
🔹 Topic 1: Programming Introduction and History of Java

✅ Definition:

- Programming is the process of writing a set of instructions that tell a computer how to perform a task.
- These instructions are written in a programming language.
- **Java** is a high-level, class-based, object-oriented programming language that is designed to have as few implementation dependencies as possible.

✅ Use Case:

Java is used to build:

- Enterprise-grade applications (e.g., banking software)
- Android mobile apps
- Web applications (via Java EE/Spring)
- Desktop GUI applications
- Scientific applications

✅ Real-Time Usage:

- **Android Development**: Java is one of the primary languages for Android apps.
- **Enterprise Systems**: Java is used in high-performance banking/finance platforms (e.g., ERP systems).
- **Big Data & Cloud**: Java integrates with Hadoop and Spark ecosystems.

🔷 Flow Diagram:

[Java Source Code (.java)]

↓

Compiled using → [Java Compiler - javac]

↓

Produces → [Bytecode (.class file)]

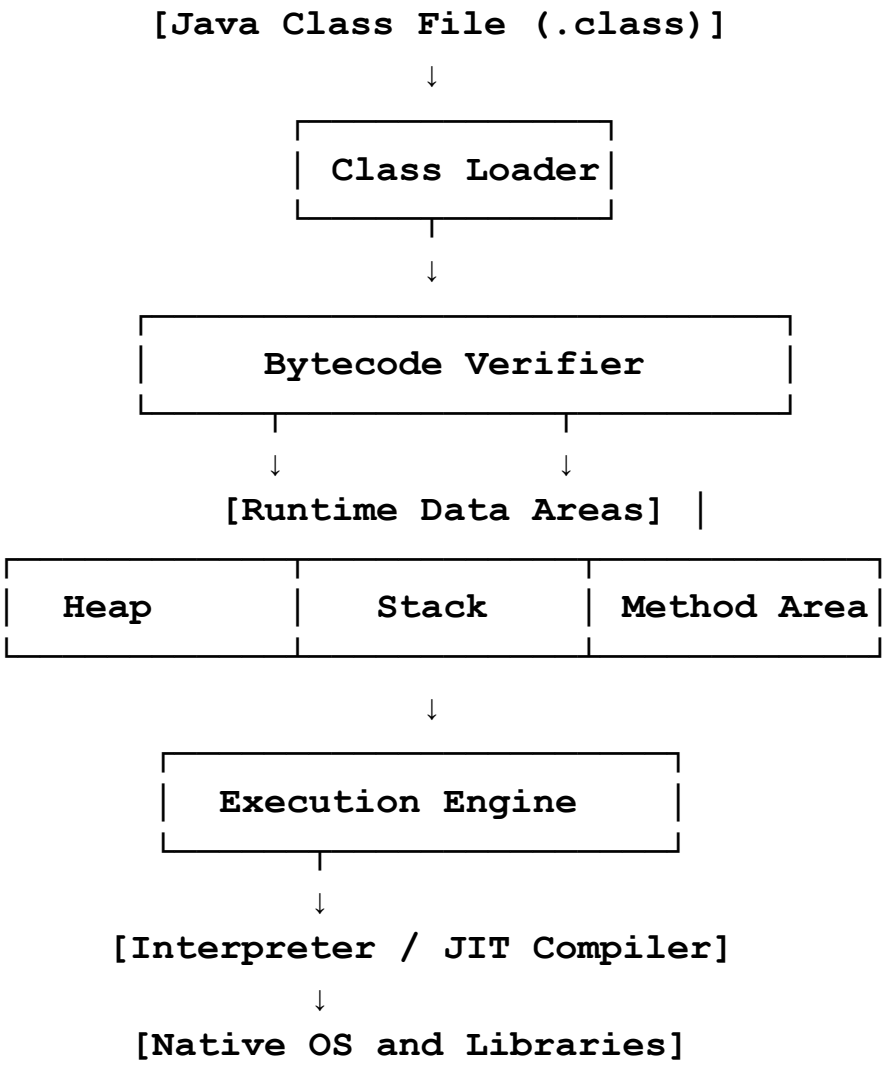
↓

Executed by → [Java Virtual Machine (JVM)]

↓

Interprets or JIT Compiles → Native Machine Code

🔷 Detailed Internal JVM Architecture:



✅ Syntax:

```
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, Java World!");
    }
}
```

✅ Keywords:

- `class`, `public`, `static`, `void`, `main`, `String`, `System`, `out`, `println`

✅ Simple Example Code:

```
public class Welcome {
    public static void main(String[] args) {
        System.out.println("Welcome to Java Programming!");
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// Simulate basic ATM login screen (console-based)
import java.util.Scanner;

public class ATMLogin {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        String validPin = "1234";

        System.out.print("Enter your 4-digit PIN: ");
        String input = sc.nextLine();

        if (input.equals(validPin)) {
            System.out.println("Login successful. Welcome
to your account!");
        } else {
```

```
            System.out.println("Invalid PIN. Please try
again.");
        }

        sc.close();
    }
}
```

✅ Sub-Topics & Related Code:

🔹 What is a Programming Language?

A formal language comprising a set of instructions that produce various kinds of output.

🔹 Types of Programming Paradigms:

Paradigm	Description	Example Languages
Procedural	Linear step-by-step execution	C, Pascal
Object-Oriented	Objects and classes organize code & data	Java, C++, Python
Functional	Based on mathematical functions	Haskell, Scala

✅ Real-Time Example Code:

```java
// Real-time calculator example in Java
import java.util.Scanner;

public class SimpleCalculator {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.println("Enter two numbers:");
        double a = sc.nextDouble();
        double b = sc.nextDouble();

        System.out.println("Enter operation (+, -, *,
/):");
        char op = sc.next().charAt(0);

        double result = 0;
        switch (op) {
            case '+': result = a + b;
                      break;
            case '-': result = a - b;
                      break;
            case '*': result = a * b;
                      break;
            case '/': result = b != 0 ? a / b : 0;
                      break;
            default: System.out.println("Invalid
operator!");
        }

        System.out.println("Result: " + result);
        sc.close();
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. Which company originally developed Java?

   A) Microsoft

   B) Sun Microsystems

   C) Apple

   D) IBM

2. Java is a:

   A) Low-level language

   B) High-level language

   C) Assembly language

   D) Machine language

3. What is the file extension for compiled Java code?

   A) .java

   B) .exe

   C) .class

   D) .cpp

4. Java Virtual Machine is:

   A) Compiler

   B) Interpreter

   C) Editor

   D) Linker

5. Java is _____.

   A) Platform-independent

B) Object-oriented

C) Secure

D) All of the above

6. Which Java keyword starts the execution?

A) main

B) static

C) start

D) init

7. Who is known as the father of Java?

A) Dennis Ritchie

B) Alan Turing

C) James Gosling

D) Bjarne Stroustrup

8. Which year was Java released?

A) 1990

B) 1995

C) 1998

D) 2000

9. What makes Java platform-independent?

A) OS-specific compilers

B) Bytecode and JVM

C) Native libraries

D) Static typing

10. Java applications are typically compiled to:

A) Machine code

B) Bytecode

C) Assembly code

D) Source code

11. Which feature allows Java to support multi-platform?

A) Write Once, Run Anywhere (WORA)

B) JDK

C) JVM

D) JRE

12. Java was initially developed for:

A) Desktop apps

B) Web apps

C) Embedded systems

D) Android

13. Java source files are saved with:

A) .java

B) .js

C) .class

D) .exe

14. Which of the following is NOT a feature of Java?

A) Object-oriented

B) Secure

C) Platform-dependent

D) Robust

15. Java program execution starts from:

A) Constructor

B) main() method

C) static block

D) import section

✅ 20 Interview Questions & Answers:

1. **Q:** What is Java?

   A: Java is a high-level, object-oriented programming language developed by Sun Microsystems in 1995.

2. **Q:** Who developed Java and why?

   A: James Gosling at Sun Microsystems, to create platform-independent software for consumer electronics.

3. **Q:** What is JVM?

   A: Java Virtual Machine executes Java bytecode, making Java platform-independent.

4. **Q:** Why is Java called platform-independent?

   A: Because compiled bytecode can run on any device with a JVM.

5. **Q:** What are the key features of Java?

   A: Object-oriented, platform-independent, secure, robust, multithreaded.

6. **Q:** What is the difference between JDK and JRE?

   A: JDK includes tools for development, JRE is used to run Java programs.

7. **Q:** What does WORA mean?

   A: Write Once, Run Anywhere — Java code runs on any platform with JVM.

8. **Q:** What is bytecode?

   A: Intermediate code generated by the Java compiler, interpreted by JVM.

9. **Q:** Why is Java considered secure?

   A: It doesn't use pointers and has a robust security manager and sandboxing.

10. **Q:** What are Java's data types?

    A: int, float, double, boolean, char, etc.

11. **Q:** Is Java interpreted or compiled?

    A: Both. Java is compiled to bytecode, which is interpreted by JVM.

12. **Q:** What are Java packages?

    A: Namespaces that organize classes and interfaces.

13. **Q:** What is the use of `public static void main(String[] args)`?

    A: Entry point of Java application.

14. **Q:** Can Java run without a main method?

    A: No, not for standalone applications.

15. **Q:** What tools are part of the JDK?

    A: javac, java, javadoc, jdb, etc.

16. **Q:** What are the main components of Java platform?

    A: JVM, JRE, JDK.

17. **Q:** Why is Java popular for enterprise development?

    A: Portability, scalability, huge community, and mature tools.

18. **Q:** Name some Java frameworks.

A: Spring, Hibernate, Struts, JavaFX.

19. **Q:** What is the difference between Java and JavaScript?

A: Java is OOP and compiled; JavaScript is scripting and interpreted.

20. **Q:** What is Java's role in Android?

A: Java is the official language for Android app development (till Kotlin took over as preferred).

✅ Topic Outcome:

After this topic, learners will:

- Understand the history and core philosophy of Java
- Know why Java is platform-independent and secure
- Write basic Java programs
- Understand how Java differs from other languages
- Be able to answer basic Java interview questions

✅ Summary:

- Java revolutionized programming by enabling platform-independent software development.
- It introduced the concept of writing code once and running it anywhere using the JVM.
- Its clean syntax, strong community, and enterprise adoption make it a must-learn for developers across the globe.

🔹 Topic 2: Java Introduction Overview

✅ Definition:

- Java is a **high-level**, **object-oriented**, **platform-independent** programming language developed by **James Gosling** at **Sun Microsystems** (released in 1995).
- It was designed with the principle of **"Write Once, Run Anywhere (WORA)"**, meaning Java applications can run on any device that has a **Java Virtual Machine (JVM)**.

✅ Use Case:

Java is widely used in:

- Web application development (Spring Boot, Java EE)

- Android app development
- Distributed systems (Microservices)
- Enterprise software (Banking, ERP)
- Scientific and research applications

✅ Real-Time Usage:

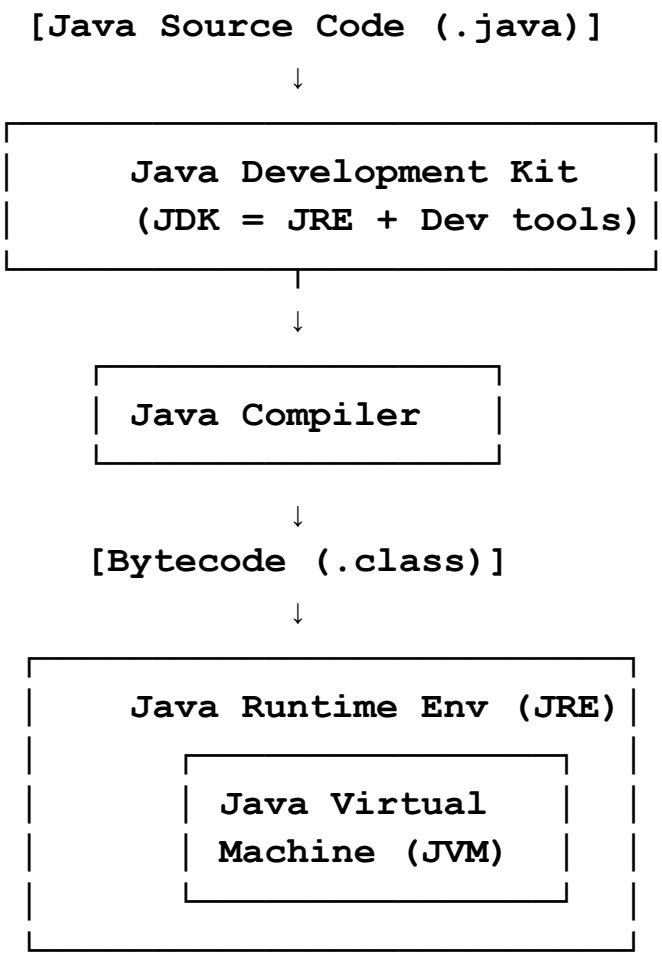
Domain	Real-Time Use Case Example
Banking/Finance	Core Banking Software using Spring Framework
Android	WhatsApp, Paytm (original versions built in Java)
Web Apps	Government portals, Student Management Systems
E-commerce	Backend systems of Flipkart, Amazon (Java-based microservices)
Big Data	Hadoop MapReduce is implemented in Java

✅ Architecture Diagram: Java Platform Overview

🔷 Description:

This diagram explains the layered structure of the **Java Platform** and how each component like **JDK**, **JRE**, and **JVM** works together for development and execution.

🔷 Architecture Diagram:



🔷 Components Explained:

Component	Description
JDK (Java Development Kit)	Contains tools to compile, debug, and run Java programs
JRE (Java Runtime Environment)	Provides libraries and JVM to run Java applications
JVM (Java Virtual Machine)	Executes Java bytecode on any platform
Bytecode	Intermediate code generated after compilation (`.class` file)

✅ Syntax:

```
public class Sample {
    public static void main(String[] args) {
        System.out.println("Java Introduction Overview");
    }
}
```

✅ Keywords:

- `class`, `public`, `static`, `void`, `main`, `String`, `System`, `out`, `println`

✅ Simple Example Code:

```
public class Hello {
    public static void main(String[] args) {
        System.out.println("Hello from Java!");
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// A basic online user login simulation
import java.util.Scanner;

public class UserLogin {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        String storedUsername = "admin";
        String storedPassword = "pass123";

        System.out.print("Enter username: ");
        String inputUser = sc.nextLine();
        System.out.print("Enter password: ");
        String inputPass = sc.nextLine();

        if (inputUser.equals(storedUsername) &&
inputPass.equals(storedPassword)) {
            System.out.println("Login Successful!");
        } else {
            System.out.println("Invalid credentials.");
        }

        sc.close();
    }
```

```
}
```

✅ Sub-Topics with Examples:

🔹 Java Editions:

- **Java SE** (Standard Edition) – Core Java (OOP, collections, threads)
- **Java EE** (Enterprise Edition) – Servlets, JSP, EJB for enterprise apps
- **Java ME** (Micro Edition) – Embedded/mobile devices
- **JavaFX** – UI application framework

🔹 Java Features:

Feature	Description
Object-Oriented	Everything in Java is associated with classes
Platform-Independent	Code runs on any OS with JVM installed
Robust	Strong memory management and exception handling
Secure	Runtime checking and no direct memory access
Multithreaded	Can perform many tasks simultaneously

✅ Real-Time Example Code:

```
// A simplified product management console simulation
public class Product {
    int productId;
    String name;
    double price;

    void display() {
        System.out.println("ID: " + productId + ", Name: "
+ name + ", Price: $" + price);
    }

    public static void main(String[] args) {
        Product p1 = new Product();
        p1.productId = 101;
        p1.name = "Laptop";
        p1.price = 45000;

        p1.display();
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. Java was released in:

   A) 1990

   B) 1995

   C) 1996

D) 2000

2. Java was developed by:

A) IBM

B) Sun Microsystems

C) Google

D) Microsoft

3. The full form of JDK is:

A) Java Default Kit

B) Java Development Kit

C) Java Download Kit

D) Java Defined Kernel

4. The Java compiler produces:

A) Machine code

B) Bytecode

C) Binary code

D) Assembly code

5. What is the core principle of Java?

A) Write multiple times

B) Write once, run anywhere

C) Compile often

D) Write and rewrite

6. Which component executes Java bytecode?

A) JVM

B) JDK

C) JRE

D) JIT

7. Which Java edition is used for enterprise applications?

A) Java SE

B) Java EE

C) Java ME

D) JavaFX

8. JVM stands for:

A) Java Virtual Memory

B) Java Virtual Machine

C) Java Verified Machine

D) Java Versatile Module

9. Which of these is NOT a feature of Java?

A) Secure

B) Portable

C) Manual memory management

D) Robust

10. Java is considered platform-independent because of:

A) .exe files

B) Bytecode and JVM

C) Linux compatibility

D) Compiled machine code

11. Which of the following is included in JRE?

A) javac

B) JVM and Libraries

C) Debugger

D) JavaFX

12. Which part is NOT in JVM?

A) Execution Engine

B) javac

C) Class Loader

D) Runtime Memory

13. What enables Java's security features?

A) Manual memory

B) Bytecode Verifier & ClassLoader

C) Garbage collector

D) Interpreter

14. JavaFX is primarily used for:

A) Web services

B) GUI and rich media applications

C) Databases

D) Back-end APIs

15. Java ME is used for:

A) Web development

B) Desktop apps

C) Embedded and mobile devices

D) Testing tools

✅ 20 Interview Q&A:

1. **Q:** What makes Java platform-independent?

   A: Bytecode and JVM enable Java programs to run on any OS.

2. **Q:** What is the difference between JDK and JRE?

   A: JDK is for development (includes JRE), while JRE is for running programs.

3. **Q:** What is JVM responsible for?

   A: Executing Java bytecode at runtime.

4. **Q:** Explain Java Editions briefly.

   A: SE (core), EE (enterprise), ME (mobile), FX (UI).

5. **Q:** What is bytecode?

   A: Intermediate code generated by the Java compiler.

6. **Q:** Is Java fully object-oriented?

   A: Not completely, as it uses primitive types.

7. **Q:** What is the function of the ClassLoader?

   A: Dynamically loads Java classes into the JVM.

8. **Q:** What is the use of `javac`?

   A: It compiles `.java` files to `.class` bytecode.

9. **Q:** What is the role of JIT compiler?

   A: Converts bytecode to native code at runtime to improve performance.

10. **Q:** Name a few companies that use Java.

    A: Amazon, Google, Flipkart, NASA, Netflix.

11. **Q:** How is memory managed in Java?

    A: Through Garbage Collection.

12. **Q:** What makes Java secure?

    A: No pointer usage, bytecode verification, sandboxing.

13. **Q:** Can Java run without a JVM?

    A: No, JVM is required to execute bytecode.

14. **Q:** What tools are provided by the JDK?

    A: `javac`, `java`, `javadoc`, `jdb`, etc.

15. **Q:** What are Java Packages?

    A: A namespace to group related classes and interfaces.

16. **Q:** Define WORA.

    A: Write Once, Run Anywhere — core philosophy of Java.

17. **Q:** Which file extension is used for compiled Java files?

    A: `.class`

18. **Q:** Difference between Java and C++?

    A: Java is platform-independent and has automatic memory management.

19. **Q:** What is Java's role in web development?

    A: Java is widely used in server-side development using servlets and frameworks.

20. **Q:** What is Java API?

    A: A set of built-in libraries provided by Java to perform common tasks.

✅ Topic Outcome:

After studying this topic, learners will:

- Understand the Java platform, editions, and components
- Grasp how Java works end-to-end from writing to execution
- Know the difference between JDK, JRE, JVM
- Be able to answer foundational Java interview questions

✅ Summary:

- Java is a robust, scalable, and cross-platform language used widely across industries.
- Understanding its platform architecture, editions, and execution flow is critical for every Java developer and lays the foundation for mastering advanced concepts in upcoming topics.

🔹 Topic 3: JDK, JRE, JVM

✅ Definition:

- **JDK (Java Development Kit)**: A software development environment used for developing Java applications. It includes tools like compiler (`javac`), debugger (`jdb`), and the Java Runtime Environment (JRE).

- **JRE (Java Runtime Environment)**: A package that provides the environment to run Java applications. It includes the JVM and core class libraries.

- **JVM (Java Virtual Machine)**: A virtual machine that executes Java bytecode. It provides platform independence and security.

✅ Use Case:

Component	Use Case Example
JDK	Used by developers to write and compile Java applications
JRE	Installed on client machines to run Java programs
JVM	Ensures Java apps can run on any OS (Windows, Linux, Mac)

✅ Real-Time Usage:

- Developers install **JDK** to write backend systems, Android apps, enterprise applications.

- End-users only need **JRE** to run Java applications (e.g., Minecraft, business applications).

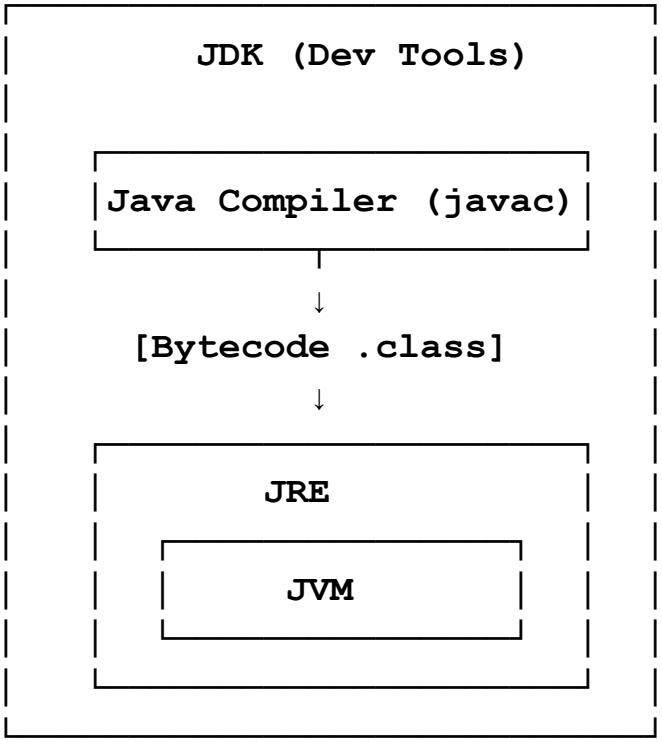
- JVM handles cross-platform execution for Java-based systems (e.g., banking software running across Windows/Linux servers).

✅ Architecture Diagram: JDK, JRE, and JVM Relationship

🔷 Description:

- This diagram shows the **hierarchical relationship** and internal components of JDK, JRE, and JVM.
- It explains how source code travels through compilation to execution.

🔷 Diagram:



🔷 Components Explained:

Component	Description
JDK	Superset of JRE. Used for developing Java applications. Contains compiler, debugger, etc.
JRE	Contains JVM and standard Java class libraries for running applications
JVM	Interprets/compiles Java bytecode into machine code during execution

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✅ Syntax: (JDK usage example)

```
javac Hello.java    // Compiles Java source code
java Hello          // Runs bytecode via JVM
```

✅ Keywords:

- javac, java, classpath, bytecode, interpreter, compiler, runtime, heap, stack, garbage collection

---

✅ Simple Example Code:

```
public class HelloJVM {
    public static void main(String[] args) {
        System.out.println("This runs using JVM!");
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// Basic simulation of compilation & execution
import java.util.Scanner;

public class SalaryCalculator {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter employee name: ");
```

```
        String name = sc.nextLine();

        System.out.print("Enter basic salary: ");
        double basic = sc.nextDouble();

        double hra = 0.20 * basic;
        double da = 0.10 * basic;
        double netSalary = basic + hra + da;

        System.out.println("Employee: " + name);
        System.out.println("Net Salary: ₹" + netSalary);
        sc.close();
    }
}
```

✅ Sub-Topics with Examples:

🔹 Differences Between JDK, JRE, JVM:

Feature	JDK	JRE	JVM
Purpose	Develop & run programs	Only runs Java apps	Executes bytecode
Tools	javac, java, jdb, javadoc	java, javaw	Bytecode interpreter
Includes	JRE + tools	JVM + libraries	Part of JRE
User	Developers	End-users	Under-the-hood engine

🔹 JVM Internals:

- **Class Loader** – Loads `.class` files into memory
- **Bytecode Verifier** – Ensures bytecode safety
- **Runtime Memory** – Heap, Stack, Method Area
- **Execution Engine** – Interpreter or JIT compiler
- **Garbage Collector** – Manages memory cleanup

✅ Real-Time Example Code:

```
// Java program to demonstrate JVM-managed memory
public class Employee {
    String name;
    double salary;

    public Employee(String n, double s) {
        name = n;
        salary = s;
    }

    public void showDetails() {
        System.out.println("Name: " + name);
        System.out.println("Salary: " + salary);
    }

    public static void main(String[] args) {
        Employee emp = new Employee("Arjun", 65000);
        emp.showDetails();
```

```
        // JVM will clean 'emp' object when it's no longer
used
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. What does JDK stand for?

   A) Java Desktop Kit

   B) Java Development Kit

   C) Java Dynamic Kit

   D) Java Deployment Kit

2. Which component is responsible for compiling Java code?

   A) JVM

   B) javac

   C) JRE

   D) JavaFX

3. Which package is required to run Java applications?

   A) JDK

   B) JRE

   C) JAR

   D) WAR

4. JVM stands for:

A) Java Virtual Memory

B) Java Virtual Machine

C) Java Versioning Machine

D) Java Volatile Mechanism

5. Bytecode is executed by:

A) JavaFX

B) Compiler

C) JVM

D) JDK

6. Which is a part of JVM?

A) javac

B) javadoc

C) Execution Engine

D) IDE

7. JRE includes:

A) Compiler

B) Debugger

C) JVM

D) javac

8. JDK is a superset of:

A) JVM

B) JavaFX

C) JRE

D) JavaBeans

9. Java Compiler generates:

A) Machine code

B) Bytecode

C) Object code

D) Binary code

10. Which one is platform-dependent?

A) JRE

B) JVM

C) OS

D) Java

11. Which executes platform-independent code?

A) JVM

B) javac

C) IDE

D) Compiler

12. javac command is used to:

A) Run programs

B) Compile programs

C) Test programs

D) Package programs

13. Which tool is NOT part of JDK?

A) javac

B) JVM

C) javadoc

D) jdb

14. Which of these is automatically managed by JVM?

A) Compilation

B) Garbage Collection

C) Source code formatting

D) Javadoc

15. Bytecode is stored in:

A) .exe file

B) .java file

C) .class file

D) .txt file

✅ 20 Interview Questions & Answers:

1. **Q:** What is JDK?

A: It is the Java Development Kit that includes the JRE and

development tools like `javac`.

2. **Q:** What is the purpose of JRE?

   A: To provide an environment to run Java programs, including JVM and libraries.

3. **Q:** Why is JVM platform-independent?

   A: Because it translates bytecode into native machine instructions based on OS.

4. **Q:** What is bytecode?

   A: Intermediate code generated by the Java compiler (`.class` files) executed by JVM.

5. **Q:** What is the role of the compiler (`javac`)?

   A: It converts Java source code into bytecode.

6. **Q:** Is JDK required to run Java programs?

   A: No, only JRE is needed to run; JDK is required to **develop** programs.

7. **Q:** Can JVM run programs written in other languages?

   A: Yes, if the language compiles to Java bytecode (e.g., Kotlin, Scala).

8. **Q:** What is the JIT compiler?

   A: Just-In-Time compiler converts bytecode to native code during runtime.

9. **Q:** What happens when we run `java MyClass`?

   A: JVM loads and executes the bytecode in `MyClass.class`.

10. **Q:** What is garbage collection in JVM?

    A: Automatic memory management that frees unused objects.

11. **Q:** What is the class loader in JVM?

    A: A component that loads `.class` files into memory dynamically.

12. **Q:** What is the method area in JVM?

    A: Part of memory that stores class structures like fields, methods, etc.

13. **Q:** What is the heap in JVM memory?

    A: Memory area where all Java objects are stored at runtime.

14. **Q:** Is JVM same for all platforms?

    A: No, JVM is OS-specific but executes the same bytecode.

15. **Q:** Can we install JRE without JDK?

    A: Yes, JRE can be downloaded and installed separately for

end-users.

16. **Q:** What happens if you run Java code without JVM?
    A: It will not run; JVM is mandatory for bytecode execution.

17. **Q:** Name a few JVM implementations.
    A: Oracle HotSpot, OpenJ9, GraalVM, Zing.

18. **Q:** What is `java` command used for?
    A: To launch the Java Virtual Machine and run `.class` files.

19. **Q:** How is security managed in JVM?
    A: With bytecode verification and class loading constraints.

20. **Q:** Can we customize JVM settings?
    A: Yes, using JVM options like `-Xmx`, `-Xms`, `-XX:+UseG1GC`, etc.

✅ Topic Outcome:

After this topic, learners will:

- Clearly understand the roles of JDK, JRE, and JVM
- Know how Java achieves platform independence

- Recognize the memory areas and components inside the JVM
- Use command-line tools to compile and execute Java programs

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✅ Summary:

- JDK, JRE, and JVM are the **core components of the Java platform**.
- Together, they ensure that Java code can be **developed, compiled, and executed** across multiple platforms without modification.
- JVM handles the heavy lifting behind the scenes by interpreting bytecode and managing memory automatically.

🔹 Topic 4: Java Syntax and Structure

✅ Definition:

- **Java Syntax** refers to the set of rules that define how a Java program is written and interpreted by the compiler.
- **Java Structure** defines the building blocks of a Java program including classes, methods, packages, and statements.

- Java is a **case-sensitive**, **statically-typed**, and **block-structured** language where every piece of executable code resides inside a **class** and inside a **method**.

✅ Use Case:

Java's syntax and structure allow:

- Clear separation of logic into classes and methods
- Organized coding using packages
- Strong data typing for fewer runtime errors
- OOP (Object-Oriented Programming) practices like encapsulation and inheritance

---

✅ Real-Time Usage:

Use Case	Real-Time Example
Android App Development	Java class defines activities and layouts
Banking Applications	Structured modules using class-based design
Web Applications (Spring)	Controllers, Services, Repositories → separate
Enterprise APIs	Consistent syntax allows scalable architecture

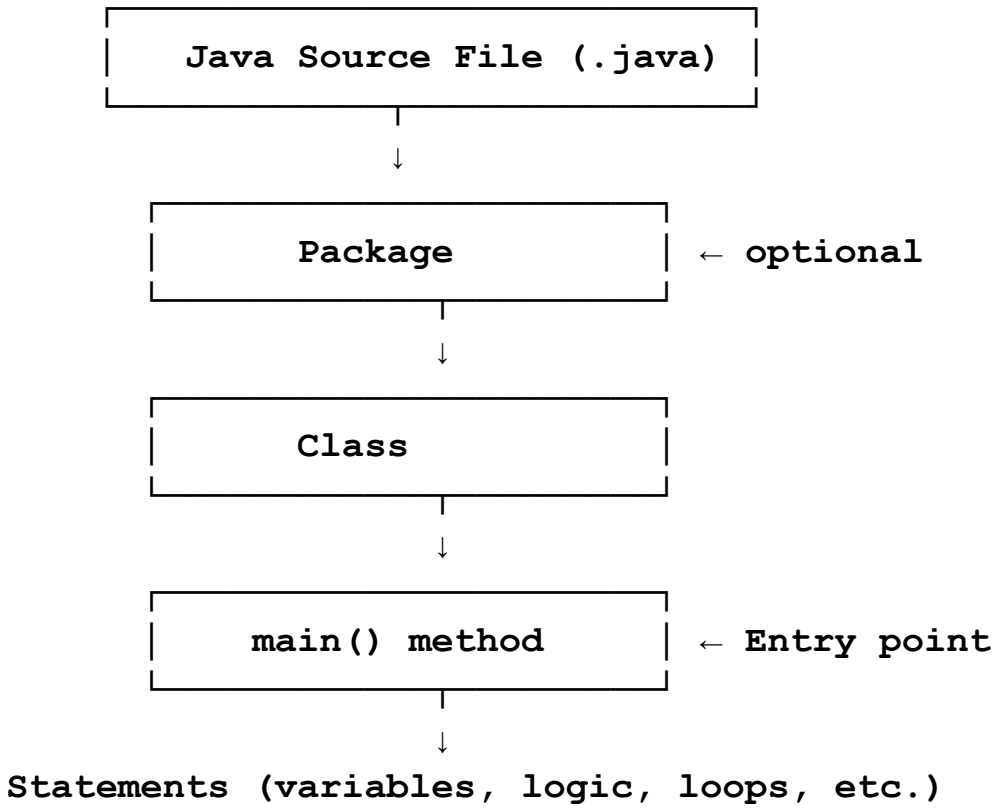
---

✅ Architecture Diagram: Java Program Structure

🔷 Description:

This diagram breaks down the **anatomy of a Java program**, showing how class, method, variables, and statements are organized in layers.

🔷 Java Program Structure Diagram:



🔷 Typical Skeleton of a Java Program:

```
package mypackage;

public class MyClass {
    public static void main(String[] args) {
        // Code logic here
    }
}
```

✅ Syntax Rules:

Concept	Syntax Example
Class	`public class MyClass {}`
Main Method	`public static void main(String[] args)`
Print	`System.out.println("Text");`
Variable	`int num = 10;`
Comment	`// Single-line comment` or `/* Multi-line */`
Blocks	Code enclosed in `{ }`

✅ Keywords:

`public`, `static`, `void`, `class`, `int`, `String`, `return`, `if`, `else`, `for`, `new`, `package`, `import`

✅ Simple Example Code:

```
public class Greeting {
    public static void main(String[] args) {
        System.out.println("Welcome to Java Syntax and
Structure!");
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// Java program to collect and display student details
import java.util.Scanner;

public class StudentDetails {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        String name;
        int age;
        double marks;

        System.out.print("Enter name: ");
        name = sc.nextLine();
        System.out.print("Enter age: ");
        age = sc.nextInt();
        System.out.print("Enter marks: ");
        marks = sc.nextDouble();

        System.out.println("\n--- Student Info ---");
        System.out.println("Name : " + name);
        System.out.println("Age  : " + age);
        System.out.println("Marks: " + marks);
```

```
        sc.close();
    }
}
```

✅ Sub-Topics with Examples:

🔹 Java Identifiers:

- Used to name variables, methods, classes, etc.
- Must begin with a letter, _, or $

```
int _count = 5;
String $message = "Hello";
```

🔹 Data Types & Declarations:

```
int age = 25;
double salary = 50000.75;
char grade = 'A';
boolean isPassed = true;
```

🔹 Statements & Blocks:

```
if (salary > 30000) {
    System.out.println("Eligible");
}
```

✅ Real-Time Example Code:

```java
// Program that checks if a number is even or odd
public class EvenOddChecker {
    public static void main(String[] args) {
        int number = 11;

        if (number % 2 == 0) {
            System.out.println("Even Number");
        } else {
            System.out.println("Odd Number");
        }
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. What is the entry point of any standalone Java application?

   A) init()

   B) main()

   C) start()

   D) run()

2. What is the correct file extension for Java files?

   A) `.js`

   B) `.java`

   C) `.class`

D) `.jav`

3. Which of the following is a valid identifier in Java?

A) _data

B) 123data

C) %value

D) -data

4. Which symbol is used for comments in Java?

A) `#`

B) //

C) `--`

D) `<!-- -->`

5. What will `System.out.println("Hello");` do?

A) Print Hello with a new line

B) Print Hello without newline

C) Compile error

D) Print in a dialog box

6. Java code blocks are enclosed in:

A) [ ]

B) ( )

C) { }

D) < >

7. Which keyword defines a class?

A) define

B) class

C) public

D) type

8. `int x = 5.5;` is:

A) Valid

B) Compile error

C) Runtime error

D) Warning

9. What is the correct way to declare a string?

A) `String name = "John";`

B) `string name = "John";`

C) A only

D) B only

10. `System.out.println()` is a method of:

A) PrintStream class

B) Math class

C) Scanner class

D) String class

11. Java is:

A) Case-sensitive

B) Case-insensitive

C) Doesn't care

D) Depends on compiler

12. In Java, every method must be inside a:

A) File

B) Object

C) Class

D) Package

13. The return type of `main()` is:

A) int

B) String

C) void

D) boolean

14. What is the valid way to start a class in Java?

A) `function class Main`

B) `public class Main`

C) `begin Main`

D) `void class Main`

15. What is `public` in Java?

A) Return type

B) Access modifier

C) Class type

D) Variable

✅ 20 Interview Q&A:

1. **Q:** What is the structure of a basic Java program?

   A: It includes package (optional), class declaration, `main()` method, and statements inside blocks `{}`.

2. **Q:** Is Java case-sensitive?

   A: Yes. `Variable` and `variable` are different.

3. **Q:** Why must everything in Java be inside a class?

   A: Java is a purely object-oriented language (except for primitives), hence everything is class-based.

4. **Q:** What is the purpose of the `main()` method?

   A: It serves as the starting point for execution in standalone Java applications.

5. **Q:** Can a Java program have more than one class?

   A: Yes, but only one class can contain the `main()` method.

6. **Q:** What is `System.out.println()`?

   A: A method to print output to the console.

7. **Q:** What happens if `main()` is missing in a Java program?

   A: The program will compile but fail to run (`Main method not found` error).

8. **Q:** What is the role of the semicolon `;` in Java?

   A: It denotes the end of a statement.

9. **Q:** What are code blocks in Java?

   A: Blocks of code enclosed within `{}` braces.

10. **Q:** Can we write Java code outside a class?

    A: No, all code must reside inside a class.

11. **Q:** What does `public static void main` mean?

    A: It defines a globally accessible, class-level method that returns nothing.

12. **Q:** What are identifiers?

    A: Names given to classes, variables, methods, etc.

13. **Q:** Can a Java class contain multiple methods?

    A: Yes.

14. **Q:** What is the role of the package declaration?

    A: It groups related classes together for better code organization.

15. **Q:** Can we run a Java program without a `main()` method?

    A: Not a standalone program. But applets and frameworks like Spring may have different entry points.

16. **Q:** What is the use of indentation in Java?

    A: Improves readability but is not syntactically required.

17. **Q:** What does `static` keyword mean?

    A: Belongs to the class, not instances.

18. **Q:** Is it necessary to save the Java file with the class name?

    A: Yes, if the class is `public`.

19. **Q:** What is a comment in Java?

    A: Text ignored by compiler, used to describe code.

20. **Q:** What is the default return type of `main()`?

    A: `void` – it doesn't return anything.

✅ Topic Outcome:

After this topic, learners will:

- Understand the basic syntax and structure of Java
- Know how to write, compile, and run basic programs
- Be able to distinguish between identifiers, keywords, blocks, and statements
- Answer foundational interview questions on Java structure

✅ Summary:

- The syntax and structure of Java provide the backbone for writing consistent, readable, and modular code.
- Every Java program starts with a class and includes a `main()` method as the entry point.
- Mastering this foundation is essential for progressing into more complex programming constructs.

🔹 Topic 5: Data Types and Its Types

✅ Definition:

- **Data Types in Java** define the type of data that can be stored and manipulated within a program.
- They determine the size and type of values that variables can hold.
- Java is a **strongly typed** language, meaning each variable must be declared with a data type before use.

✅ Use Case:

Data types are used in:

- Variable declarations (`int age = 25;`)
- Memory allocation
- Type checking and conversions
- Ensuring consistent data operations in enterprise systems, games, Android apps, etc.

✅ Real-Time Usage:

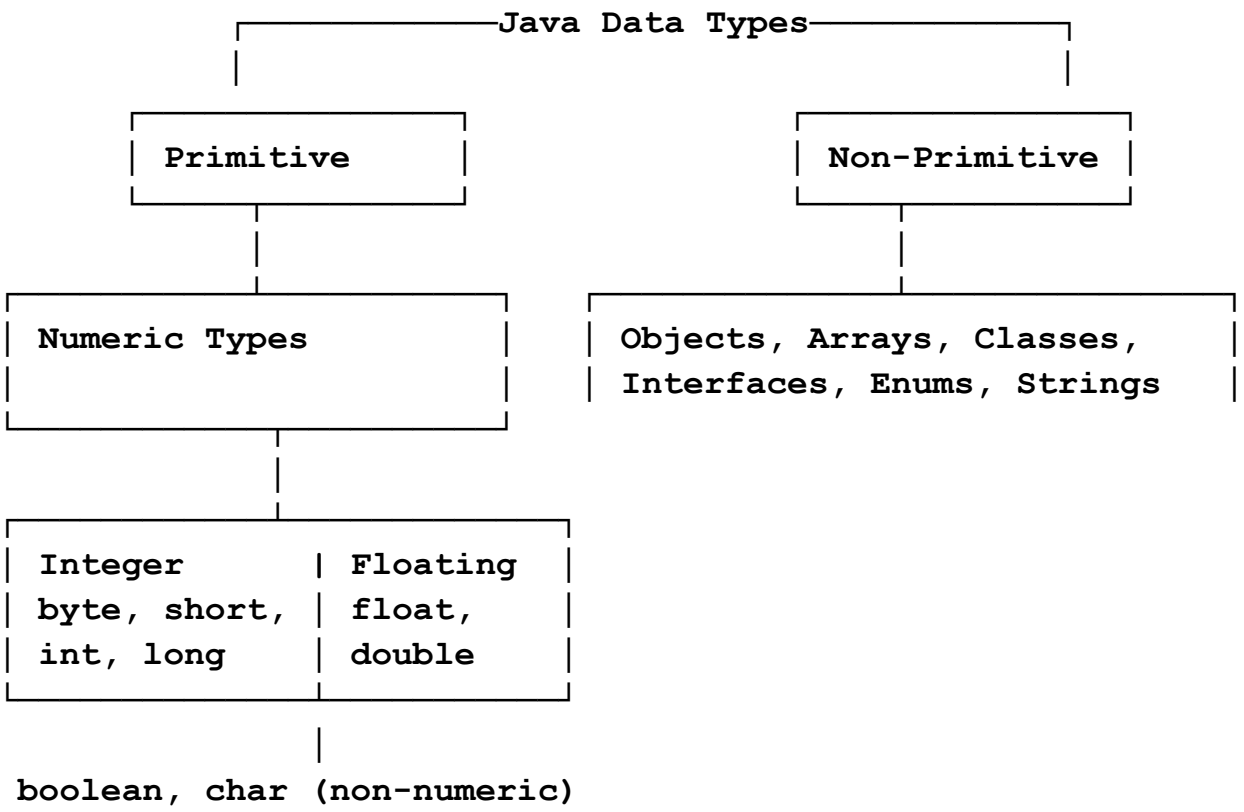
Use Case	Real-Time Example
Banking System	`double` to store balance with decimals
Attendance Tracking	`boolean` to indicate presence/absence
Student Management	`int` for ID, `String` for name, `char` for grade
E-Commerce Pricing	`float` or `double` for product price
Online Exam Application	`char` for options ('A', 'B', etc.)

✅ Architecture Diagram: Java Data Type Hierarchy

🔷 Description:

This diagram outlines the **classification of Java data types** into **primitive** and **non-primitive** categories.

🔷 Diagram:



✅ Syntax:

```
int age = 25;
float price = 99.99f;
char grade = 'A';
boolean isValid = true;
String name = "Java";
```

✅ Keywords:

byte, short, int, long, float, double, char, boolean, String

✅ Simple Example Code:

```
public class DataTypeExample {
    public static void main(String[] args) {
        int age = 30;
        double salary = 55000.75;
        char gender = 'M';
        boolean isMarried = false;

        System.out.println("Age: " + age);
        System.out.println("Salary: ₹" + salary);
        System.out.println("Gender: " + gender);
        System.out.println("Married: " + isMarried);
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// A Java program to store employee info using data types
public class Employee {
    int empId;
    String empName;
    double salary;
    char grade;
    boolean isPermanent;

    public Employee(int id, String name, double sal, char
gr, boolean status) {
        empId = id;
        empName = name;
        salary = sal;
```

```
        grade = gr;
        isPermanent = status;
    }

    public void displayDetails() {
        System.out.println("ID        : " + empId);
        System.out.println("Name      : " + empName);
        System.out.println("Salary    : ₹" + salary);
        System.out.println("Grade     : " + grade);
        System.out.println("Permanent: " + isPermanent);
    }

    public static void main(String[] args) {
        Employee e = new Employee(101, "Ravi", 85000.50,
'A', true);
        e.displayDetails();
    }
}
```

✅ Sub-Topics with Code Examples:

🔹 Primitive Data Types:

Type	Size	Range/Example	Default
`byte`	1 byte	-128 to 127	0
`short`	2 bytes	-32,768 to 32,767	0
`int`	4 bytes	-2^31 to 2^31-1	0
`long`	8 bytes	-2^63 to 2^63-1	0L
`float`	4 bytes	3.4e−038 to 3.4e+038	0.0f

`double`	8 bytes	1.7e−308 to 1.7e+308	0.0d
`char`	2 bytes	Single 16-bit Unicode character	'\u0000'
`boolean`	1 bit	true / false	false

```
byte b = 100;
short s = 32000;
int i = 500000;
long l = 1000000000L;
float f = 12.45f;
double d = 12345.6789;
char c = 'J';
boolean status = true;
```

🔹 **Non-Primitive Data Types:**

- Classes, Arrays, Interfaces, Enums, and `String`

```
String name = "Java";
int[] marks = {85, 90, 78};
```

✅ Real-Time Example Code:

```
// Student grades using primitive and non-primitive types
public class Student {
    public static void main(String[] args) {
        String name = "Kavya";
        int rollNo = 501;
        float avgMarks = 87.5f;
        char grade = 'A';
        boolean isPassed = true;
```

```
        System.out.println(name + " | Roll: " + rollNo);
        System.out.println("Average Marks: " + avgMarks);
        System.out.println("Grade: " + grade);
        System.out.println("Passed: " + isPassed);
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. Which of the following is not a primitive type in Java?

   A) `int`

   B) `char`

   C) `boolean`

   D) `String`

2. What is the size of `int` in Java?

   A) 2 bytes

   B) 4 bytes

   C) 8 bytes

   D) Depends on system

3. What is the default value of a `boolean` variable?

   A) true

   B) false

   C) null

D) 0

4. Which data type is used to store decimal numbers?

A) `int`

B) `float` or `double`

C) `char`

D) `boolean`

5. Which one is correct to assign a float value?

A) `float f = 45.5;`

B) `float f = 45.5f;`

C) `float = 45.5d;`

D) `float: 45.5;`

6. Which type is used for a single character?

A) `String`

B) `char[]`

C) `char`

D) `byte`

7. What is the range of `byte`?

A) 0 to 256

B) 0 to 128

C) -128 to 127

D) -256 to 256

8. What is the default value of `double`?

A) 0.0

B) 0

C) null

D) undefined

9. Which keyword is used to define a data type?

A) int

B) var

C) define

D) value

10. Which type can hold true/false?

A) `int`

B) `byte`

C) `boolean`

D) `short`

11. How to represent Unicode characters?

A) `%U`

B) `'\uXXXX'`

C) `UTF-16`

D) `*U*`

12. Which data type has the highest precision?

A) `float`

B) `double`

C) `int`

D) `short`

13. Which one of these is not a valid variable name?

A) `_count`

B) `total$`

C) `123value`

D) `value123`

14. Which one is a non-primitive data type?

A) `int`

B) `double`

C) `String`

D) `char`

15. What is the output of `System.out.println(10.5f);`?

A) 10

B) 10.5

C) Error

D) “10.5”

✅ 20 Interview Questions & Answers:

1. **Q:** What are the two main categories of data types in Java?

   A: Primitive and Non-Primitive.

2. **Q:** What is the size of an `int`?

   A: 4 bytes.

3. **Q:** What is the difference between `float` and `double`?

   A: `double` has double precision and more size (64-bit) than `float` (32-bit).

4. **Q:** What is the default value of `boolean`?

   A: `false`.

5. **Q:** Can `char` hold numeric values?

   A: Yes, as it internally uses Unicode.

6. **Q:** What is a non-primitive data type?

   A: Data types created by the user or provided by Java: String, Arrays, Classes, etc.

7. **Q:** Why use data types in Java?

   A: For type safety, memory efficiency, and preventing runtime errors.

8. **Q:** Is `String` a primitive type?

   A: No, it is a non-primitive (class) type.

9. **Q:** What happens if you don't assign a value to a local variable?

   A: Compilation error.

10. **Q:** Can `boolean` be cast to `int`?

    A: No, Java does not allow implicit boolean-to-integer conversion.

11. **Q:** Is `null` a valid primitive value?

    A: No, only objects can be `null`.

12. **Q:** Can we use `var` in Java?

    A: Yes, from Java 10 onwards (for local variables only).

13. **Q:** Can you assign a `double` to a `float`?

    A: Not directly. It requires explicit casting.

14. **Q:** What is the default value of `char`?

    A: `'\u0000'`.

15. **Q:** Why are primitive types preferred in performance-critical apps?

    A: Because they are stored directly in memory and don't have object overhead.

16. **Q:** What happens if you assign an out-of-range value to `byte`?

    A: Compilation error or unexpected behavior.

17. **Q:** Can a `char` be assigned a number?

    A: Yes, e.g., `char c = 65; // 'A'`

18. **Q:** How many primitive types are in Java?

    A: 8.

19. **Q:** Is `array` a data type?

    A: Arrays are non-primitive reference types.

20. **Q:** Difference between `int[]` and `Integer[]`?

    A: `int[]` holds primitives; `Integer[]` holds wrapper objects.

✅ Topic Outcome:

After this topic, learners will:

- Understand the difference between primitive and non-primitive data types
- Learn appropriate data type usage for different scenarios
- Be able to write clean, memory-efficient code
- Prepare confidently for data type-related interview questions

---

✅ Summary:

- Java's type system enables memory safety, efficient performance, and code clarity.
- Mastering data types ensures better control over variables and smoother debugging.
- Choosing the right type at the right time is foundational to Java development.

🔹 Topic 6: Variables and Its Types

✅ Definition:

- A **variable** in Java is a name given to a memory location that stores data during program execution.
- Variables are containers for storing values that can change (vary) as the program runs.
- Java variables must be **declared with a type** and can be initialized with a value.
- Java supports different types of variables depending on **scope, usage, and lifetime**.

✅ Use Case:

Variables are used to:

- Store user input or program-generated values
- Perform arithmetic and logical operations
- Maintain state across function calls or class instances
- Enable configuration and flow control in applications

✅ Real-Time Usage:

Use Case	Variable Example
Shopping Cart System	`int quantity`, `double totalPrice`
Banking App	`String accountHolder`, `float balance`
Attendance Tracking	`boolean isPresent`
Temperature Sensor App	`double temperatureReading`
Employee Management System	`String empName`, `int empID`, `char grade`

✅ Architecture Diagram: Java Variable Classification

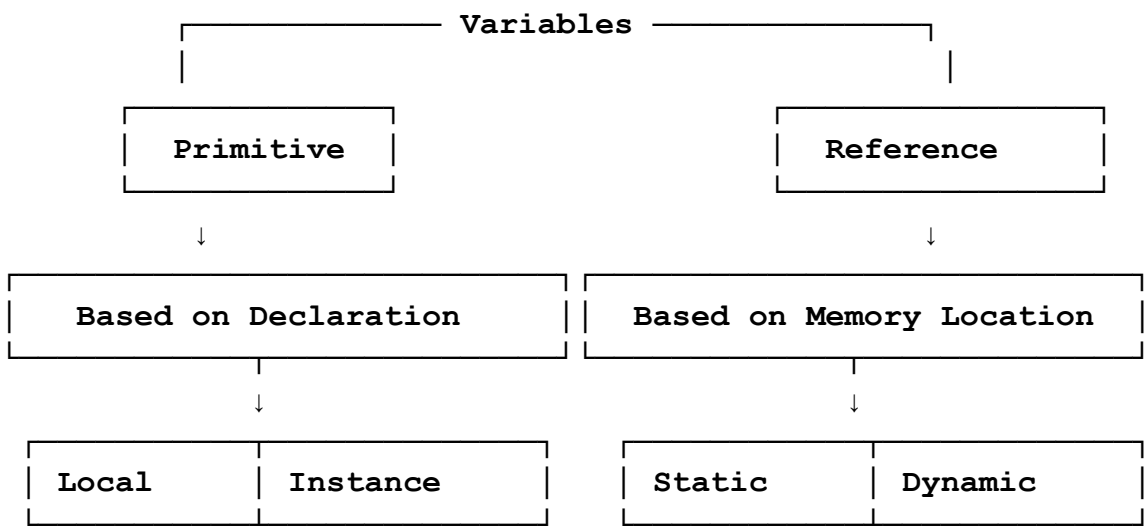
🔷 Description:

This diagram categorizes Java variables based on their **scope and declaration location**.

✅ Syntax:

```
int age = 30;                    // Local variable
static int count = 0;            // Static variable
String name = "John";            // Instance variable
```

🔷 Diagram:



✅ Keywords:

`int`, `float`, `char`, `boolean`, `String`, `static`, `final`, `this`

✅ Simple Example Code:

```
public class Car {
    String model = "Toyota"; // instance variable

    public void showModel() {
        int speed = 120; // local variable
        System.out.println("Model: " + model);
        System.out.println("Speed: " + speed);
    }

    public static void main(String[] args) {
        Car c = new Car();
```

```
        c.showModel();
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// Online banking simulation using all types of variables
public class BankAccount {
    static String bankName = "State Bank"; // Static
Variable
    int accountNumber;                     // Instance
Variable
    double balance;                        // Instance
Variable

    BankAccount(int accNo, double bal) {
        accountNumber = accNo;
        balance = bal;
    }

    void deposit(double amount) {
        double serviceCharge = 5.0; // Local Variable
        balance += amount - serviceCharge;
    }

    void display() {
        System.out.println("Bank       : " + bankName);
        System.out.println("Account #  : " + accountNumber);
        System.out.println("Balance    : ₹" + balance);
    }

    public static void main(String[] args) {
        BankAccount b1 = new BankAccount(12345, 10000);
        b1.deposit(2000);
```

```
        b1.display();
    }
}
```

✅ Sub-Topics with Code Examples:

🔹 Types of Variables in Java:

Type	Scope	Lifetime	Declared Inside
Local	Within method/block	Only within method	Methods, loops, blocks
Instance	For each object	As long as object exists	Class (non-static block)
Static (Class)	Shared across all objects	Until program ends	Declared with `static` keyword

---

```
public class Demo {
    static int count = 0;              // static
    int id;                            // instance

    Demo(int id) {
        this.id = id;
        count++;
    }

    void show() {
        String msg = "Student ID: "; // local
        System.out.println(msg + id);
    }
```

```
    public static void main(String[] args) {
        Demo d1 = new Demo(1);
        Demo d2 = new Demo(2);
        d1.show();
        d2.show();
        System.out.println("Total objects: " + count);
    }
}
```

✅ Real-Time Example Code:

```
// Attendance tracking system
public class Attendance {
    String studentName;           // instance variable
    static String course = "Java"; // static variable

    Attendance(String name) {
        studentName = name;
    }

    void markPresent() {
        boolean isPresent = true; // local variable
        System.out.println(studentName + " is present in "
+ course + ": " + isPresent);
    }

    public static void main(String[] args) {
        Attendance s1 = new Attendance("Priya");
        s1.markPresent();
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. Variables declared inside a method are called:

   A) Instance variables

   B) Local variables

   C) Static variables

   D) Global variables

2. Which keyword is used to create a class-level variable?

   A) const

   B) static

   C) public

   D) final

3. What is the default value of an instance variable of type int?

   A) 1

   B) null

   C) 0

   D) undefined

4. Which of the following can't be static?

   A) Variables

   B) Methods

   C) Constructors

   D) Blocks

5. A variable common to all objects of a class is:

A) Local

B) Instance

C) Static

D) Final

6. A local variable must be:

A) Initialized before use

B) Static

C) Final

D) Public

7. Where are static variables stored?

A) Stack

B) Heap

C) Method Area

D) Constant Pool

8. What is the lifetime of a local variable?

A) Till method exits

B) Till program ends

C) Forever

D) None

9. Variables declared inside a class but outside methods are:

A) Local

B) Instance/Static

C) Loop variables

D) Final

10. Can two variables with the same name exist in the same scope?

A) Yes

B) No

C) Only if static

D) Only if private

11. Can instance variables be accessed in static methods?

A) Yes

B) No

C) Depends on compiler

D) Yes, with reference

12. Which type of variable stores object-specific values?

A) Static

B) Instance

C) Final

D) Global

13. What is the use of the `this` keyword in variables?

A) Refers to current object's instance variable

B) Accesses superclass

C) Deletes variable

D) None

14. What happens to a local variable after method execution?

A) Stays in memory

B) Destroyed

C) Becomes global

D) Saved in stack

15. Can we declare final variables without initialization?

A) No

B) Yes, but must be initialized later

C) Always initialized by JVM

D) Only in interfaces

✅ 20 Interview Questions & Answers:

1. **Q:** What is a variable in Java?

   A: It is a name given to a memory location used to store data during execution.

2. **Q:** What are the types of variables?

   A: Local, Instance, and Static.

3. **Q:** What is the difference between local and instance variables?

A: Local is within methods; instance is per object.

4. **Q:** What is a static variable?

   A: A variable shared by all instances of a class.

5. **Q:** What happens to local variables after method exits?

   A: They are destroyed and removed from memory.

6. **Q:** Can static variables be accessed with class name?

   A: Yes.

7. **Q:** Are instance variables initialized by default?

   A: Yes, with default values.

8. **Q:** Can you access instance variables inside static methods?

   A: No, unless through an object reference.

9. **Q:** What is the memory location for static variables?

   A: Method Area (Class Memory).

10. **Q:** What is the use of `this` keyword?

    A: Refers to current class object's members.

11. **Q:** Is variable shadowing allowed in Java?

    A: Yes, but can be confusing and should be avoided.

12. **Q:** Can we declare two variables with the same name?
    A: Not within the same scope.

13. **Q:** Can static and instance variables have same name?
    A: Yes, but accessed differently.

14. **Q:** What is the default value for boolean instance variables?
    A: `false`.

15. **Q:** What happens if you forget to initialize a local variable?
    A: Compilation error.

16. **Q:** Where are instance variables stored?
    A: Heap (as part of the object).

17. **Q:** Can a static method modify an instance variable?
    A: No, unless accessed via object.

18. **Q:** How to create constant variables in Java?
    A: Use `final` keyword.

19. **Q:** Can a static variable be final?
    A: Yes, it becomes a constant shared value.

20. **Q:** Can local variables be static?
    A: No.

✅ Topic Outcome:

After this topic, learners will:

- Understand variable scopes and their uses
- Distinguish between local, static, and instance variables
- Implement proper variable declarations and access patterns
- Prepare for variable-related interview and MCQ questions

✅ Summary:

- Variables are the core of programming logic.
- Java provides different variable types based on scope and purpose.
- Understanding variable lifetime, memory, and behavior improves code efficiency and clarity in large-scale applications.

🔹 Topic 7: Constants

✅ Definition:

- A **constant** in Java is a variable whose value cannot be changed once assigned.
- Constants are declared using the `final` keyword and are typically written in **uppercase letters with underscores** to denote immutability.
- Constants make code **more readable**, **maintainable**, and **secure** by preventing accidental modifications to fixed values.

✅ Use Case:

Constants are used to:

- Represent fixed values like tax rates, interest rates, configuration keys, etc.
- Avoid magic numbers in code
- Centralize value changes (e.g., updating `PI` or `MAX_USERS`)
- Improve code readability and prevent reassignments

✅ Real-Time Usage:

Real-Time Use Case	Constant Example
Banking Application	`final double INTEREST_RATE = 0.07;`
Exam System	`final int MAX_ATTEMPTS = 3;`
E-Commerce App	`final double GST_RATE = 0.18;`
Android App Development	`final String API_KEY = "xyz123";`
Game Development	`final int MAX_LIVES = 5;`

✅ Architecture Diagram: Constant Declaration & Use Flow

🔷 Description:

This flow explains how constants are **declared, initialized**, and **used across the application** using the `final` keyword.

🔷 Diagram:

```
[Declare Constant] → [final data_type NAME = VALUE;]
        ↓
[Compile-Time Constant (if static final)]
        ↓
[Can be accessed globally if public static]
        ↓
[Used in functions, classes, calculations]
```

✅ Syntax:

```
final data_type CONSTANT_NAME = value;
```

✅ Keywords:

`final`, `static`, `public`, `private`, `constant`, `immutable`

✅ Simple Example Code:

```
public class Circle {
    final double PI = 3.14159;

    public double calculateArea(double radius) {
        return PI * radius * radius;
    }

    public static void main(String[] args) {
        Circle c = new Circle();
        System.out.println("Area: " + c.calculateArea(5));
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// GST Calculator using constant
public class BillingSystem {
    final static double GST_RATE = 0.18;

    public double calculateTotal(double price) {
        return price + (price * GST_RATE);
    }

    public static void main(String[] args) {
        BillingSystem bill = new BillingSystem();
        double total = bill.calculateTotal(1200);
        System.out.println("Total with GST: ₹" + total);
    }
}
```

✅ Sub-Topics with Examples:

🔹 `final` Keyword:

- Used to create constants (non-changeable variables)
- Once assigned, a final variable **cannot** be reassigned

```
final int MAX_STUDENTS = 60;
MAX_STUDENTS = 80; // ❌ Compile-time error
```

🔹 `static final` Constants (Global Constants):

```
public class Config {
    public static final String DB_NAME = "students_db";
    public static final int MAX_USERS = 100;
}
```

✅ Real-Time Example Code:

```
public class University {
    public static final int MAX_SEMESTERS = 8;

    public static void main(String[] args) {
        System.out.println("Max semesters allowed: " +
MAX_SEMESTERS);
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. Which keyword is used to declare a constant in Java?

   A) static

   B) const

   C) final

   D) constant

2. What happens when you try to change a `final` variable?

   A) Nothing

B) Runtime error

C) Compile-time error

D) Warning only

3. `final` variables must be:

A) Redeclared

B) Initialized once

C) public only

D) Used only in classes

4. Constants are typically named:

A) in camelCase

B) in PascalCase

C) IN_UPPER_CASE

D) with a # prefix

5. Which of the following is a valid constant declaration?

A) `final int num;`

B) `final int MAX = 100;`

C) `const int val = 10;`

D) `int constant = 5;`

6. What is the use of `static final`?

A) Creates a modifiable global value

B) Creates a constant shared value

C) Allows inheritance

D) Creates runtime values

7. Can a final variable be initialized later?

A) Yes, if it's a blank final

B) No

C) Only if static

D) Only inside static methods

8. What is a blank final variable?

A) One without type

B) Declared but not yet initialized

C) Global variable

D) An unused constant

9. Which is true about constants?

A) They are changeable

B) Declared with `final`

C) Must be private

D) Always static

10. What happens if a constant is declared but not initialized?

A) Auto-initialized

B) Compile error

C) Becomes null

D) Runtime error

11. Where are static final variables stored?

A) Heap

B) Method Area (Class memory)

C) Stack

D) Constant Pool

12. Can constants be used in switch statements?

A) Yes, if static final

B) No

C) Only in enums

D) Only for strings

13. Can a constant be an object?

A) Yes, the reference can't change

B) No

C) Only strings

D) Only arrays

14. Can `final` be used with methods?

A) No

B) Yes, to prevent overriding

C) Only in abstract classes

D) Only in interfaces

15. Can you declare constants in interfaces?

A) Yes, they are implicitly public static final

B) No

C) Only in abstract classes

D) Only as private members

✅ 20 Interview Questions & Answers:

1. **Q:** What is a constant in Java?

   A: A variable whose value is fixed after initialization, declared with `final`.

2. **Q:** What is the difference between `final` and `static final`?

   A: `final` makes a variable immutable; `static final` creates a global constant.

3. **Q:** Can you reassign a final variable?

   A: No, it leads to a compile-time error.

4. **Q:** Can constants be declared inside methods?

   A: Yes, they are method-local constants.

5. **Q:** Why are constants usually written in uppercase?

   A: It's a naming convention to distinguish them easily.

6. **Q:** What is a blank final variable?

   A: A final variable declared but not initialized during declaration, must be initialized later.

7. **Q:** Can a final variable be used in switch-case?

   A: Yes, if it's a compile-time constant (`static final`).

8. **Q:** Where are constants stored in memory?

   A: In the Method Area (as part of class metadata).

9. **Q:** Can an object be declared final?

   A: Yes. The reference cannot change, but internal fields may.

10. **Q:** What happens if a final variable is not initialized?

    A: Compilation error unless it is a blank final variable.

11. **Q:** Is `const` a keyword in Java?

    A: It is a reserved keyword but not used; Java uses `final`.

12. **Q:** Can constants be declared in interfaces?

    A: Yes. They are `public static final` by default.

13. **Q:** What is the scope of a static final variable?

    A: Class-level (shared across all instances).

14. **Q:** What is the difference between constant and literal?

A: Constant is a named final variable; literal is a direct value (e.g., 10, 'A').

15. **Q:** Can a constant be private?

A: Yes, it can be declared with any access modifier.

16. **Q:** Can `final` be applied to methods and classes?

A: Yes. Methods → non-overridable, Classes → non-inheritable.

17. **Q:** Are constants initialized at compile-time or runtime?

A: Compile-time if declared as `static final` and initialized with literals.

18. **Q:** Why are constants preferred over literals?

A: Improves readability, maintainability, and reduces errors.

19. **Q:** What happens if you try to override a final method?

A: Compile-time error.

20. **Q:** What's the best place to store constants in an application?

A: In a separate constants/configuration class or interface.

✅ Topic Outcome:

After completing this topic, learners will:

- Understand how to declare and use constants in Java
- Know the significance of `final` and `static final`
- Avoid reassignments by using constants properly
- Answer interview questions related to constants and immutability

---

✅ Summary:

- Constants are vital in Java for protecting values from unwanted changes.
- Using `final` and `static final` ensures stability and reliability in logic-driven applications.
- This is especially important in enterprise systems, configurations, and domain rule enforcement.

🔹 Topic 8: Java Comments and Operators

✅ Definition:

- **Comments** in Java are non-executable statements used to explain the code.
- They improve readability and maintainability.
- **Operators** are special symbols used to perform operations on variables and values, such as arithmetic, logical, comparison, and assignment.

✅ Use Case:

- **Comments** are used to describe logic, disable code during testing, or clarify complex operations.

- **Operators** are essential in every part of programming — from calculations to decision-making, looping, and assignments.

✅ Real-Time Usage:

Feature	Real-Time Example
Comments	Code documentation in APIs, modules, and legacy systems
Arithmetic	Total price calculation: `total = price * quantity`
Comparison	User login check: `if (inputPass.equals(actualPass))`
Logical Ops	Eligibility checks: `if(age > 18 && hasID)`
Assignment	Default initializations: `balance = 0.0`

✅ Syntax:

🔹 Comments:

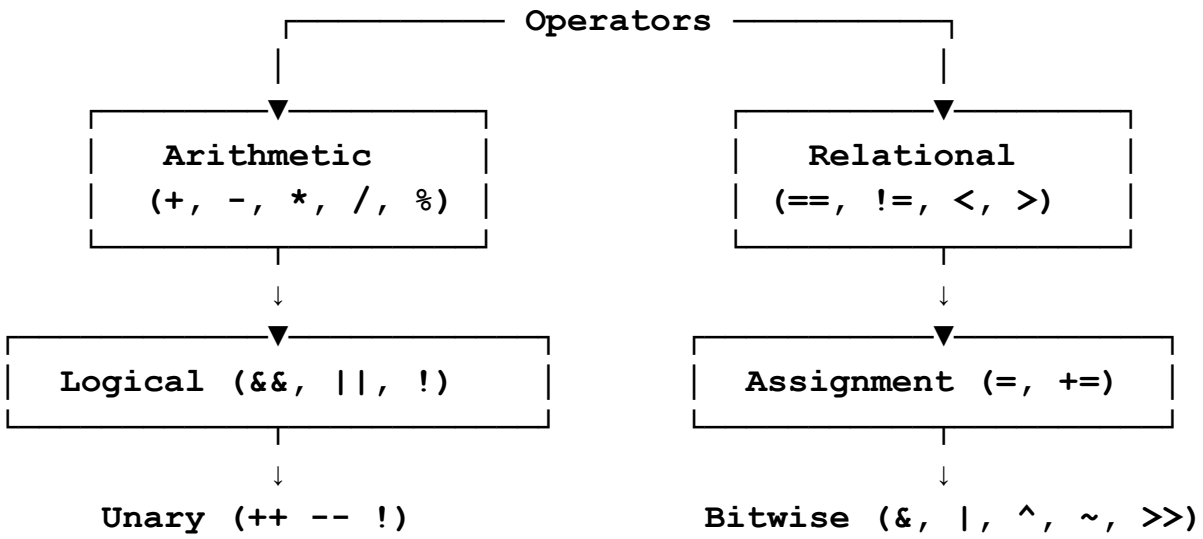
```
// Single-line comment

/*
   Multi-line comment
*/

/**
 * JavaDoc comment - used for documentation
 */
```

✅ Architecture Diagram: Operators Classification Tree

🔷 Description:

The following diagram classifies **Java operators** into key categories based on function and purpose.

🔷 Diagram:



🔹 Operators:

```
int a = 5, b = 10;
int sum = a + b;        // Arithmetic
boolean result = a > b; // Relational
a += 3;                 // Assignment
boolean valid = (a > 0 && b > 0); // Logical
```

✅ Keywords:

//, /* */, +, -, *, /, %, ==, !=, <, >, <=, >=, &&, ||, !, =, +=, ++, --, ^, >>, <<

✅ Simple Example Code:

```
public class CommentsAndOperators {
    public static void main(String[] args) {
        // This is a single-line comment
        int x = 10;
        int y = 20;

        /* Calculate the sum of two numbers */
        int sum = x + y;

        System.out.println("Sum: " + sum); // Display
output
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// Java program to calculate EMI (Simple version)
public class LoanCalculator {
    public static void main(String[] args) {
        double principal = 100000;  // Loan amount
        double rate = 0.08;         // Annual interest rate
        int years = 5;

        // Calculate total interest
        double interest = principal * rate * years;
```

```
        // Calculate total repayment
        double totalAmount = principal + interest;

        System.out.println("Loan Amount: ₹" + principal);
        System.out.println("Total Interest: ₹" + interest);
        System.out.println("Total Payable: ₹" +
totalAmount);
    }
}
```

✅ Sub-Topics with Examples:

🔹 Types of Comments:

Type	Symbol(s)	Example Usage
Single-line	`//`	`// This is a comment`
Multi-line	`/* */`	`/* Block comment */`
JavaDoc	`/** */`	Used for documenting classes and methods

🔹 Operator Types:

Type	Symbols	Description
Arithmetic	`+ - * / %`	Basic math operations
Relational	`== != > < >= <=`	Compare values
Logical	`&&	

Assignment	`= += -= *= /=`	Assign or modify variables
Unary	`++ -- + -`	Operate on single operand
Bitwise	`&	^ ~ << >>`
Ternary	`? :`	Conditional expression

✅ Real-Time Example Code:

```
public class GradingSystem {
    public static void main(String[] args) {
        int marks = 75;

        // Check grade using conditional and relational
operators
        if (marks >= 90) {
            System.out.println("Grade A");
        } else if (marks >= 75 && marks < 90) {
            System.out.println("Grade B");
        } else {
            System.out.println("Grade C");
        }
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. What symbol is used for single-line comments in Java?

   A) `/* */`

   B) //

C) <!-- -->

D) #

2. What is the result of `5 % 2`?

A) 0

B) 1

C) 2

D) 2.5

3. Which of the following is a relational operator?

A) `&&`

B) `!=`

C) `=`

D) `+`

4. What does `a += 5;` mean?

A) Assign 5 to a

B) Add 5 to a and assign

C) Multiply a by 5

D) Compare a with 5

5. Which is the correct way to write a block comment?

A) `/**/`

B) `/* comment */`

C) `# comment`

D) `// comment //`

6. What is the use of `&&`?

   A) OR operation

   B) NOT operation

   C) Logical AND

   D) Assignment

7. What will `true || false` return?

   A) true

   B) false

   C) error

   D) null

8. Which operator is used for conditional expressions?

   A) `if`

   B) `:`

   C) `? :`

   D) `!`

9. Which is a valid JavaDoc comment?

   A) `/* */`

   B) `//`

   C) `/** ... */`

D) `<! -->`

10. What is the output of `++x` if `x = 3`?

A) 4

B) 3

C) Error

D) 5

11. What does `x == y` check?

A) Assigns value

B) Checks equality

C) Multiplies values

D) Reverses value

12. Which operator inverts a boolean value?

A) `&&`

B) `!`

C) `^`

D) `=`

13. What does `x >> 1` mean?

A) Left shift

B) Right shift

C) Divide

D) Compare

14. Which operator is used to concatenate strings?

A) +

B) &

C) *

D) =

15. Can comments affect program output?

A) Yes

B) No

C) Only in loops

D) Only with JavaDoc

✅ 20 Interview Questions & Answers:

1. **Q:** What is the purpose of comments in Java?

   A: To document and explain code without affecting execution.

2. **Q:** What are the types of comments in Java?

   A: Single-line (`//`), Multi-line (`/* */`), and JavaDoc (`/** */`).

3. **Q:** What are Java operators?

   A: Symbols that perform operations on variables and values.

4. **Q:** What is the difference between `=` and `==`?

   A: `=` assigns a value, `==` compares values.

5. **Q:** What is a unary operator?

   A: Operator that works on a single operand (e.g., `++`, `--`, `!`).

6. **Q:** What is the difference between `&&` and `&`?

   A: `&&` is logical AND; `&` is bitwise AND.

7. **Q:** Can we nest comments in Java?

   A: No. Nested multi-line comments are not allowed.

8. **Q:** How does JavaDoc help developers?

   A: It generates documentation from structured comments.

9. **Q:** What is a ternary operator?

   A: A shortcut for `if-else`, syntax: `condition ? true : false`.

10. **Q:** What does `%` operator do?

    A: Returns the remainder of division.

11. **Q:** Can comments be used to temporarily disable code?

    A: Yes, especially during debugging.

12. **Q:** What is the output of `10 / 3` in integer division?

    A: `3`

13. **Q:** Can operators be overloaded in Java?

    A: No. Java does not support operator overloading.

14. **Q:** Difference between logical `||` and bitwise `|`?

    A: `||` short-circuits; `|` evaluates both operands.

15. **Q:** What does `x += y` mean?

    A: `x = x + y`

16. **Q:** How are JavaDoc comments different from others?

    A: They can be parsed to generate API documentation.

17. **Q:** What is the function of `++x` and `x++`?

    A: `++x` pre-increments, `x++` post-increments.

18. **Q:** What are compound assignment operators?

    A: Operators that combine arithmetic with assignment (e.g., `+=`, `*=`).

19. **Q:** What is operator precedence?

    A: Rules that determine the order in which operators are

evaluated.

20. **Q:** Is `==` reliable for comparing strings?

    A: No. Use `.equals()` for string comparison.

✅ Topic Outcome:

After completing this topic, learners will:

- Master the use of Java comments and their types
- Understand operator types and how to apply them in logic and calculations
- Improve code clarity and maintainability
- Prepare for operator-based technical interviews

✅ Summary:

- Java comments improve code readability while operators handle all computational and logical operations.
- Mastering both is essential for writing expressive, maintainable, and functional Java programs.

🔹 Topic 9: Object, Scanner Class, Accessing Class Members, `static`

✅ Definition:

- An **object** is an instance of a class that contains state (fields) and behavior (methods).
- The `Scanner` **class** is a built-in Java utility used to read input from users via the console.
- **Accessing class members** means using an object (or class if static) to refer to fields and methods defined in that class.
- The `static` **keyword** is used to create class-level members that belong to the class itself rather than any object.

✅ Use Case:

- Objects are used to model real-world entities in programs (e.g., a Student or BankAccount).
- Scanner is widely used in console-based applications for interactive input.

- Static members are ideal for utilities, shared data, or constants (e.g., `Math.PI`, `System.out`).

✅ Real-Time Usage:

Feature	Real-Time Application Example
Objects	Representing a user, product, or transaction
Scanner	Taking user input in banking/login/quiz apps
Accessing Members	Accessing object attributes in student/employee apps
Static Keyword	Defining global constants and utility methods

✅ Syntax:

🔹 Object Creation:

```
ClassName obj = new ClassName();
```

🔹 Scanner Input:

```
Scanner sc = new Scanner(System.in);
String input = sc.nextLine();
```

🔹 Static Members:

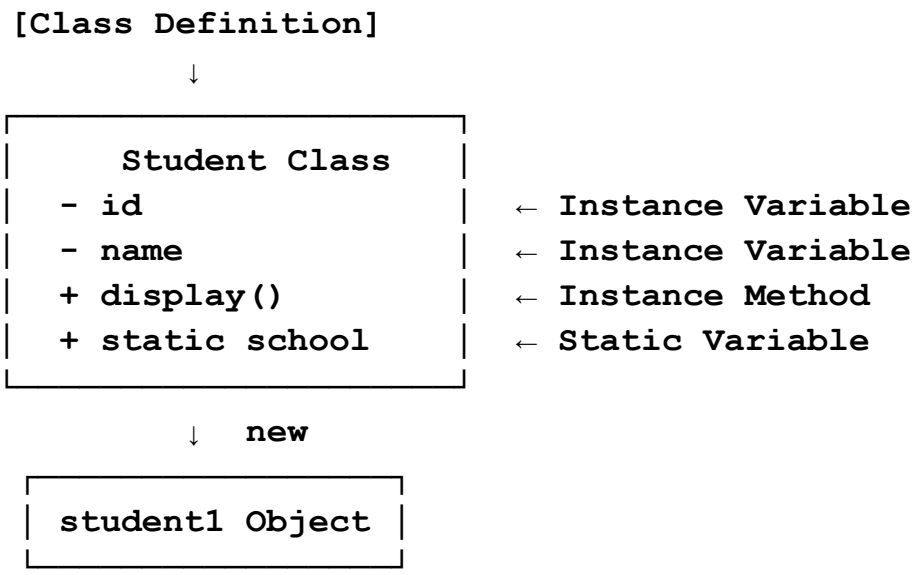
```
ClassName.staticMember
```

✅ Architecture Diagram: Object and Class Member Access

🔷 Description:

This diagram shows how an object is created from a class and how members (both instance and static) are accessed.

🔷 Diagram:




```
Object Access:
student1.id, student1.name, student1.display()

Static Access:
Student.school
```

✅ Keywords:

`class`, `object`, `new`, `this`, `static`, `Scanner`, `import java.util.Scanner;`

✅ Simple Example Code:

```
public class Car {
    String model = "Honda";

    public void display() {
        System.out.println("Model: " + model);
    }

    public static void main(String[] args) {
        Car c = new Car(); // Creating object
        c.display();       // Accessing method
    }
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// A program to collect and display employee data using Scanner and static variables
import java.util.Scanner;

public class Employee {
    int empId;
    String empName;
    static String company = "Tech Solutions"; // static variable
```

```
    void readData() {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter Employee ID: ");
        empId = sc.nextInt();
        sc.nextLine(); // clear newline
        System.out.print("Enter Name: ");
        empName = sc.nextLine();
    }

    void displayData() {
        System.out.println("Company: " + company);
        System.out.println("ID      : " + empId);
        System.out.println("Name    : " + empName);
    }

    public static void main(String[] args) {
        Employee e1 = new Employee();
        e1.readData();
        e1.displayData();
    }
}
```

✅ Sub-Topics with Code Examples:

🔹 Creating and Using Objects:

```
Student s1 = new Student(); // object creation
s1.name = "John";
s1.display();
```

🔹 Scanner Input Handling:

```
Scanner sc = new Scanner(System.in);
System.out.print("Enter age: ");
int age = sc.nextInt();
```

🔹 Static vs Instance Members:

```
class Utility {
    static int maxUsers = 100;
    int userId;

    void displayId() {
        System.out.println(userId);
    }

    static void displayMax() {
        System.out.println(maxUsers);
    }
}
```

✅ Real-Time Example Code:

```
// Program to track students and shared school name using
static
public class Student {
    int rollNo;
    String name;
    static String school = "ABC International";

    void getDetails(int r, String n) {
        rollNo = r;
```

```
        name = n;
    }

    void displayDetails() {
        System.out.println("School : " + school);
        System.out.println("Roll No: " + rollNo);
        System.out.println("Name   : " + name);
    }

    public static void main(String[] args) {
        Student s1 = new Student();
        Student s2 = new Student();

        s1.getDetails(101, "Ravi");
        s2.getDetails(102, "Priya");

        s1.displayDetails();
        s2.displayDetails();
    }
}
```

✅ 15 MCQ Questions (with Answers):

1. Which keyword is used to create an object?

   A) class

   B) new

   C) this

   D) create

2. What does the `Scanner` class do?

   A) Print output

B) Take input

C) Perform loops

D) Manage files

3. What is `static` used for?

A) Looping

B) Shared class members

C) Arrays

D) Memory allocation

4. How do you access a static variable?

A) `object.staticVar`

B) `ClassName.staticVar`

C) `this.staticVar`

D) None

5. What package contains Scanner?

A) java.io

B) java.util

C) java.lang

D) java.scan

6. What is an object in Java?

A) Instance of a class

B) File

C) Variable

D) Keyword

7. How do you import the Scanner class?

A) `import java.util.Scanner;`

B) `include scanner`

C) `import scanner.util;`

D) `scanner java.util.*;`

8. What happens if you access a non-static field from a static method?

A) Compile-time error

B) Nothing

C) Runtime exception

D) Valid

9. Which of the following is a static method?

A) `public void get()`

B) `public static void main()`

C) `final void show()`

D) `public private void show()`

10. Which of these is true about `static` variables?

A) One copy shared by all objects

B) Separate copy per object

C) Cannot be modified

D) Exists only in loops

11. What will happen if you forget to import Scanner?

A) Compilation error

B) Nothing

C) Warning only

D) Runtime exception

12. Which of the following statements is valid?

A) `Scanner sc = Scanner();`

B) `Scanner sc = new Scanner(System.in);`

C) `Scanner sc = import Scanner;`

D) `Scanner = new sc();`

13. What keyword is used to refer to current class instance?

A) object

B) this

C) that

D) static

14. Which keyword is used to create a class?

A) object

B) create

C) class

D) make

15. How many copies of static variables exist for a class?

A) As many as objects

B) One shared copy

C) Zero

D) Depends on JVM

✅ 20 Interview Questions & Answers:

1. **Q:** What is an object in Java?

   A: An instance of a class that contains fields and methods.

2. **Q:** How do you create an object?

   A: Using the `new` keyword, e.g., `Car c = new Car();`

3. **Q:** What is the `Scanner` class used for?

   A: To read input from the user (keyboard).

4. **Q:** Which package is required for Scanner?

   A: `java.util`

5. **Q:** What does `static` mean in Java?

   A: Belongs to the class, not the instance.

6. **Q:** Can you call instance methods from static methods?

   A: No, unless you use an object reference.

7. **Q:** Can `main()` access static variables?

   A: Yes, because `main()` is static itself.

8. **Q:** Can we use Scanner without importing?

   A: No, it must be imported.

9. **Q:** What is `this` keyword used for?

   A: Refers to the current class object.

10. **Q:** What is the output of accessing static variable via object?

    A: It works, but it's discouraged. Best to use class name.

11. **Q:** Can a static block exist in a class?

    A: Yes, it runs once when the class is loaded.

12. **Q:** What is the default value of static int?

    A: 0

13. **Q:** What is the difference between static and instance variable?

    A: Static is shared; instance is object-specific.

14. **Q:** Is `Scanner` a class or interface?

    A: Class.

15. **Q:** Can we overload static methods?

    A: Yes.

16. **Q:** Can we override static methods?

    A: No, static methods cannot be overridden.

17. **Q:** What is the memory location of static variables?

    A: Method Area (Class memory).

18. **Q:** Why is `main()` method static?

    A: JVM can call it without creating an object.

19. **Q:** Can an object call a static method?

    A: Yes, but it's recommended to call via class name.

20. **Q:** How do you take `String` input using Scanner?

    A: `String name = sc.nextLine();`

✅ Topic Outcome:

After this topic, learners will:

- Understand object creation and member access in Java
- Use the `Scanner` class for dynamic input handling
- Differentiate between static and instance members
- Apply `static` for constants, utility functions, and shared resources

---

✅ Summary:

- Understanding how to work with objects, user input, and class members is essential in Java programming.
- The `Scanner` class enables interaction, while `static` allows memory-efficient, class-wide data sharing.
- This foundation enables effective design of scalable, modular Java applications.

🔹 Topic 10: Control Statements

✅ Definition:

Control statements in Java manage the flow of execution in a program based on conditions or repetitions. They allow developers to:

- Make decisions (e.g., if a user is eligible)
- Repeat actions (e.g., read multiple inputs)
- Jump to specific sections (e.g., break a loop early)

Control statements are categorized into:

1. **Decision-making statements** – `if`, `if-else`, `if-else-if`, `switch`
2. **Looping statements** – `for`, `while`, `do-while`
3. **Jumping statements** – `break`, `continue`, `return`

✅ Use Case:

Use Case	Control Statement Used
User login check	`if-else`
Menu-driven programs	`switch`
Repeating inputs	`while`, `for`
Early exit on error	`break`, `return`

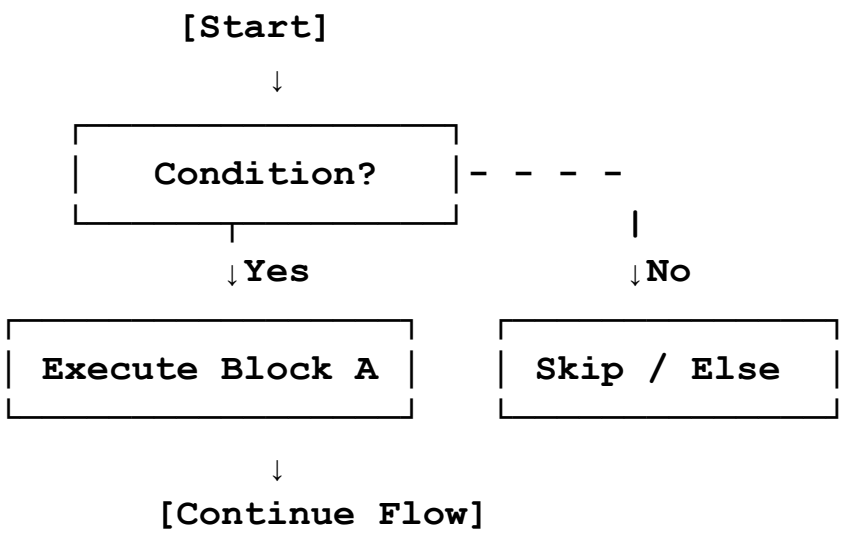
✅ Real-Time Usage:

Application Area	Example
Online Quiz App	Switch-case for question options
Banking System	If-else to validate transactions
Attendance Tracker	For-loop to mark attendance
Game Development	While-loop to keep game running
Billing App	Do-while for repeating invoice generation

✅ Architecture Diagram: Control Flow Based on Conditions

🔷 Description:

This flow diagram shows how control statements dictate the execution path based on logic or conditions.



✅ Syntax:

🔹 if-else:

```
if (condition) {
    // true block
} else {
    // false block
}
```

🔹 switch-case:

```
switch (variable) {
    case 1:
        // code
        break;
```

```
    default:
        // code
}
```

🔹 **for-loop:**

```
for (int i = 0; i < 5; i++) {
    System.out.println(i);
}
```

✅ Keywords:

`if`, `else`, `switch`, `case`, `default`, `break`, `continue`, `return`, `for`, `while`, `do`

✅ Simple Example Code:

```
int age = 20;
if (age >= 18) {
    System.out.println("Eligible to vote.");
} else {
    System.out.println("Not eligible.");
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// Banking menu system using switch-case
import java.util.Scanner;

public class ATMMenu {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        int balance = 10000;
        int choice;

        do {
            System.out.println("1. Check Balance\n2.
Withdraw\n3. Exit");
            System.out.print("Enter your choice: ");
            choice = sc.nextInt();

            switch (choice) {
                case 1:
                    System.out.println("Balance: ₹" +
balance);
                    break;
                case 2:
                    System.out.print("Enter amount: ");
                    int amt = sc.nextInt();
                    if (amt <= balance) {
                        balance -= amt;
                        System.out.println("Withdrawal
successful!");
                    } else {
                        System.out.println("Insufficient
balance.");
                    }
                    break;
                case 3:
                    System.out.println("Thank you!");
```

```
                    break;
                default:
                    System.out.println("Invalid option.");
            }
        } while (choice != 3);

        sc.close();
    }
}
```

✅ Sub-Topics with Examples:

🔹 if-else-if Ladder:

```
int marks = 85;
if (marks >= 90) {
    System.out.println("Grade A");
} else if (marks >= 75) {
    System.out.println("Grade B");
} else {
    System.out.println("Grade C");
}
```

🔹 Nested if:

```
if (user.equals("admin")) {
    if (password.equals("1234")) {
        System.out.println("Access Granted");
    }
}
```

🔹 **Looping Preview (for reference):**

```
for (int i = 0; i < 5; i++) {
    if (i == 3) continue;
    System.out.println(i);
}
```

✅ Real-Time Example Code:

```
// Student pass/fail system
int marks = 40;

if (marks >= 50) {
    System.out.println("Passed");
} else {
    System.out.println("Failed");
}
```

✅ 15 MCQ Questions (with Answers):

1. Which statement is used for decision-making in Java?

   A) if

   B) switch

   C) while

   D) do

2. What is the default case in a switch statement?

   A) The first case

   B) The fallback case if no match is found

C) None

D) End marker

3. Which is valid syntax for `if` statement?

A) `if x > 5`

B) `if(x > 5)`

C) if (x > 5)

D) `if(x => 5)`

4. Which statement exits a loop or switch?

A) break

B) stop

C) exit

D) return

5. Which of the following supports multiple conditions?

A) if

B) if-else-if ladder

C) while

D) switch only

6. Can you nest if statements in Java?

A) Yes

B) No

C) Only in loops

D) Only with static methods

7. What will be the result of `if (false)`?

A) Run

B) Skip the block

C) Error

D) Run else always

8. Which keyword is optional in a switch-case?

A) case

B) break

C) default

D) switch

9. What is used to skip an iteration in a loop?

A) stop

B) continue

C) break

D) return

10. Which loop executes at least once?

A) for

B) while

C) do-while

D) infinite

11. Which operator is commonly used in control statements?

A) Relational (==, <, >)

B) Bitwise

C) Arithmetic

D) Logical only

12. Can switch be used with Strings?

A) No

B) Yes (Java 7+)

C) Only with char

D) Only with numbers

13. Which statement is used to return control from a method?

A) return

B) break

C) continue

D) exit

14. Which is preferred for multiple mutually exclusive conditions?

A) switch-case

B) for

C) nested if

D) while

15. What does `if-else` evaluate?

A) Boolean condition

B) Loop condition

C) Expression only

D) int or char

✅ 20 Interview Questions & Answers:

1. **Q:** What are control statements?

   A: Statements that control the flow of program execution based on logic.

2. **Q:** What types of control statements exist in Java?

   A: Decision-making (`if`, `switch`), looping (`for`, `while`, `do-while`), and jumping (`break`, `continue`, `return`).

3. **Q:** Difference between `if` and `switch`?

   A: `if` handles ranges and conditions; `switch` is better for fixed values.

4. **Q:** What is a switch-case used for?

   A: Multi-way branching based on exact matches.

5. **Q:** What happens if you forget a `break` in switch?

   A: Fall-through to next case.

6. **Q:** Can switch-case be used with strings?

   A: Yes, from Java 7 onward.

7. **Q:** When to use `if-else-if` ladder?

   A: When there are multiple ranges or conditions to check.

8. **Q:** How does `continue` work?

   A: Skips current iteration and moves to the next loop iteration.

9. **Q:** What does `break` do in a loop?

   A: Terminates the loop prematurely.

10. **Q:** What's the difference between `break` and `return`?

    A: `break` exits a loop/switch; `return` exits a method.

11. **Q:** Can you nest if statements?

    A: Yes, Java supports nesting control statements.

12. **Q:** What happens if the condition in if() is false?

    A: The block is skipped.

13. **Q:** Can switch-case handle ranges?

    A: No, only exact values.

14. **Q:** When is `do-while` preferred?

    A: When the loop must run at least once.

15. **Q:** Can we use loops inside if blocks?

    A: Yes, nesting is allowed.

16. **Q:** Can we use logical operators inside if()?

    A: Yes (e.g., `if(x > 5 && y < 10)`)

17. **Q:** Can a loop be infinite?

    A: Yes, e.g., `while(true) {}`

18. **Q:** Is default mandatory in switch-case?

    A: No, it's optional.

19. **Q:** What are conditional operators?

    A: `? :` — used for short if-else expressions.

20. **Q:** Can `break` be used outside loops/switch?

    A: No, compile-time error.

✅ Topic Outcome:

After completing this topic, learners will:

- Understand how to use conditional logic in programs
- Apply different control structures to real-world use cases
- Write clean, logical, and interactive Java applications
- Confidently handle branching logic in interviews

✅ Summary:

- Control statements are the decision-making backbone of Java programs.
- Mastering `if`, `switch`, loops, and jump statements enables flexible and intelligent flow control in logic-driven systems like web apps, business logic engines, and games.

🔹 Topic 11: Looping Statements

✅ Definition:

Looping statements in Java allow the execution of a block of code repeatedly based on a condition.

Java supports three main types of loops:

1. `for` **loop** – Known number of iterations
2. `while` **loop** – Unknown number of iterations (condition-controlled)
3. `do-while` **loop** – Similar to `while` but executes **at least once**

Loops reduce code duplication and automate repetitive tasks efficiently.

✅ Use Case:

Use Case	Loop Type Used
Displaying a menu repeatedly	`do-while`
Iterating through arrays	`for`
Reading user inputs until valid	`while`

Countdown timers	`for`, `while`
Table generation	`for`

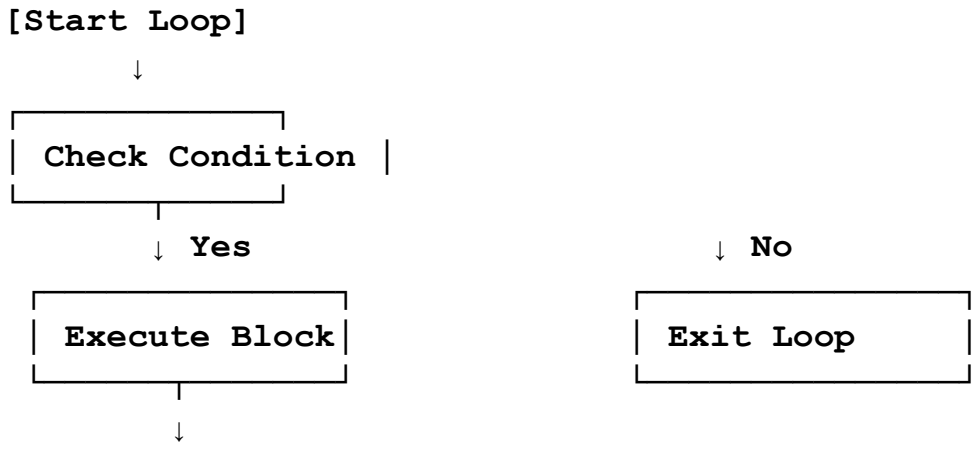
✅ Real-Time Usage:

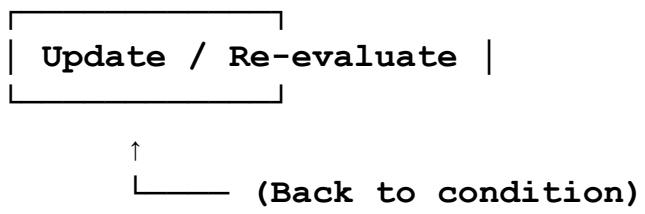
Application	Example
Quiz App	Looping through questions using `for`
Online Form	Keep asking for input until valid using `while`
ATM Program	Menu system with `do-while`
Payroll System	Looping through employee records
Shopping Cart	Calculating total of multiple items in a cart

✅ Architecture Diagram: Loop Flow Control

🔷 Description:

This flow diagram shows the basic working of loops in Java.





✅ Syntax:

🔹 for loop:

```
for (initialization; condition; update) {
    // loop body
}
```

🔹 while loop:

```
while (condition) {
    // loop body
}
```

🔹 do-while loop:

```
do {
    // loop body
} while (condition);
```

✅ Keywords:

`for`, `while`, `do`, `break`, `continue`, `loop`, `increment`, `decrement`

✅ Simple Example Code:

```
// Print numbers 1 to 5
for (int i = 1; i <= 5; i++) {
    System.out.println("Number: " + i);
}
```

✅ Detailed Example Code with Real-Time Usage:

```
// Do-while menu system for ATM
import java.util.Scanner;

public class MenuExample {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        int option;

        do {
            System.out.println("1. Balance\n2. Withdraw\n3.
Exit");
            System.out.print("Enter option: ");
            option = sc.nextInt();

            switch (option) {
                case 1:
                    System.out.println("Balance: ₹10,000");
                    break;
                case 2:
                    System.out.println("Withdraw
functionality...");
                    break;
                case 3:
                    System.out.println("Exiting...");
```

```
                    break;
                default:
                    System.out.println("Invalid option.");
            }
        } while (option != 3);
    }
}
```

✅ Sub-Topics with Examples:

🔹 Nested Loops:

```
for (int i = 1; i <= 3; i++) {
    for (int j = 1; j <= 2; j++) {
        System.out.println("i = " + i + ", j = " + j);
    }
}
```

🔹 Loop with `break` and `continue`:

```
for (int i = 1; i <= 5; i++) {
    if (i == 3) continue;
    if (i == 5) break;
    System.out.println(i);
}
```

✅ Real-Time Example Code:

```java
// Calculate sum of even numbers between 1 to 20
int sum = 0;
for (int i = 1; i <= 20; i++) {
    if (i % 2 == 0) {
        sum += i;
    }
}
System.out.println("Sum of even numbers: " + sum);
```

✅ 15 MCQ Questions (with Answers):

1. Which loop guarantees at least one execution?

   A) for

   B) while

   C) do-while

   D) None

2. Which loop is preferred when the number of iterations is known?

   A) while

   B) do-while

   C) for

   D) None

3. What does the `continue` keyword do?

   A) Exits the loop

B) Skips to next iteration

C) Repeats the same iteration

D) Restarts loop

4. What is printed by: `for(int i=1;i<=3;i++) System.out.print(i);`?

   A) 1 2 3

   B) 123

   C) 321

   D) 0 1 2

5. Which loop checks the condition after execution?

   A) for

   B) while

   C) do-while

   D) All

6. What is the minimum iteration of `while(false)`?

   A) 0

   B) 1

   C) Infinite

   D) Error

7. What is wrong with this loop: `for(;;)`?

   A) Nothing (infinite loop)

   B) Syntax error

C) Runtime error

D) Cannot compile

8. Which loop does not need an initializer?

A) while

B) for

C) do-while

D) if

9. Which of the following is valid?

A) while(true)

B) if while

C) switch while

D) for do

10. Can a loop be nested inside another?

A) Yes

B) No

C) Only in `for`

D) Only if condition is true

11. `break` exits which structure?

A) Class

B) Loop or switch

C) Package

D) Method only

12. In which loop does the condition check happen at the start?

A) while, for

B) do-while

C) Nested only

D) None

13. Can `for` loop be written without condition?

A) Yes, infinite loop

B) No

C) Only in C++

D) Only in static block

14. Which is the best loop for infinite execution?

A) while(true)

B) for

C) do

D) switch

15. What happens in `continue` inside `for` loop?

A) Ends loop

B) Skips remaining code for current iteration

C) Skips all iterations

D) Jumps to method

✅ 20 Interview Questions & Answers:

1. **Q:** What are the three types of loops in Java?

   A: `for`, `while`, and `do-while`.

2. **Q:** Which loop is entry-controlled?

   A: `for` and `while`.

3. **Q:** Which loop is exit-controlled?

   A: `do-while`.

4. **Q:** What is the syntax of `for` loop?

   A: `for(initialization; condition; update)`

5. **Q:** How does `while` loop differ from `do-while`?

   A: `while` checks condition first; `do-while` executes at least once.

6. **Q:** When to use `break`?

   A: To exit loop/switch early.

7. **Q:** When to use `continue`?

   A: To skip current loop iteration.

8. **Q:** Can loops be infinite?

   A: Yes, e.g., `while(true)`.

9. **Q:** Can loops be nested?

   A: Yes, one inside another.

10. **Q:** Is it mandatory to provide all expressions in `for` loop?

    A: No, they're optional.

11. **Q:** What is the scope of a variable declared in loop?

    A: Limited to loop block.

12. **Q:** Can `for` loop have multiple initializations?

    A: Yes, separated by commas.

13. **Q:** What does `i++` mean in loops?

    A: Increments value after use.

14. **Q:** Can loops contain if conditions?

    A: Yes.

15. **Q:** What's the output of `for(int i=0;i<0;i++)`?

    A: Nothing; condition false initially.

16. **Q:** How to break outer loop from inner loop?
    A: Use labeled loops.

17. **Q:** Can `while(true)` be broken?
    A: Yes, with `break`.

18. **Q:** What happens if loop condition is never false?
    A: Infinite loop.

19. **Q:** Can loop variables be declared outside the loop?
    A: Yes.

20. **Q:** Can `return` be used inside a loop?
    A: Yes, it exits the method.

✅ Topic Outcome:

After completing this topic, learners will:

- Understand all types of loops in Java
- Choose the right loop for a given problem
- Use `break` and `continue` to control execution
- Write logic-intensive code for repeated tasks

✅ Summary:

- Loops are essential for automating repetitive tasks, improving efficiency, and reducing code length.
- By mastering `for`, `while`, and `do-while` along with `break` and `continue`, developers can build powerful logic flows in real-world Java applications.

🔹 Topic 12: Jump Statements

✅ Definition:

Jump statements in Java are used to control the flow of execution by *transferring control* to another part of the program. These are:

1. **`break`** – Terminates the current loop or switch.
2. **`continue`** – Skips the current iteration of a loop and jumps to the next one.
3. **`return`** – Exits from the current method and optionally returns a value.

They enhance program control in complex conditions, especially in nested loops, switch statements, or conditional returns.

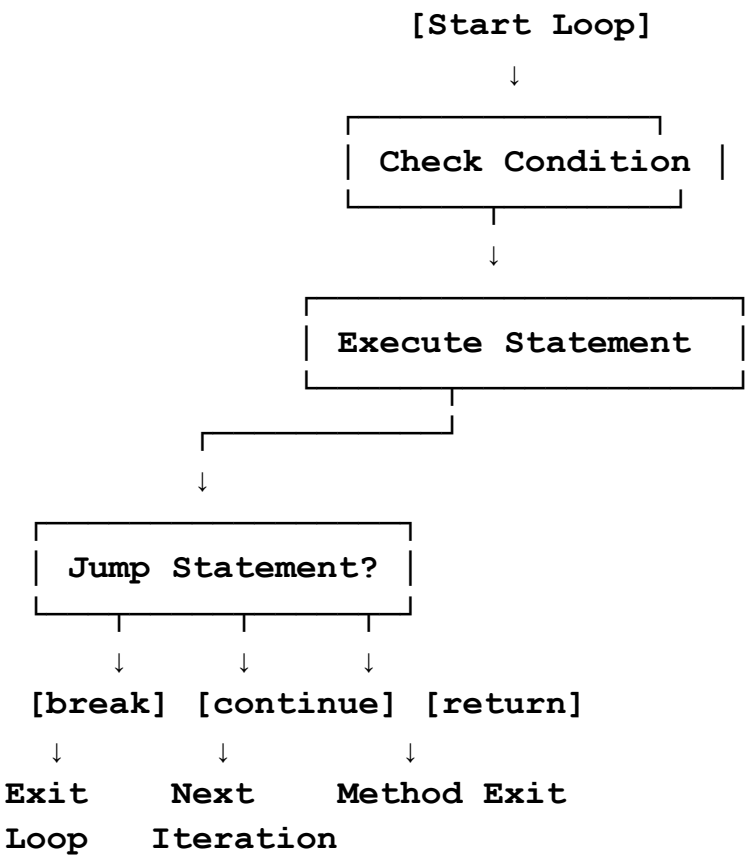
✅ Use Case:

Use Case	Jump Statement Used
Exit a loop when a condition is met	`break`
Skip processing certain data	`continue`
Terminate method execution early	`return`
Exiting menu selection	`break` in `switch`
Validate input inside a loop	`continue` in loops

✅ Real-Time Usage:

Application	Real-Time Scenario Example	Jump Statement
Online Quiz	Exit after user finishes	`return`
Data Filtering App	Skip invalid entries in list	`continue`
Banking App	Exit ATM menu on selection	`break`
Compiler	Exit method after error detected	`return`

✅ Architecture Diagram: Jump Control Flow



✅ Syntax:

🔹 break:

```
if (condition) {
    break;
}
```

🔹 continue:

```
if (condition) {
    continue;
}
```

🔹 **return:**

```
return value; // or simply return;
```

✅ Keywords:

`break`, `continue`, `return`, `loop`, `switch`, `exit`, `flow`, `condition`

✅ Simple Example Code:

```java
for (int i = 1; i <= 5; i++) {
    if (i == 3)
        break;
    System.out.println(i);
}
```

✅ Detailed Example Code with Real-Time Usage:

```java
// Print only odd numbers between 1 and 10 using continue
public class ContinueExample {
    public static void main(String[] args) {
        for (int i = 1; i <= 10; i++) {
            if (i % 2 == 0)
                continue; // Skip even numbers
            System.out.println("Odd number: " + i);
        }
    }
}
```

✅ Sub-Topics with Examples:

🔹 break in switch-case:

```
switch (choice) {
    case 1:
        System.out.println("Option 1");
        break;
    default:
        System.out.println("Invalid");
}
```

🔹 continue in while loop:

```
int i = 0;
while (i < 5) {
    i++;
    if (i == 3) continue;
    System.out.println(i);
}
```

🔹 return from a method:

```
public static void greet(String name) {
    if (name == null) return;
    System.out.println("Hello " + name);
}
```

✅ Real-Time Example Code:

```
// Check whether a number is prime using break
int n = 29;
boolean isPrime = true;

for (int i = 2; i <= n / 2; i++) {
    if (n % i == 0) {
        isPrime = false;
        break; // not prime
    }
}

System.out.println(n + " is " + (isPrime ? "Prime" : "Not
Prime"));
```

✅ 15 MCQ Questions (with Answers):

1. Which keyword exits a loop immediately?

   A) break

2. Which keyword skips the current iteration in a loop?

   B) continue

3. Which keyword exits a method?

   C) return

4. Which statement is not a jump statement?

   A) break

   B) return

C) switch

D) continue

5. Can `break` be used outside loop/switch?

C) No, compile-time error

6. What does `return` without value do?

A) Exits method with no return

7. What is the effect of `continue` in a loop?

B) Skips rest of the loop body for current iteration

8. Can `break` be used in nested loops?

A) Yes, exits innermost loop

9. Where is `return` valid?

C) Inside methods

10. Which is more suitable for exiting loops conditionally?

A) break

11. Does `break` work in if statement alone?

D) No, must be inside loop or switch

12. Can `return` end the main method?

A) Yes

13. What happens if `break` is used in a `for` loop?

C) Loop terminates

14. Can we use `continue` in a switch-case block?

D) No

15. In a method returning int, what must `return` include?

A) an int value

✅ 20 Interview Questions & Answers:

1. **Q:** What is the purpose of `break`?

   A: To terminate loop or switch immediately.

2. **Q:** Can `break` be used in nested loops?

   A: Yes, exits the innermost loop.

3. **Q:** What is `continue` used for?

   A: Skips the current loop iteration.

4. **Q:** Difference between `break` and `continue`?

   A: `break` exits loop, `continue` skips current iteration.

5. **Q:** What happens when `return` is executed?

   A: Method execution ends and control is returned.

6. **Q:** Can `return` be used in void methods?

   A: Yes, without a value.

7. **Q:** Is `break` valid in `if` statements?

   A: Only inside loops or switch; otherwise, error.

8. **Q:** Can `continue` be used in switch-case?

   A: No, compile-time error.

9. **Q:** What is labeled break?

   A: Breaks from a specific outer loop in nested structures.

10. **Q:** Can return be used with loops?

    A: Yes, to exit the method during loop execution.

11. **Q:** What is returned by default if method has no return?

    A: Compile error unless method return type is `void`.

12. **Q:** Can `break` be used to exit recursion?

    A: No, use `return` for recursion.

13. **Q:** Is `return` mandatory in all methods?

    A: Only in non-void methods.

14. **Q:** Does `continue` affect loop counter?

    A: No, counter must be managed separately.

15. **Q:** What is infinite loop escape method?

    A: Use `break` when condition is met.

16. **Q:** Is `break` allowed in `try-catch`?

    A: Yes, if inside a loop.

17. **Q:** Can `return` be in both try and catch?

    A: Yes, method exits when reached.

18. **Q:** Can `break` skip multiple loops?

    A: Only using labeled break.

19. **Q:** Can `continue` skip multiple loops?

    A: No, only innermost loop.

20. **Q:** Can we use `return` in constructors?

    A: No, constructors don't return values.

✅ Topic Outcome:

After this topic, learners will:

- Understand how to control flow using `break`, `continue`, and `return`
- Use jump statements effectively in loops, methods, and switches
- Handle conditions and exit strategies in real-world code logic

---

✅ Summary:

- Jump statements give developers precise control over program execution.
- Whether it's breaking out of loops, skipping unwanted iterations, or exiting methods early, understanding `break`, `continue`, and `return` is crucial for writing efficient and readable Java code.