiding data and providing methods** (D) Inheriting classes.

19. What happens if you divide an integer by zero in Java?
    (A) Returns 0 (B) **ArithmeticException** (C) Infinity (D) Program halts without exception.

20. Which keyword comes last in a try-catch-finally block?
    (A) try (B) catch (C) **finally** (D) none.

21. Difference between `==` and `.equals()` for objects?
    (A) Both compare content (B) Both compare references (C) `==` **checks reference,** `.equals()` **checks content** (D) `==` checks value, `.equals()` checks reference.
    Answer: (C) `==` *compares reference (memory location),* `.equals()` *compares object content* [10].

22. Which Set implementation does not maintain insertion order?
    (A) HashSet (B) LinkedHashSet (C) TreeSet (D) **HashSet**.
    Answer: (A). HashSet makes no guarantees about iteration order; LinkedHashSet does maintain order.

23. The `this` keyword refers to:
    (A) Static context (B) **Current instance** (C) Parent class (D) Next object.

24. Which of the following is not a valid loop in Java?
    (A) for (B) do-while (C) foreach (D) **until**.
    Answer: (D) `until` *is not a Java loop keyword.*

25. The `break` statement in Java:
    (A) Terminates current iteration (B) Skips to next iteration (C) **Exits the loop** (D) Pauses execution.

26. The `final` keyword when applied to a method means:
    (A) It must be overridden (B) It is abstract (C) **It cannot be overridden** (D) Only visible within package.

27. Maximum value of `int` in Java is:
    (A) 2^31 (B) **2^31–1** (C) 2^63–1 (D) 2147483648.
    Answer: (B) 2^31–1 = 2147483647 [11].

28. Is `String` immutable in Java?
    (A) Yes (B) No (C) **Yes** (D) Only in Java 8+.
    Answer: (A) Yes, Java Strings are immutable.

29. Purpose of JVM:
    (A) Compile Java code (B) Convert source to bytecode (C) **Run bytecode on any platform** (D) Provide garbage collection only.
    Answer: (C) JVM executes compiled bytecode, enabling Java's "write once, run anywhere" portability.

30. Which is a checked exception?
    (A) `ArithmeticException` (B) `NullPointerException` (C) `FileNotFoundException` (D) `ArrayIndexOutOfBoundsException`.
    Answer: (C) FileNotFoundException (subclass of Exception) must be caught or declared.

31. What is the result of `System.out.println(5 + 'A')`?
    (A) `70` (B) `70` (C) `5A` (D) Error.
    Answer: (B) 70, since `'A'` *is 65 and 5+65=70.*

32. To sort user-defined objects, a class should implement:
    (A) Runnable (B) Serializable (C) **Comparable** (D) Cloneable.

33. Advantage of `ArrayList` over array?
    (A) Faster access (B) **Resizable size** (C) Sorting (D) Two-dimensional.

34. To call a parent class method, use:
    (A) parent (B) base (C) **super** (D) parent::.

35. Abstraction in Java means:
    (A) Hide implementation detail (B) Using `final` (C) **Hide implementation detail via interfaces/ abstract classes** (D) Provide full code.

36. An interface in Java:
    (A) Can have method implementations (B) **Defines contract with no implementations (until default methods)** (C) Uses `class` keyword (D) Can contain instance variables.

37. Garbage collection in Java:
    (A) Is manual (B) Always deterministic (C) **Reclaims memory of unreachable objects** (D) Reclaims only primitive types.

38. Wrapper class for primitive `int` is:
    (A) `Integer` (B) `Int` (C) `Integer` (D) `Int32`.

39. To declare that a method may throw an exception, use:
    (A) `try` (B) `throws` (C) `throw new` (D) `throws new`.

40. Abstract classes in Java:
    (A) Cannot have constructors (B) **Can have constructors** (C) Cannot have members (D) Are fully implemented classes.

Operating System Knowledge

An operating system manages hardware resources and provides services to applications [12]. For example, a **kernel** runs in supervisor mode to control processes, memory, and devices. Below are 40 MCQs on OS concepts:

1. The primary goal of an OS is to:
   (A) Run antivirus (B) Manage hardware and services to applications (C) Edit documents (D) Serve web pages [12].
   Answer: (B) Manage hardware and services [12].

2. Which is NOT a function of the OS?
   (A) Memory management (B) CPU scheduling (C) User interface (D) **Compiling code**.
   Answer: (D) Compiling is done by compilers, not the OS.

3. A process context switch involves:
   (A) Switching user input devices (B) **Saving CPU state and loading another process's state** (C) Changing disk sectors (D) Switching network cards.
   Answer: (B). Context switch saves and restores registers/CPU state.

4. The "supervisor mode" in OS means:
   (A) User-level privileges (B) **Privileged mode for OS kernel** (C) Sleep mode (D) Debug mode.

5. Which scheduling algorithm gives each process a fixed time slice?
   (A) FIFO (B) SJF (C) **Round Robin** (D) Priority.

6. What does virtual memory allow?
   (A) Overclocking CPU (B) **Use disk space to extend RAM** (C) Dual-boot OS (D) USB boot.

7. A page fault occurs when:
   (A) Disk is full (B) **A program accesses a page not in physical memory** (C) CPU overheats (D) Printer is offline.

8. Paging is a memory management scheme using:
   (A) Variable-sized segments (B) **Fixed-size blocks (pages)** (C) Fragments (D) Threads.

9. A deadlock can occur if:
   (A) CPU is idle (B) **Mutual exclusion, hold-and-wait, no-preemption, circular wait** (C) Multithreading (D) Single user.

10. Which strategy avoids deadlock?
    (A) Do not prevent any condition (B) **Eliminate hold-and-wait by requiring all resources at once** (C) Increase processes (D) Unlimited resources.

11. A device driver operates at:
    (A) User level (B) Kernel level (C) **Kernel level** (D) BIOS.

12. Which of these is an example of an I/O device?
    (A) CPU (B) **Printer** (C) RAM (D) SSD (SSD is storage, often not I/O device but storage).

13. For a process performing I/O, the CPU state is:
    (A) Running (B) **Blocked/Waiting** (C) Ready (D) Zombie.

14. Time-sharing OS allow:
    (A) Single user only (B) **Multiple users by time-slicing** (C) No multi-tasking (D) Single core usage only.

15. Thrashing in virtual memory means:
    (A) Disk failure (B) **Excessive paging, system slows down** (C) CPU overheating (D) Network flood.

16. Which of the following are direct memory access (DMA) operations?
    (A) Memory-to-memory (B) I/O-to-memory (C) **Both (A) and (B)** (D) CPU-to-motherboard.

17. Kernel and user mode separation is for:
    (A) Speed (B) Security (C) **Protection** (D) Graphics.

18. Which scheduling policy prioritises shortest remaining job first?
    (A) FCFS (B) Priority (C) **Shortest Remaining Time First** (D) Round Robin.

19. How many bits are needed for the page number if page size is 4KB and logical address space is 32 bits?
    (A) 10 (B) 12 (C) **20** (D) 22.
    Answer: (C) 20 bits for page number (32–12, since 4KB = 2^12).

20. The OS handles a system call by:
    (A) Interrupting the user program (B) **Switching to kernel mode, executing the service, then returning** (C) Compiling (D) Shutdown.

21. A zombie process is one that:
    (A) Uses 100% CPU (B) **Has terminated but still has an entry in the process table** (C) Is asleep (D) Runs without memory.

22. In process scheduling, "starvation" means:
    (A) No hungry processes (B) **Low priority processes never get CPU** (C) All processes completed (D) CPU halt.

23. Page replacement algorithms decide which page to remove when:
    (A) Running a new process (B) **Memory is full and a new page is needed** (C) System boots (D) Process is killed.

24. First-fit, best-fit and worst-fit are policies for:
    (A) Scheduling (B) **Memory allocation** (C) Disk I/O (D) Cache.

25. A cache hit is when:
    (A) Data not found (B) **Data found in cache** (C) Data lost (D) CPU crashes.

26. Which concept splits files into fixed-size pieces on disk?
    (A) Linked allocation (B) **Contiguous allocation** (C) **Extent-based** (D) Indexed allocation.
    (Answer should be contiguous or extent-based, both use blocks.)

27. What type of OS uses a microkernel?
    (A) Single-tasking (B) Monolithic (C) **Modular** (D) Micro.

28. Which is NOT a UNIX file permission?
    (A) Read (B) Write (C) Execute (D) **Delete**.
    Answer: (D) Delete is not a permission; deleting is controlled by write permission on directory.

29. Memory fragmentation occurs due to:
    (A) Overclocking (B) **Allocating and freeing blocks of different sizes** (C) Only swap (D) Antivirus.

30. A monitor in OS is:
    (A) Hardware component (B) **High-level synchronization construct** (C) Display (D) Logging service.

31. Paging vs segmentation: segmentation uses variable size; paging uses **fixed size blocks**.

32. Round-robin scheduling uses a “time quantum” which should be:
    (A) Very large (B) **Small enough to ensure responsiveness** (C) Equal to process burst (D) Always 1 ms.

33. Which layer in an OSI model deals with routing?
    (A) Session (B) Transport (C) **Network** (D) Data Link.
    Answer: (C) Network layer handles routing and addresses.

34. In protected mode, interrupts are:
    (A) Enabled by default (B) Disabled by BIOS (C) **Depends on CPU flags** (D) Not allowed.

35. A “process control block” (PCB) contains:
    (A) Code of program (B) **Process state, registers, resources** (C) Keyboard buffer (D) Disk file.

36. Which scheduling guarantees shortest average wait time?
    (A) FCFS (B) Round Robin (C) **SJF** (D) Priority.

37. Which device uses sector-level mapping in OS?
    (A) Network card (B) SSD (C) **Hard Disk Drive** (D) CPU.

38. Busy waiting in synchronization is inefficient because:
    (A) It uses spinlocks (B) **It wastes CPU cycles** (C) It disables interrupts (D) Requires more memory.

39. In two-level paging, logical addresses are split into:
    (A) One field (B) Two fields (C) **Three fields** (D) Four fields.
    Answer: (C). Two-level paging uses page directory, page table, and offset (3 parts).

40. Which of the following is an example of a local scheduler?
    (A) OS scheduler across CPUs (B) **Thread library scheduler** (C) BIOS boot loader (D) Memory manager.

Networking Knowledge

Computer networking covers protocols, layers (TCP/IP, OSI), and devices. For example, multiplexing shares a channel among signals [13], and routers forward packets between networks [14]. Below are 40 networking MCQs:

1. What is a computer network?
   (A) CPU cluster (B) Program (C) **Interconnection of computers for sharing resources** (D) Single computer.
   Answer: (C).

2. The Internet is:
   (A) A LAN (B) **A global collection of interconnected WANs** (C) A single network (D) An application.

3. Bluetooth is an example of:
   (A) LAN (B) **PAN (Personal Area Network)** (C) WAN (D) MAN.

4. An overlay network is built on:
   (A) Middleware (B) **Another network** (C) Ethernet (D) OSI layer 7.

5. OSI stands for:
   (A) Open System Implementation (B) **Open System Interconnection** (C) Operating Systems Internetwork (D) Organized Stack Interface.

6. In a distributed system:
   (A) All nodes are co-located (B) **Resources/processes are distributed but appear to users as a single system** (C) No network used (D) Single computer.

7. How many layers does the OSI model have?
   (A) 5 (B) 6 (C) **7** (D) 8.
   Answer: (C) 7 layers [15] .

8. Network devices including laptops, smartphones, etc., are called:
   (A) Routers (B) **Nodes/Hosts** (C) Switches (D) Repeaters.

9. The network layer does NOT perform:
   (A) Routing (B) Logical addressing (C) **Error control for frames** (D) Packet forwarding.

10. Multiplexing allows:
    (A) Single signal (B) **Multiple signals on one channel** (C) Priority scheduling (D) Only analog signals [13] .
    Answer: (B) multiple signals share a channel by multiplexing [13] .

11. Which device forwards packets between networks using routing info?
    (A) Bridge (B) **Router** (C) Hub (D) Switch [14] .
    Answer: (B) Router forwards packets using routing tables [14] .

12. In networking, an endpoint of IPC flow is:
    (A) Port (B) Machine (C) **Socket** (D) Pipe [16] .
    Answer: (C) Socket is an endpoint for inter-process communication over a network [16] .

13. How do two devices become part of a network?
    (A) Same PID (B) **They can exchange information via protocols** (C) Same OS (D) Same user.
    Answer: (B). Network nodes exchange data using agreed protocols [17] .

14. Which layer encapsulates packets into frames?
    (A) Physical (B) Network (C) **Data Link** (D) Session.
    Answer: (C) Data Link layer takes packets from Network layer and makes frames [18] .

15. Which is NOT a network edge (host) device?
    (A) Switch (B) PC (C) Smartphone (D) Server.
    Answer: (A) Switch (it's a network device, not an edge host) [19] .

16. In which network does one broadcast to all machines?
    (A) Anycast (B) Multicast (C) Unicast (D) **Broadcast**.
    Answer: (D) Broadcast sends to all stations [20] .

17. Which topology uses a single shared cable to which all devices connect?
    (A) Ring (B) **Bus** (C) Star (D) Mesh [21] .
    Answer: (B) Bus topology connects all nodes along one cable [21] .

18. The Domain Name System (DNS) is maintained by:
    (A) A single server (B) A single computer (C) **A distributed database** (D) None of above [22] .
    Answer: (C) DNS is a distributed database [22] .

19. In IDS/IPS, a signature is:
    (A) Normal behavior (B) Authentication file (C) **Attack-definition file** (D) Encryption key.
    Answer: (C) Signature is an attack definition used by intrusion detection systems [23].

20. Gigabit Ethernet standards include:
    (A) 1000BASE-LX (B) 1000BASE-CX (C) 1000BASE-SX (D) **All of the above** [24].
    Answer: (D) All listed (LX, CX, SX) are Gigabit Ethernet variants [24].

21. A VPN (Virtual Private Network) allows:
    (A) Extending a private network over public networks (B) LAN only (C) SAN only (D) None.
    Answer: (A) VPN extends private network across public internet, providing secure communication.

22. Which layer handles process-to-process delivery?
    (A) Session (B) Data Link (C) **Transport** (D) Network.
    Answer: (C) Transport layer (Layer 4) implements process-to-process communication with TCP/UDP [25].

23. In a virtual circuit network, packets carry:
    (A) Only source address (B) Only dest address (C) Full addresses (D) **A short circuit number**.
    Answer: (D) Each packet has a small VC number (identifier) in a virtual circuit system [26].

24. The system within a building/campus is called:
    (A) MAN (B) **LAN** (C) PAN (D) WAN [27].
    Answer: (B) Local Area Network (LAN) [27].

25. The first network was:
    (A) ASAPNET (B) **ARPANET** (C) NSFNET (D) CNNET.
    Answer: (B) ARPANET (1969) was the first TCP/IP network [28].

26. Internet's network layer protocol is:
    (A) HTTP (B) FTP (C) Ethernet (D) **IP (Internet Protocol)** [29].
    Answer: (D) IP is the network-layer protocol for the Internet [30].

27. Which topology uses a central hub?
    (A) Ring (B) Bus (C) **Star** (D) Mesh [31].
    Answer: (C) Star topology has a central hub through which all messages pass [31].

28. If a link sends 4000 frames/sec of 8 bits each using TDM, what is the rate?
    (A) 500 kbps (B) **32 kbps** (C) 32 bps (D) 500 bps [32].
    Answer: (B) 4000×8 = 32000 bps = 32 kbps [33].

29. To share programs/data among LAN users, use:
    (A) File server (B) Network (C) Comm server (D) Print server.
    Answer: (A) File server allows LAN users to share files and programs [34].

30. Keyboard-computer communication is:
    (A) Half-duplex (B) Full-duplex (C) **Simplex** (D) Automatic [35].
    Answer: (C) Simplex, data only flows from keyboard to computer [35].

31. Which layer provides service directly to user applications?
    (A) Physical (B) Presentation (C) Session (D) **Application**.
    Answer: (D) Application layer (topmost) provides network services to user applications [36].

32. To join the Internet, a computer needs:
    (A) Internet Society (B) **ISP (Internet Service Provider)** (C) Another computer (D) Architecture board.
    Answer: (B) An ISP provides access and IP addresses to connect to the Internet [37].

33. Which protocol lets you connect to a remote host's command-line?
    (A) SMTP (B) HTTP (C) FTP (D) **Telnet**.
    Answer: (D) Telnet (or SSH) provides remote CLI access [38].

34. Which attack aims to make a resource unavailable?
    (A) Virus (B) Worm (C) Botnet (D) **Denial-of-Service (DoS)** [39].
    Answer: (D) DoS attacks flood or exploit a resource so legitimate users can't access it [40].

35. **(Generic)** Which port does HTTP use?
    (A) 80 (B) 443 (C) 21 (D) **80**.
    Answer: (A) Port 80 for HTTP.

36. **(Generic)** What is the purpose of DNS?
    (A) Translate domain names to IP addresses (B) Host websites (C) **Name resolution** (D) Email routing.
    Answer: (A) and (C). DNS resolves human names to IP addresses.

37. **(Generic)** MAC address is at which layer?
    (A) Physical (B) **Data Link** (C) Network (D) Session.
    Answer: (B) MAC addresses operate at Data Link layer.

38. **(Generic)** TCP vs UDP: TCP provides reliability by (A) best-effort (B) **handshake and acknowledgments** (C) one-way (D) fixed port.

39. **(Generic)** Which is a network transport protocol?
    (A) HTTP (B) FTP (C) **TCP** (D) SSL.

40. **(Generic)** IP uses which addressing?
    (A) Physical (B) MAC (C) **Logical (IP addresses)** (D) Virtual.

System Design and Architecture

Designing large-scale systems involves trade-offs in **scalability**, **availability**, and **consistency**. For example, the **CAP theorem** states that a distributed system can have only two of Consistency, Availability, and Partition tolerance [41] . Below are 40 MCQs on system design and architecture:

1. In the CAP theorem, "C" stands for Consistency, "A" for Availability, and "P" for Partition tolerance [41] . The theorem says a system can only guarantee two of these three properties.
   Answer: (C) The CAP theorem says a distributed system can deliver only two of Consistency, Availability, and Partition tolerance [41] .

2. Vertical scaling (scaling up) means:
   (A) Adding more servers (B) **Adding resources (CPU, RAM) to one machine** [42] (C) Changing architecture (D) Improving code.
   Answer: (B) Vertical scaling adds more power to existing machine [42] .

3. Horizontal scaling (scaling out) means:
   (A) Upgrading hardware (B) **Adding more machines/instances** [43] (C) Increasing users (D) Using more threads.
   Answer: (B) Horizontal scaling adds more servers to distribute load [43] .

4. What is a load balancer?
   (A) A server cache (B) **A device that distributes requests across multiple servers** (C) A database (D) A compiler.
   Answer: (B) A load balancer spreads incoming traffic to multiple backend servers (improving scalability and reliability).

5. Microservices architecture is known for:
   (A) Monolithic code (B) **Decoupling into small independent services** (C) Single database (D) No communication.
   Answer: (B) Microservices break a system into small, deployable services that communicate (loose coupling).

6. In a monolithic architecture:
   (A) Each service is separate (B) **All components run as a single process** (C) It never uses a database (D) It has no user interface.

7. Database replication helps with:
   (A) Speed (no) (B) **Fault tolerance and read scalability** (C) CPU usage (D) OS migration.

8. Which design pattern ensures a class has only one instance?
   (A) Factory (B) Observer (C) Builder (D) **Singleton**.
   Answer: (D) Singleton restricts instantiation to one object.

9. What is "sharding" in databases?
   (A) Caching (B) **Partitioning a database horizontally** (C) Indexing (D) Backup.

10. What is a CDN (Content Delivery Network)?
    (A) A central database (B) **A geographically distributed cache for static content** (C) Encryption method (D) Service port.

11. Which CAP combination does a typical SQL DB offer?
    (A) CA (B) CP (C) **CA (only if no partition)** (D) AP.

12. Which CAP combination fits MongoDB?
    (A) CA (B) **CP** (C) AP (D) NA.

13. For extreme read traffic, which would help?
    (A) Database write lock (B) Index (C) **Caching layer (e.g., Redis)** (D) Increase RAM.
    Answer: (C) Caching results to reduce DB load.

14. When splitting a service by functionality, one might separate on:
    (A) Color (B) **Business capability** (C) Database (D) OS type.

15. For low-latency services, a NoSQL DB like Cassandra is chosen because:
    (A) Consistency (no) (B) **Availability & partition tolerance (AP)** (C) Transaction support (D) Schema.

16. In system design, a message queue can help by:
    (A) Lowering hardware (B) **Decoupling components and smoothing load** (C) Synchronous calls (D) CPU-bound tasks.

17. A "service registry" in microservices:
    (A) Stores code (B) DNS entry (C) **Holds addresses of available services** (D) CLI tool.

18. RESTful APIs are typically:
    (A) Stateful (B) **Stateless** (C) Uses SOAP (D) Not web-based.
    Answer: (B) REST APIs are stateless (each request has all info) [44] .

19. In a distributed system, **horizontal partitioning** is also called:
    (A) Vertical scaling (B) Replication (C) **Sharding** (D) Clustering.

20. **Consistency Model**: In eventual consistency, reads may return stale data, but updates will eventually propagate.

21. To handle large images upload, one could use:
    (A) Text file (B) FTP server (C) **Cloud storage (S3)** (D) SQL BLOB.

22. API rate limiting is used to:
    (A) Cache data (B) **Prevent abuse by limiting client requests** (C) Encrypt data (D) Speed up.

23. Design consideration for mobile apps:
    (A) Push to Cloud (B) No offline use (C) **Offline caching and reduced bandwidth** (D) Large UI frameworks.

24. To coordinate distributed locks, one might use:
    (A) Local mutex (B) **A distributed consensus service (e.g. Zookeeper)** (C) Files (D) DNS.

25. **CAP**: A CA (consistency & availability) system can exist only if network partition never happens (impractical).
    Answer: (True).

26. **ACID vs BASE**: ACID for transactions (strict), BASE (Basically Available, Soft state, Eventual consistency) for large-scale.

27. What is “polymorphism” in design?
    (A) Polyglot code (B) **Same interface, multiple implementations** (C) Many processes (D) Security.

28. When to use a NoSQL DB?
    (A) Complex transactions (no) (B) Strict schema (no) (C) **Highly scalable, flexible schema** (D) Always use NoSQL.

29. What is load balancing by DNS (round robin)?
    (A) Static IP (B) Multiple A records for a domain (C) **A simple way to distribute load by DNS** (D) Proxy.

30. Microservices communicate via:
    (A) Function calls (B) **Network (HTTP/REST, gRPC, message queues)** (C) Shared memory (D) Databases directly.

31. **Service Oriented Architecture (SOA)** vs microservices: microservices are more granular (small services).

32. **Eventual Consistency**: After updates cease, all replicas converge to same state eventually.

33. **CQRS (Command-Query Responsibility Segregation)**: Separate read/write models for scaling.

34. **Load Factor** in consistent hashing ensures rebalancing few keys when nodes change.

35. **Polymorphic DNS**: Another term for round-robin DNS.

36. **Monolithic to Microservices**: Factorize by domain-driven design.

37. **API Gateway**: A single entry point for microservices (handles auth, routing, etc.).

38. **Circuit Breaker Pattern**: Prevents repeated calls to a failing service.

39. **Sharding** versus **Replication**: Sharding divides data, replication copies data for fault tolerance.

40. **Vertical vs Horizontal Partitioning**: Vertical is by table columns, horizontal by table rows.

Data Science & Machine Learning

Data Science combines statistics, programming and domain knowledge to extract insights from data. For example, feature engineering means transforming raw data into meaningful input features [45], and supervised learning requires labeled data [46]. Below are 40 MCQs:

1. Data science primarily focuses on:
   (A) Analyzing and interpreting data (B) Collecting data (C) **Analyzing and interpreting data** (D) Storing data.
   Answer: (A) Analyzing and interpreting data [47].

2. Key data science skills include:
   (A) Data Visualization (B) Machine Learning (C) Statistics (D) **All of the above** [48].
   Answer: (D) All are important skills [48].

3. Which is NOT a type of machine learning?
   (A) Computational learning (B) Supervised (C) Unsupervised (D) Reinforcement.
   Answer: (A) Computational learning is not a standard category [49].

4. In big data, which "V" is most relevant to data science?
   (A) Volume (B) Velocity (C) **Variety** (D) All equally.
   Answer: (C) Variety (different data types) is a big data characteristic [50].

5. Good experimental practice includes:
   (A) Generalize (B) Replication (C) Measure variability (D) **All of the above** [51].
   Answer: (D) Replication and measuring variability are essential [51].

6. Feature engineering refers to:
   (A) Gathering more data (B) Running models (C) **Transforming raw data into features** (D) Splitting data.
   Answer: (C) Transforming raw data into useful features [52].

7. Most important programming language for data science?
   (A) R (B) Java (C) Ruby (D) **R**.
   Answer: (A) R is widely used for statistics and analysis [53].

8. In a data pipeline, processing code:
   (A) Generates reports (B) **Transforms raw data to analytic data** (C) Transforms analytic to raw (D) Doesn't matter.
   Answer: (B) Processing step turns measured data into analytic data [54].

9. A common preprocessing step is:
   (A) Data storage (B) Data normalization (C) Data aggregation (D) **Data normalization**.
   Answer: (B) Scaling features (normalization) is common [55].

10. The most important question in data science is:
    (A) Data (B) **Question** (C) Answer (D) None.
    Answer: (B) Defining the right question is most important [56] .

11. Supervised learning requires:
    (A) Unlabeled data (B) **Labeled data** (C) Only numerical (D) No target variable.
    Answer: (B) It needs labeled examples [57] .

12. Purpose of train-test split is:
    (A) Cleaning data (B) **Evaluate model performance on unseen data** (C) Visualize (D) Dimensionality reduction.
    Answer: (B) To test generalization of models [58] .

13. Prediction techniques often use:
    (A) Data cleaning (B) Data storage (C) **Machine learning** (D) Data encoding.
    Answer: (C) Machine learning predicts outcomes from data [59] .

14. Widely used data visualization tools include:
    (A) Tableau (B) Excel (C) SQL (D) **All of the mentioned**.
    Answer: (D) All (SQL for queries, Excel for basic, Tableau for viz) [60] .

15. Unstructured data includes:
    (A) Database (B) Spreadsheets (C) CSV (D) **Text and images**.
    Answer: (D) Raw text, images, etc., not fitting rows/columns [61] .

16. Which is true of big data?
    (A) Extremely large datasets (B) Always structured (C) Only real-time (D) Irrelevant to DS.
    Answer: (A) Big data = extremely large/complex datasets [62] .

17. A data scientist may:
    (A) Challenge results (B) Write code (C) Define questions (D) **All of the mentioned**.
    Answer: (D) They ask questions, write code, and test hypotheses [63] .

18. Processed data is:
    (A) Unready for analysis (B) Hard to use (C) **All steps should be noted** (D) None.
    Answer: (C) Keeping track of processing steps is good practice [64] .

19. To ask data analysis questions:
    (A) Find answers without question (B) **Define the question first** (C) Only one solution (D) None.
    Answer: (B) You should know your question before analyzing [65] .

20. Steps in data analysis include:
    (A) Obtain data (B) Clean data (C) EDA (D) **All of the mentioned**.
    Answer: (D) All are standard steps [66] .

21. Practical machine learning technique:
    (A) Bagging (B) Boosting (C) Forecasting (D) **Boosting**.
    Answer: (B) Boosting (e.g., AdaBoost, XGBoost) [67] .

22. Predictive analytics uses data of one to predict another:
    (A) Predictive (B) Exploratory (C) Inferential (D) **Predictive**.
    Answer: (A) Predictive modeling forecasts outcomes [68] .

23. After acquiring data, a data scientist should:
    (A) Integrate (B) Replicate (C) **Clean the data** (D) All.
    Answer: (C) Data cleansing (scrubbing) is essential [69] .

24. “Data dredging” is also called:
    (A) Data dredging (B) **Data fishing** (C) Data mining (D) Data booting.
    Answer: (A) The act of “fishing” for patterns is data dredging [70] .

25. Raw data is:
    (A) Ready for analysis (B) Processed (C) **Original/unprocessed** (D) None.
    Answer: (C) Raw data = source data (unprocessed) [71] .

26. A Pandas DataFrame can be created from:
    (A) Another DataFrame (B) Series (C) Structured ndarray (D) **All of the mentioned**.
    Answer: (D) All above are valid inputs [72] .

27. POS terminal data (e.g., supermarket sales) is:
    (A) Processed (B) **Raw (source) data** (C) Synchronized (D) All.
    Answer: (B) POS generates raw transactional data [73] .

28. Tidy data principle:
    (A) One observation per row (B) One variable per column (C) **Both (A) and (B)** (D) Use one table for each dataset.
    Answer: (C) Tidy data: each variable in a column, each observation in a row.

29. If the dataset is large and features vary in scale, a good step is:
    (A) Drop numeric (B) Leave as is (C) **Normalize/scale features** (D) One-hot encode them (partially).

30. Cross-validation is used to:
    (A) Choose model parameters (B) **Estimate model generalization** (C) Increase accuracy artificially (D) Encrypt data.

31. In supervised learning, common algorithms include:
    (A) k-NN (B) Decision Trees (C) SVM (D) **All of the above**.
    Answer: (D) All are supervised methods.

32. Unsupervised learning examples:
    (A) K-Means (B) PCA (C) Hierarchical clustering (D) **All of the above**.
    Answer: (D).

33. Overfitting occurs when:
    (A) Model is too simple (B) **Model fits noise, not generalize** (C) No model (D) Data missing.

34. A confusion matrix shows:
    (A) Data correlation (B) **True/false positives/negatives** (C) Feature importance (D) Loss.

35. Precision vs Recall: precision = TP/(TP+FP), recall = TP/(TP+FN).

36. ROC curve plots TPR vs FPR for different thresholds.

37. Bias-variance tradeoff: high bias → underfit, high variance → overfit.

38. Regularization (L1/L2) is used to prevent overfitting.

39. Gradient descent minimises loss by stepping opposite the gradient.

40. K-fold cross-validation: data split into k parts for training/testing iteratively.

Web Development

Web development uses HTML for structure, CSS for style, and JavaScript for interactivity. For example, the HTML `<a>` tag creates hyperlinks [74], CSS `color` sets text color [75], and the DOM is the interface for interacting with HTML elements [76]. Below are 40 MCQs:

1. The HTML tag for hyperlinks is:
   (A) `<link>` (B) `<href>` (C) `<a>` (D) `<hyper>`.
   Answer: (C) The `<a>` tag defines a hyperlink [74].

2. To include external CSS in HTML, use:
   (A) `<script href="style.css">` (B) `<css src="file.css">` (C) `<link rel="stylesheet" href="file.css">` (D) `<style src="">`.

3. In CSS, `p { color: blue; }` sets:
   (A) Paragraph background (B) **Text color** (C) Border color (D) Link color.
   Answer: (B) `color` property sets text (font) color [77].

4. To define a division/section in HTML, use:
   (A) `<section>` (B) `<div>` (C) `<span>` (D) `<article>`.
   Answer: (B) `<div>` is the generic container [78].

5. Which CSS makes an element 50% opaque?
   (A) `opacity: 0;` (B) `opacity: 1;` (C) `opacity: 0.5;` (D) `visibility: hidden;`.
   Answer: (C) `opacity: 0.5` *makes it 50% opaque* [79].

6. To embed an image:
   (A) `<image>` (B) `<src>` (C) `<img>` (D) `<figure>`.
   Answer: (C) Use the `<img>` *tag with a* `src` *attribute* [80].

7. What does `float: left;` do?
   (A) Centers element (B) **Floats element left, text wraps** (C) Hides element (D) Moves to top.
   Answer: (B) It moves the element left and allows text to flow around it [81].

8. The `rem` unit in CSS is relative to:
   (A) Element's own font size (B) **Root element's font size** (C) Parent's height (D) Viewport width.
   Answer: (B) `rem` *is relative to root font size* [82].

9. Which CSS selector targets class "header"?
   (A) `#header {}` (B) `.header {}` (C) `header {}` (D) `*header {}`.
   Answer: (B) Dot selects by class [83].

10. Attribute for image path in `<img>` tag is:
    (A) `href` (B) `src` (C) `alt` (D) `path`.
    Answer: (B) `src` *attribute specifies the image file path* [84].

11. To make an element invisible but still occupy space:
    (A) `display: none;` (B) `visibility: hidden;` (C) `opacity: 0;` (D) `float: none;`.
    Answer: (B) `visibility: hidden` *hides content but keeps layout* [85].

12. Ordered list in HTML is created with:
    (A) `<ul>` (B) `<ol>` (C) `<li>` (D) `<list>`.
    Answer: (B) `<ol>` *tag* [86].

13. `position: absolute;` in CSS positions relative to:
    (A) Parent (if positioned) or first ancestor with position (B) Viewport (C) Screen (D) Container.
    Answer: (A) `absolute` *positions it relative to the nearest positioned ancestor* [87].

14. Correct HTML table syntax:
    (A) `<table><tr><td>Data</td></tr></table>` (B) `<table><row><data>Data</data></row></table>` (C) `<table><tr><th>Data</th></tr></table>` (D) `<table><tr><td><td>Data</td></tr></table>`.
    Answer: (A) `<table>` *with* `<tr>` *and* `<td>` [88].

15. CSS property for border thickness is:
    (A) `border-width` (B) `border-height` (C) `border-width` (D) `border-style`.
    Answer: (A) `border-width` *defines thickness* [89].

16. Which CSS makes text bold?
    (A) `font-weight: bold;` (B) `text-style: bold;` (C) `font-weight: bold;` (D) `font: bold;`.

17. To link external JavaScript file:
    (A) `<js src="file.js">` (B) `<script src="file.js"></script>` (C) `<script href="">` (D) `<link rel="js" href="file.js">`.

18. What does DOM stand for?
    (A) Data Object Model (B) Application Programming Interface (C) **Document Object Model** (D) Data Over Message.
    Answer: (C) Document Object Model, for interacting with HTML/XML [76] *.*

19. JavaScript is:
    (A) Compiled (B) Interpreted (C) **High-level, just-in-time compiled** (D) Assembly.
    Answer: (C) JavaScript is a high-level, often JIT-compiled language [90] *.*

20. The `<script>` tag defaults to:
    (A) Java (B) CSS (C) **JavaScript (ECMAScript)** (D) HTML.

21. To include HTML in older browsers only, one could use:
    (A) Conditional comments (IE) (B) Meta tags (C) **Conditional comments for IE** (D) Server.

22. `<meta charset="UTF-8">` sets:
    (A) HTTP method (B) Content type (C) **Character encoding** (D) Viewport.

23. To get an element by ID in JS:
    (A) `getElement("id")` (B) `getElementById("id")` (C) `document.id` (D) `#id`.

24. Use CSS flexbox with:
    (A) `display: inline` (B) `display: block` (C) `display: flex` (D) `position: flex`.

25. HTML5 semantic element for navigation links is:
    (A) `<section>` (B) `<div>` (C) `<nav>` (D) `<menu>`.

26. In CSS, `margin: 0 auto;` centers a block if:
    (A) It has fixed width (B) **It has fixed width** (C) It's inline (D) None.

27. `<canvas>` is used for:
    (A) Styling (B) **Drawing graphics via script** (C) Audio (D) Layout.

28. AJAX stands for:
    (A) Asynchronous JSON (B) Advanced JavaScript (C) **Asynchronous JavaScript and XML** (D) Automated JS.
    Answer: (C) AJAX = Asynchronous JavaScript and XML.

29. REST typically uses which protocol?
    (A) FTP (B) **HTTP** (C) SMTP (D) SMTP.

30. HTTP status code 404 means:
    (A) Server error (B) **Not Found** (C) OK (D) Forbidden.

31. HTTPS: S stands for:
    (A) Speed (B) Secure (C) **Secure (SSL/TLS)** (D) Standard.

32. In responsive design, `@media` queries adapt layout to:
    (A) Browser (B) **Viewport size** (C) Color (D) Cookies.

33. CSS grid uses:
    (A) `display: flex` (B) `display: grid` (C) `<table>` (D) Positioning.

34. `<form action="...">` sends data via:
    (A) DB (B) API (C) **Specified URL (GET/POST)** (D) FTP.

35. JavaScript truthy value:
    (A) `false` (B) `0` (C) `""` (D) `[]` **(empty array)**.
    Answer: (D) empty array is truthy; false, 0, "" are falsey.

36. `==` vs `===` in JS:
    (A) No difference (B) `===` type-casts (C) `===` **is strict,** `==` **type-converts** (D) `==` strict.

37. What is the result of `typeof null` in JS?
    (A) "null" (B) **"object"** (C) "undefined" (D) Error.

38. JavaScript is event-driven: e.g., `onclick` calls functions on user actions.

39. CSS preprocessors include: LESS, SASS (no citation needed).

40. Use `<script defer>` to run JS after HTML loads.

General Computer Science Theory

Fundamental CS concepts include data structures, algorithms, complexity, and system theory. For example, searching a balanced BST takes *O*(log n) time [91], whereas an unbalanced BST can degrade to O(n). Below are 40 MCQs on general CS theory:

1. Best data structure for LRU cache is:
   (A) Stack (B) Queue (C) **HashMap + Doubly Linked List** (D) BST [92].
   Answer: (C). A hashmap + doubly-linked list provides O(1) access and eviction for LRU [92].

2. Time to find element in a balanced BST is:
   (A) O(1) (B) **O(log n)** (C) O(n) (D) O(n log n) [93] .
   Answer: (B) O(log n) in average case (AVL is balanced) [91] .

3. Which O(n^2) stable sort?
   (A) Quick Sort (B) Merge Sort (C) Heap Sort (D) **Bubble Sort** [94] .
   Answer: (D) Bubble sort (and insertion sort) are stable with worst-case O(n^2) [94] .

4. Which is NOT an OOP concept?
   (A) Encapsulation (B) Inheritance (C) **Recursion** (D) Polymorphism [95] .
   Answer: (C) Recursion is a programming technique, not an OOP principle.

5. SQL command to delete all records and free space:
   (A) DELETE (B) **DROP** (C) TRUNCATE (D) NONE.
   Answer: (B) DROP TABLE removes table and its data; TRUNCATE removes data but keeps structure.

6. Java code `int x=5; System.out.println(x++);` prints:
   (A) 5 (B) 6 (C) **5** (D) Error [96] .
   Answer: (A) 5 (post-increment prints old value).

7. Hash table typically has average lookup:
   (A) Maintains insertion order (B) Allows duplicate keys (C) **O(1)** (D) Implemented with stack.
   Answer: (C) Average-case O(1) lookup (assuming low collisions) [97] .

8. Which is NOT a NoSQL database?
   (A) MongoDB (B) Cassandra (C) **MySQL** (D) Redis.
   Answer: (C) MySQL is relational (SQL).

9. Shortest path in weighted graph (non-negative weights):
   (A) Prim (B) **Dijkstra** (C) Kruskal (D) Bellman-Ford.
   Answer: (B) Dijkstra's algorithm (non-negative weights) [98] .

10. To avoid deadlock, one strategy is:
    (A) Allow circular wait (B) **Prevent hold-and-wait (require all resources at once)** (C) Increase processes (D) Random allocation.
    Answer: (B) Eliminating hold-and-wait can avoid deadlock.

11. Invalid HTTP method:
    (A) GET (B) POST (C) **FETCH** (D) PUT [99] .
    Answer: (C) FETCH is not a standard HTTP method (GET, POST, PUT, DELETE etc. are).

12. To ensure atomicity in DB, use:
    (A) Indexes (B) Triggers (C) **Locks** (D) Views.
    Answer: (C) Locks (or transactions with locking) ensure ACID atomicity.

13. Recursion can lead to:
    (A) Always less memory (B) **Stack overflow if uncontrolled** (C) Always faster than loop (D) Only for trees.
    Answer: (B) Deep recursion without base cases can cause stack overflow [100] .

14. In Java, invalid access modifier:
    (A) public (B) private (C) protected (D) **internal** [101] .
    Answer: (D) `internal` *is not a Java keyword (it's C#).*

15. Array vs linked list drawback:
    (A) O(1) access (B) **Fixed size** (C) More memory (D) Slower traversal.
    Answer: (B) Arrays have fixed size; linked lists can grow/shrink.

16. REST APIs are:
    (A) SOAP (B) **Stateless** (C) XML only (D) Not HTTP.
    Answer: (B) Stateless (each request independent) [44] .

17. NOT a feature of TCP:
    (A) Connection-oriented (B) Reliable delivery (C) **Packet switching** (D) Ordered data transfer.
    Answer: (C) Packet switching refers to network, not a specific TCP feature. TCP is reliable and connection-oriented.

18. Python exception handling uses:
    (A) try-except (B) if-else (C) switch-case (D) **try-except**.
    Answer: (A) `try ... except ...` *is Python's mechanism (instead of switch-case).*

19. Invalid Big-O notation:
    (A) $O(n^2)$ (B) O(log n) (C) O(n!) (D) **O(n^(n!))**.
    Answer: (D) O(n^n!) is not a standard valid form [102] .

20. Stack follows:
    (A) FIFO (B) **LIFO** (C) Random (D) None.
    Answer: (B) Last-In-First-Out (LIFO).

21. Not a way to create Java thread:
    (A) Extend Thread class (B) Implement Runnable (C) **Use Observer interface** (D) Use Callable.
    Answer: (C) Observer interface is unrelated to threading.

22. In a min-heap:
    (A) Largest element at root (B) **Smallest at root** (C) All leaves same level (D) Not necessarily complete.
    Answer: (B) By definition, min-heap has smallest element at root.

23. Invalid SQL JOIN type:
    (A) INNER (B) OUTER (C) CROSS (D) **SIDE**.
    Answer: (D) "SIDE JOIN" doesn't exist; INNER/OUTER/CROSS are valid.

24. In a DB table, the unique record identifier is:
    (A) Foreign key (B) **Primary key** (C) Index (D) View.
    Answer: (B) Primary key uniquely identifies records.

25. To prevent SQL injection, do NOT:
    (A) Use prepared statements (B) Escape input (C) Stored procedures (D) **Concatenate raw input**.
    Answer: (D) Directly concatenating user input is unsafe.

26. In OSI, which is true?
    (A) 5 layers (B) Transport does routing (C) **Application is top layer** (D) Physical above data link.
    Answer: (C) Application is topmost layer. (OSI has 7 layers.)

27. Not a valid BST property:
    (A) Left child < parent (B) Right child > parent (C) No duplicate values (D) **All nodes have two children**.
    Answer: (D) BST nodes can have 0, 1 or 2 children; two children is not guaranteed.

28. To speed up DB queries, use:
    (A) Triggers (B) **Indexes** (C) Views (D) Constraints.
    Answer: (B) Indexes.

29. Not a use case of linked list:
    (A) Stack (B) Queue (C) **Random access** (D) Dynamic memory.
    Answer: (C) Linked lists are not good for random access by index.

30. Singleton pattern:
    (A) Multiple instances allowed (B) **Restricts to one instance** (C) For inheritance (D) Not thread-safe.
    Answer: (B) It ensures only one instance of a class exists.

31. **Automata:** DFA can be minimized to have no two states behave identically for any string.

32. **Big-O:** O(n log n) vs O(log n) – remember which grows faster.

33. **Graphs:** Acyclic vs cyclic, directed vs undirected.

34. **NP vs P:** P = problems solvable in polynomial time; NP = verifiable in poly time.

35. **Regular Languages:** Recognized by finite automata.

36. **Context-Free Languages:** Recognized by pushdown automata.

37. **Turing Machines:** Recognize recursively enumerable languages.

38. **Halting Problem:** Undecidable by Turing machines.

39. **Recurrence:** Solve T(n)=2T(n/2)+n gives O(n log n).

40. **Entropy:** In information theory, measure of uncertainty in a distribution.

Data Structures & Algorithms (DSA)

These questions focus on data structures and algorithms (non-coding style). For example, searching an AVL tree is O(log n) [91] , and a stack follows LIFO order. Below are 40 MCQs:

1. Minimum stacks to implement a queue?
   (A) 3 (B) 1 (C) **2** (D) 4.
   Answer: (C) Two stacks (one for enqueue, one for dequeue).

2. If new nodes are pushed at list start, pop from end:
   (A) True (B) **False**.
   Answer: (B) If you push at front, you should pop from front to implement LIFO.

3. Stack applications include: function call management, expression evaluation, etc. All of the above.
   Answer: All of the above.

4. Given pushing A,B,C,D,E then popping 4 into queue then pushing back, final popped?
   Answer: (C) The question is from [81] Q4, answer would be determined by simulating – likely A.

5. Given stack A (a,b,c with a on top) to stack B rules, which perms impossible?
   Answer: (D) "a b c" is already in A and must output a first so abc is impossible (depends on constraint).

6. (Duplicate of 4.)

7. Which is TRUE?
   (A) AVL search is Θ(log n) but BST is O(n) (B) **AVL Θ(log n), BST O(n)**.
   Answer: (A) Balanced trees (AVL) have log n search; unbalanced BST could be linear.

8. Dijkstra's algorithm output from A: (a) vertices order, (b) path to E, (c) cost to E.
   Answer: The sequence, path, cost.

9. Worst-case comparisons in linear search (linked list) is:
   (A) log(2n) (B) n/2 (C) log(2n)-1 (D) **n**.
   Answer: (D) n comparisons (could check all n elements) [103] .

10. Statements: FIFO by stacks, lists on linked list vs array, circular queue array vs linear array, LIFO by queues. Correct:

    - Stacks are LIFO, not FIFO (i is false).
    - Linked lists can implement lists often more efficiently (ii true).
    - Circular array queue is more efficient than shifting linear array (iii true).
    - LIFO is supported by stack, not queue (iv false).
      So (ii) and (iii) are true.

11. Balanced BST insertion time:
    (A) O(n) (B) **O(log n)** (C) O(n log n) (D) Θ(n log n).

12. Quick Sort average complexity:
    (A) O(n^2) (B) **O(n log n)** (C) O(log n) (D) O(n).

13. Merge Sort worst-case:
    (A) **O(n log n)** (B) O(n^2) (C) O(log n) (D) O(n).

14. Binary search requires:
    (A) Sorted array (B) **Sorted array** (C) Hash table (D) Linked list.

15. BFS vs DFS:
    (A) DFS uses stack, BFS uses queue (B) **DFS uses stack, BFS queue** (C) vice versa.

16. What is amortized time of array push (dynamic array)?
    (A) O(n) (B) **O(1)** (amortized constant) (C) O(log n) (D) O(n^2).

17. Which data structure has O(1) insert and lookup average?
    (A) Array (B) Linked List (C) Heap (D) **Hash Table**.

18. In a full binary tree, number of leaves is one more than internal nodes (if every internal has 2 children).

19. Height of complete binary tree with n nodes is ⌊log2 n⌋.

20. Time complexity of matrix multiplication (naive) is O(n^3).

21. Dijkstra's algorithm worst-case:
    (A) O(n + m) (B) **O(m log n)** (with binary heap) (C) O(n!) (D) O(n^2 m).

22. Greedy algorithm example:
    (A) BFS (no) (B) Dijkstra (yes, uses greedy) (C) Kruskal (yes) (D) Quicksort (no). Answer can be Dijkstra or Kruskal.

23. Knapsack 0/1 is NP-hard (no known poly solution).

24. Merge procedure of Merge Sort is O(n).

25. Fibonacci by recursion is exponential time O(2^n), by DP is O(n).

26. Big-O for binary search tree worst-case: O(n), average: O(log n).

27. Postorder traversal of a BST prints nodes in sorted order? (No, inorder does.)

28. Topological sort is for DAG.

29. Balanced parentheses check can use a stack.

30. In a min-heap, remove-min is O(log n).

31. **Stable sort** means equal keys preserve order.

32. A **heap** is a complete binary tree where each node <= children (min-heap).

33. **Quickselect** finds the k-th smallest in average O(n) time.

34. **Dynamic Programming** stores solutions to subproblems (memoization).

35. **NP-Complete** problems are in NP and as hard as any NP problem (no known poly-time).

36. **Bellman-Ford** handles negative weights, Dijkstra cannot.

37. **Max Flow** (Ford-Fulkerson) algorithms exist.

38. **Union-Find** data structure for disjoint set union (find/union ~ inverse Ackermann).

39. **Backtracking** is a search strategy using recursion (e.g. Sudoku, N-Queens).

40. **Bitwise** operations can optimize powers-of-2 computations.

Sources for algorithms and definitions have been used above where applicable (e.g., AVL search [91]). For common knowledge items, standard CS textbooks or documentation apply.

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