Java Programming (4343203) - Summer 2024 Solution

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Question 1(a) [3 marks]

Explain Garbage collection in java.

Solution

Garbage collection in Java automatically reclaims memory by removing unused objects.

Table 1: Garbage Collection Process

Phase	**Description**
Mark	JVM identifies all live objects in memory
Sweep	Unused objects are removed
Compact	Remaining objects are reorganized to free up space

- **Automatic**: No manual memory management required
- **Background**: Runs in separate low-priority thread

Mnemonic

"MSC: Mark-Sweep-Compact frees memory automatically"

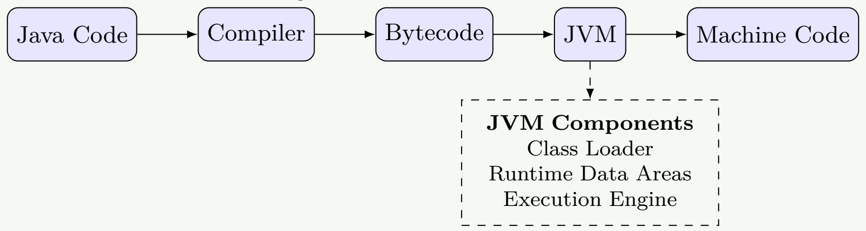
Question 1(b) [4 marks]

Explain JVM in detail.

Solution

JVM (Java Virtual Machine) is a virtual machine that enables Java's platform independence by converting bytecode to machine code.

Figure 1: JVM Architecture



- **Platform Independence**: Write once, run anywhere
- **Security**: Bytecode verification prevents dangerous operations
- **Optimization**: Just-in-time compilation improves performance

Mnemonic

"CLASS: Class Loader Leads All System Security"

Question 1(c) [7 marks]

Write a program in java to print Fibonacci series for N terms.

Solution

Fibonacci series generates numbers where each is the sum of the two preceding ones.

```java
import java.util.Scanner;

public class FibonacciSeries {
    public static void main(String[] args) {
        Scanner input = new Scanner(System.in);

        System.out.print("Enter number of terms: ");
        int n = input.nextInt();

        int first = 0, second = 1;

        System.out.print("Fibonacci Series: ");

        for (int i = 1; i <= n; i++) {
            System.out.print(first + " ");

            int next = first + second;
            first = second;
            second = next;
        }

        input.close();
    }
}
```

Listing 1: Fibonacci Series Program

- **Initialize**: Start with 0 and 1
- **Loop**: Iterate N times to generate sequence
- **Calculation**: Each number is sum of previous two

Mnemonic

"FSN: First + Second = Next number in sequence"

Question 1(c OR) [7 marks]

Write a program in java to find out minimum from any ten numbers using command line argument.

Solution

Command line arguments allow passing input values directly when executing a Java program.

```java
public class FindMinimum {
    public static void main(String[] args) {
        if (args.length < 10) {
            System.out.println("Please provide 10 numbers");
            return;
        }

        int min = Integer.parseInt(args[0]);

        for (int i = 1; i < 10; i++) {
            int current = Integer.parseInt(args[i]);
            if (current < min) {
                min = current;
            }
        }

        System.out.println("Minimum number is: " + min);
    }
}
```

Listing 2: Finding Minimum from Command Line Arguments

- **Parse Arguments**: Convert string arguments to integers
- **Initialize**: Set first number as minimum
- **Compare**: Check each number against current minimum

Mnemonic

”ICU: Initialize, Compare, Update the minimum”

Question 2(a) [3 marks]

List out basic concepts of Java OOP. Explain any one in details.

Solution

Java Object-Oriented Programming is built on fundamental concepts for modeling real-world entities.

Table 2: OOP Concepts in Java

Concept	**Description**
Encapsulation	Binding data and methods together as a single unit
Inheritance	Creating new classes from existing ones
Polymorphism	One interface, multiple implementations
Abstraction	Hiding implementation details, showing functionality

- **Encapsulation**: Protects data through access control
- **Data Hiding**: Private variables accessible through methods

Mnemonic

”PEAI: Programming Encapsulates Abstracts Inherits”

Question 2(b) [4 marks]

Explain final keyword with example.

Solution

The final keyword in Java restricts modification and creates constants, unchangeable methods, and non-inheritable classes.

Table 3: Uses of final Keyword

Usage	Effect	Example
final variable	Cannot be changed	`final int MAX = 100;`
final method	Cannot be overridden	`final void display() {}`
final class	Cannot be extended	`final class Math {}`

```java
public class FinalDemo {
    final int MAX_VALUE = 100;  // constant

    final void display() {
        System.out.println("This method cannot be overridden");
    }
}

final class MathOperations {
    // This class cannot be inherited
}
```

Listing 3: Final Keyword Demonstration

Mnemonic

"VCM: Variables Constants Methods can't change"

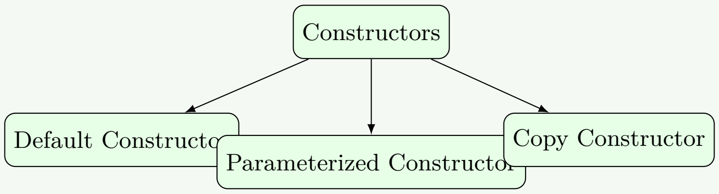
Question 2(c) [7 marks]

What is constructor? Explain parameterized constructor with example.

Solution

A constructor initializes objects when created, with the same name as its class and no return type.

Figure 2: Constructor Types



```java
public class Student {
    String name;
    int age;

    // Parameterized constructor
    Student(String n, int a) {
        name = n;
        age = a;
    }

    void display() {
        System.out.println("Name: " + name + ", Age: " + age);
    }

    public static void main(String[] args) {
        // Object creation using parameterized constructor
        Student s1 = new Student("John", 20);
        s1.display();
    }
}
```

Listing 4: Parameterized Constructor Example

- **Parameters**: Accept values during object creation
- **Initialization**: Set object properties with passed values
- **Overloading**: Multiple constructors with different parameters

Mnemonic

"SPO: Student Parameters Object initializes properties"

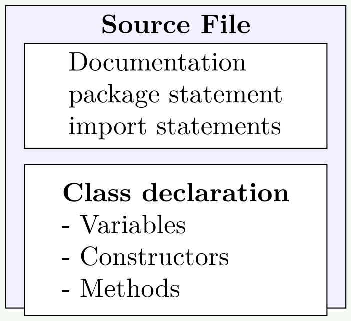
Question 2(a OR) [3 marks]

Explain the Java Program Structure with example.

Solution

Java program structure follows a specific hierarchy of elements organized logically.

Figure 3: Java Program Structure



- **Package**: Groups related classes
- **Import**: Includes external classes
- **Class**: Contains variables and methods

Mnemonic

"PIC: Package Imports Class in every program"

Question 2(b OR) [4 marks]

Explain static keyword with suitable example.

Solution

Static keyword creates class-level variables and methods shared by all objects, accessible without creating instances.

Table 4: Static vs Non-Static

Feature	Static	Non-Static
Memory	Single copy	Multiple copies
Access	Without object	Through object
Reference	Class name	Object name
When loaded	Class loading	Object creation

```java
public class Counter {
    static int count = 0;  // Shared by all objects
    int instanceCount = 0; // Unique to each object

    Counter() {
        count++;
        instanceCount++;
    }

    public static void main(String[] args) {
        Counter c1 = new Counter();
        Counter c2 = new Counter();

        System.out.println("Static count: " + Counter.count);
        System.out.println("c1's instance count: " + c1.instanceCount);
        System.out.println("c2's instance count: " + c2.instanceCount);
    }
}
```

Listing 5: Static Keyword Demonstration

Mnemonic

”SCM: Static Creates Memory once for all objects”

Question 2(c OR) [7 marks]

Define Inheritance. List out types of it. Explain multilevel and hierarchical inheritance with suitable example.

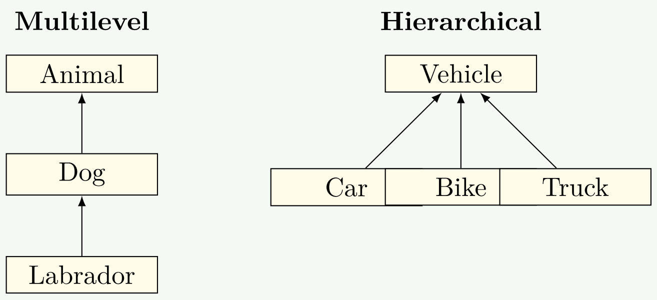
Solution

Inheritance is an OOP principle where a new class acquires properties and behaviors from an existing class.

Table 5: Types of Inheritance in Java

Type	Description
Single	One subclass extends one superclass
Multilevel	Chain of inheritance (`A`→`B`→`C`)
Hierarchical	Multiple subclasses extend one superclass
Multiple	One class extends multiple classes (via interfaces)

Figure 4: Multilevel vs Hierarchical Inheritance



```java
// Multilevel inheritance
class Animal {
    void eat() { System.out.println("eating"); }
}

class Dog extends Animal {
    void bark() { System.out.println("barking"); }
}

class Labrador extends Dog {
    void color() { System.out.println("golden"); }
}

// Hierarchical inheritance
class Vehicle {
    void move() { System.out.println("moving"); }
}

class Car extends Vehicle {
    void wheels() { System.out.println("4 wheels"); }
}

class Bike extends Vehicle {
    void wheels() { System.out.println("2 wheels"); }
}
```

Listing 6: Multilevel and Hierarchical Inheritance

Mnemonic

”SMHM: Single Multilevel Hierarchical Makes inheritance types”

Question 3(a) [3 marks]

Explain this keyword with suitable example.

Solution

The ‘this’ keyword in Java refers to the current object, used to differentiate between instance variables and parameters.

Table 6: Uses of ‘this’ Keyword

Use	Purpose
this.variable	Access instance variables
this()	Call current class constructor
return this	Return current object

```java
public class Student {
    String name;

    Student(String name) {
        this.name = name;  // Refers to instance variable
    }

    void display() {
        System.out.println("Name: " + this.name);
    }
}
```

Listing 7: This Keyword Example

Mnemonic

”VAR: Variables Access Resolution using this”

Question 3(b) [4 marks]

Explain different access controls in Java.

Solution

Access controls in Java regulate visibility and accessibility of classes, methods, and variables.

Table 7: Java Access Modifiers

Modifier	Class	Package	Subclass	World
private	✓	×	×	×
default	✓	✓	×	×
protected	✓	✓	✓	×
public	✓	✓	✓	✓

- **Private**: Only within the same class
- **Default**: Within the same package
- **Protected**: Within package and subclasses
- **Public**: Accessible everywhere

Mnemonic

”PDPP: Private Default Protected Public from narrow to wide”

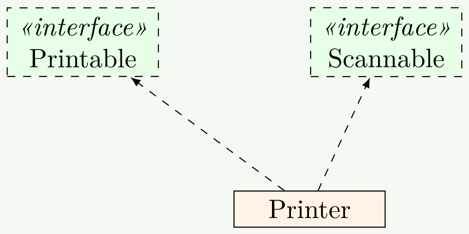
Question 3(c) [7 marks]

What is interface? Explain multiple inheritance using interface with example.

Solution

An interface is a contract that specifies what a class must do, containing abstract methods, constants, and (since Java 8) default methods.

Figure 5: Multiple Inheritance with Interfaces



```java
interface Printable {
    void print();
}

interface Scannable {
    void scan();
}

// Multiple inheritance using interfaces
class Printer implements Printable, Scannable {
    public void print() {
        System.out.println("Printing...");
    }

    public void scan() {
        System.out.println("Scanning...");
    }

    public static void main(String[] args) {
        Printer p = new Printer();
        p.print();
        p.scan();
    }
}
```

Listing 8: Package Creation and Usage

- **Contract**: Defines behavior without implementation
- **Implements**: Classes fulfill the contract
- **Multiple**: Can implement many interfaces

Mnemonic

"CIM: Contract Implements Multiple interfaces"

Question 3(a OR) [3 marks]

Explain super keyword with example.

Solution

The super keyword refers to the parent class, used to access parent methods, constructors, and variables.

Table 8: Uses of super Keyword

Use	**Purpose**
super.variable	Access parent variable
super.method()	Call parent method
super()	Call parent constructor

```java
class Vehicle {
    String color = "white";

    void display() {
        System.out.println("Vehicle class");
    }
}

class Car extends Vehicle {
    String color = "black";

    void display() {
        super.display();  // Calls parent method
        System.out.println("Car color: " + color);
        System.out.println("Vehicle color: " + super.color);
    }
}
```

Listing 9: Super Keyword Example

Mnemonic

”VMC: Variables Methods Constructors accessed by super”

Question 3(b OR) [4 marks]

What is package? Write steps to create a package and give example of it.

Solution

A package in Java is a namespace that organizes related classes and interfaces, preventing naming conflicts.

Table 9: Steps to Create a Package

Step	Action
1	Declare package name at top of file
2	Create directory structure matching package name
3	Save Java file in the directory
4	Compile with -d option
5	Import package to use it

```java
// Step 1: Declare package (save as Calculator.java)
package mathematics;

public class Calculator {
    public int add(int a, int b) {
        return a + b;
    }
}

// In another file (UseCalculator.java)
import mathematics.Calculator;

class UseCalculator {
    public static void main(String[] args) {
        Calculator calc = new Calculator();
        System.out.println(calc.add(10, 20));
    }
}
```

Listing 10: Multiple Inheritance Using Interfaces

Mnemonic

"DISCO: Declare Import Save Compile Organize"

Question 3(c OR) [7 marks]

Define: Method Overriding. List out Rules for method overriding. Write a java program that implements method overriding.

Solution

Method overriding occurs when a subclass provides a specific implementation for a method already defined in its parent class.

Table 10: Rules for Method Overriding

Rule	Description
Same name	Method must have same name
Same parameters	Parameter count and type must match
Same return type	Return type must be same or subtype (covariant)
Access modifier	Can't be more restrictive
Exceptions	Can't throw broader checked exceptions

```java
class Animal {
    void makeSound() {
        System.out.println("Animal makes a sound");
    }
}

class Dog extends Animal {
    // Method overriding
    @Override
    void makeSound() {
        System.out.println("Dog barks");
    }
}

class Cat extends Animal {
    // Method overriding
    @Override
    void makeSound() {
        System.out.println("Cat meows");
    }
}

public class MethodOverridingDemo {
    public static void main(String[] args) {
        Animal animal = new Animal();
        Animal dog = new Dog();
        Animal cat = new Cat();

        animal.makeSound();  // Output: Animal makes a sound
        dog.makeSound();     // Output: Dog barks
        cat.makeSound();     // Output: Cat meows
    }
}
```

Listing 11: Method Overriding Demonstration

- **Runtime Polymorphism**: Method resolution at runtime
- **@Override**: Annotation ensures method is overriding
- **Inheritance**: Requires IS-A relationship

Mnemonic

"SPARE: Same Parameters Access Return Exceptions"

Question 4(a) [3 marks]

Explain abstract class with suitable example.

Solution

An abstract class cannot be instantiated and may contain abstract methods that must be implemented by subclasses.

Table 11: Abstract Class vs Interface

Feature	Abstract Class	Interface
Instantiation	Cannot	Cannot
Methods	Concrete and abstract	Abstract (+ default since Java 8)
Variables	Any type	Only constants
Constructor	Has	Doesn't have

```java
abstract class Shape {
    // Abstract method - no implementation
    abstract double area();

    // Concrete method
    void display() {
        System.out.println("This is a shape");
    }
}

class Circle extends Shape {
    double radius;

    Circle(double r) {
        radius = r;
    }

    // Implementation of abstract method
    double area() {
        return 3.14 * radius * radius;
    }
}
```

Listing 12: Abstract Class Implementation

Mnemonic

"PAI: Partial Abstract Implementation is key"

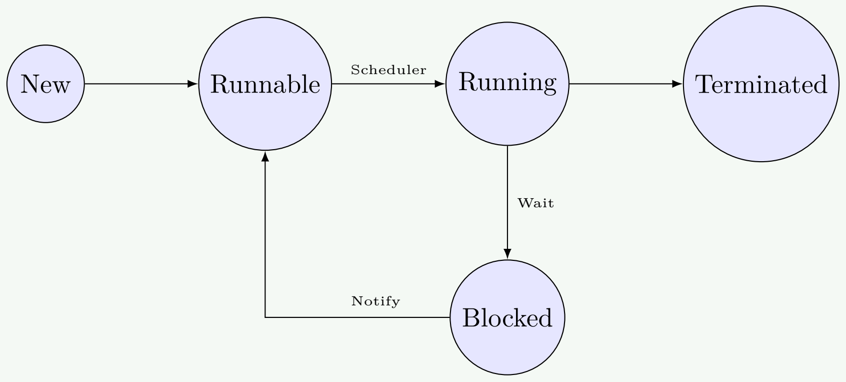
Question 4(b) [4 marks]

What is Thread? Explain Thread life cycle.

Solution

A thread is a lightweight subprocess, the smallest unit of processing that allows concurrent execution.

Figure 6: Thread Life Cycle



- **New**: Thread created but not started
- **Runnable**: Ready to run when CPU time is given
- **Running**: Currently executing
- **Blocked/Waiting**: Temporarily inactive
- **Terminated**: Completed execution

Mnemonic

"NRRBT: New Runnable Running Blocked Terminated"

Question 4(c) [7 marks]

Write a program in java that creates the multiple threads by implementing the Thread class.

Solution

Creating threads by implementing Thread class allows multiple tasks to execute concurrently.

```java
class MyThread extends Thread {
    private String threadName;

    MyThread(String name) {
        this.threadName = name;
    }

    @Override
    public void run() {
        try {
            for (int i = 1; i <= 5; i++) {
                System.out.println(threadName + ": " + i);
                Thread.sleep(500);
            }
        } catch (InterruptedException e) {
            System.out.println(threadName + " interrupted");
        }
        System.out.println(threadName + " completed");
    }
}

public class MultiThreadDemo {
    public static void main(String[] args) {
        MyThread thread1 = new MyThread("Thread-1");
        MyThread thread2 = new MyThread("Thread-2");
        MyThread thread3 = new MyThread("Thread-3");

        thread1.start();
        thread2.start();
        thread3.start();
    }
}
```

Listing 13: Multiple Thread Creation

- **Extend Thread**: Create thread by extending Thread class
- **Override run()**: Define task in run method
- **start()**: Begin thread execution

Mnemonic

"ERS: Extend Run Start to create threads"

Question 4(a OR) [3 marks]

Explain final class with suitable example.

Solution

A final class cannot be extended, preventing inheritance and modification of its design.

Table 12: Final Class Characteristics

Feature	**Description**
Inheritance	Cannot be subclassed
Methods	Implicitly final
Security	Prevents design alteration
Example	String, Math classes

```java
final class Security {
    void secureMethod() {
        System.out.println("Secure implementation");
    }
}

// Error: Cannot extend final class
// class HackAttempt extends Security { }
```

Listing 14: Final Class Example

- **Security**: Protects sensitive implementations
- **Immutability**: Helps create immutable classes
- **Optimization**: JVM can optimize final classes

Mnemonic

"SIO: Security Immutability Optimization"

Question 4(b OR) [4 marks]

Explain thread priorities with suitable example.

Solution

Thread priorities determine the order in which threads are scheduled for execution, from 1 (lowest) to 10 (highest).

Table 13: Thread Priority Constants

Constant	Value	Description
MIN_PRIORITY	1	Lowest priority
NORM_PRIORITY	5	Default priority
MAX_PRIORITY	10	Highest priority

```java
class PriorityThread extends Thread {
    PriorityThread(String name) {
        super(name);
    }

    public void run() {
        System.out.println("Running: " + getName() +
                          " with priority: " + getPriority());
    }
}

public class ThreadPriorityDemo {
    public static void main(String[] args) {
        PriorityThread low = new PriorityThread("Low Priority");
        PriorityThread norm = new PriorityThread("Normal Priority");
        PriorityThread high = new PriorityThread("High Priority");

        low.setPriority(Thread.MIN_PRIORITY);
        high.setPriority(Thread.MAX_PRIORITY);

        low.start();
        norm.start();
        high.start();
    }
}
```

Listing 15: Thread Priority Demonstration

Mnemonic

”HNL: High Normal Low priorities in threads”

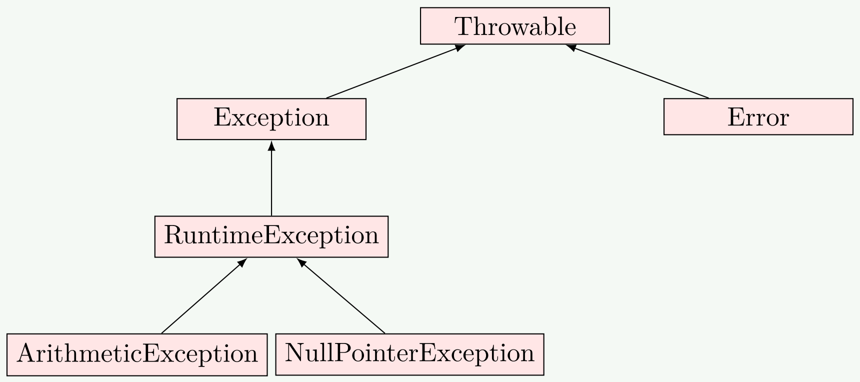
Question 4(c OR) [7 marks]

What is Exception? Write a program that shows the use of Arithmetic Exception.

Solution

An exception is an abnormal condition that disrupts the normal flow of program execution.

Figure 7: Exception Hierarchy



```java
public class ArithmeticExceptionDemo {
    public static void main(String[] args) {
        try {
            // This will cause ArithmeticException
            int result = 100 / 0;
            System.out.println("Result: " + result);
        }
        catch (ArithmeticException e) {
            System.out.println("ArithmeticException caught: " + e.getMessage());
            System.out.println("Cannot divide by zero");
        }
        finally {
            System.out.println("This block always executes");
        }

        System.out.println("Program continues after exception handling");
    }
}
```

Listing 16: Arithmetic Exception Handling

- **Try Block**: Contains code that might throw exceptions
- **Catch Block**: Handles the specific exception
- **Finally Block**: Always executes regardless of exception

Mnemonic

”TCF: Try Catch Finally handles exceptions”

Question 5(a) [3 marks]

Write a Java Program to find sum and average of 10 numbers of an array.

Solution

Arrays store multiple values of the same type, enabling sequential processing of elements.

```java
public class ArraySumAverage {
    public static void main(String[] args) {
        int[] numbers = {10, 20, 30, 40, 50, 60, 70, 80, 90, 100};

        int sum = 0;

        // Calculate sum
        for (int i = 0; i < numbers.length; i++) {
            sum += numbers[i];
        }

        // Calculate average
        double average = (double) sum / numbers.length;

        System.out.println("Sum = " + sum);
        System.out.println("Average = " + average);
    }
}
```

Listing 17: Array Sum and Average Calculation

- **Declaration**: Creates fixed-size collection
- **Iteration**: Sequential access to elements
- **Calculation**: Process values for results

Mnemonic

"DIC: Declare Iterate Calculate for array processing"

Question 5(b) [4 marks]

Write a Java program to handle user defined exception for 'Divide by Zero' error.

Solution

User-defined exceptions allow creating custom exception types for specific application requirements.

```java
// Custom exception class
class DivideByZeroException extends Exception {
    public DivideByZeroException(String message) {
        super(message);
    }
}

public class CustomExceptionDemo {
    // Method that throws custom exception
    static double divide(int numerator, int denominator) throws DivideByZeroException {
        if (denominator == 0) {
            throw new DivideByZeroException("Cannot divide by zero!");
        }
        return (double) numerator / denominator;
    }

    public static void main(String[] args) {
        try {
            System.out.println(divide(10, 2));
            System.out.println(divide(20, 0));
        } catch (DivideByZeroException e) {
            System.out.println("Custom exception caught: " + e.getMessage());
        }
    }
}
```

Listing 18: User-Defined Exception for Division by Zero

- **Custom Class**: Extends Exception class
- **Throwing**: Use throw keyword with new instance
- **Handling**: Catch specific exception type

Mnemonic

”CTE: Create Throw Exception when needed”

Question 5(c) [7 marks]

Write a java program to create a text file and perform read operation on the text file.

Solution

Java provides I/O classes to work with files, allowing creation, writing, and reading operations.

```java
import java.io.FileWriter;
import java.io.FileReader;
import java.io.IOException;
import java.io.BufferedReader;

public class FileOperationsDemo {
    public static void main(String[] args) {
        try {
            // Create and write to file
            FileWriter writer = new FileWriter("sample.txt");
            writer.write("Hello World!\n");
            writer.write("Welcome to Java File Handling.\n");
            writer.write("This is the third line.");
            writer.close();
            System.out.println("Successfully wrote to the file.");

            // Read from file
            FileReader reader = new FileReader("sample.txt");
            BufferedReader buffReader = new BufferedReader(reader);

            String line;
            System.out.println("\nFile contents:");
            while ((line = buffReader.readLine()) != null) {
                System.out.println(line);
            }

            reader.close();

        } catch (IOException e) {
            System.out.println("An error occurred: " + e.getMessage());
        }
    }
}
```

Listing 19: File Creation and Reading Operations

- **FileWriter**: Creates and writes to files
- **FileReader**: Reads character data from files
- **BufferedReader**: Efficiently reads text by lines

Mnemonic

”WRC: Write Read Close for file operations”

Question 5(a OR) [3 marks]

Explain java I/O process.

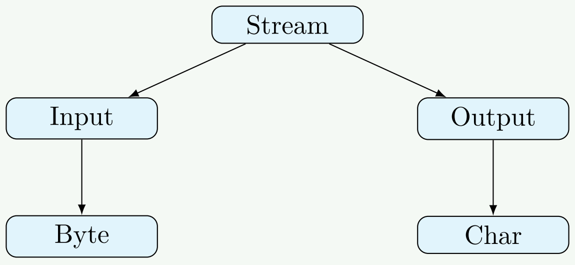
Solution

Java I/O process involves transferring data to and from various sources using streams.

Table 14: Java I/O Stream Types

Classification	Types
Direction	Input, Output
Data Type	Byte Streams, Character Streams
Functionality	Basic, Buffered, Data, Object

Figure 8: Java I/O Hierarchy



- **Stream**: Sequence of data flowing between source and destination
- **Buffering**: Improves performance by reducing disk access

Mnemonic

"SBI: Stream Buffered Input/Output"

Question 5(b OR) [4 marks]

Explain throw and finally in Exception Handling with example.

Solution

Exception handling mechanisms control program flow during errors, ensuring graceful execution.

Table 15: throw vs finally

Feature	throw	finally
Purpose	Explicitly throws exception	Ensures code execution
Placement	Inside method	After try-catch blocks
Execution	When condition met	Always, even with return
Usage	Control flow	Resource cleanup

```java
public class ThrowFinallyDemo {
    public static void validateAge(int age) {
        try {
            if (age < 18) {
                throw new ArithmeticException("Not eligible to vote");
            } else {
                System.out.println("Welcome to vote");
            }
        } catch (ArithmeticException e) {
            System.out.println("Exception caught: " + e.getMessage());
        } finally {
            System.out.println("Validation process completed");
        }
    }

    public static void main(String[] args) {
        validateAge(15);
        System.out.println("---------");
        validateAge(20);
    }
}
```

Listing 20: Throw and Finally in Exception Handling

Mnemonic

”TERA: Throw Exception Regardless Always finally executes”

Question 5(c OR) [7 marks]

Write a java program to display the content of a text file and perform append operation on the text file.

Solution

```java
import java.io.*;

public class FileAppendDemo {
    public static void main(String[] args) {
        try {
            // Create initial file
            FileWriter writer = new FileWriter("example.txt");
            writer.write("Original content line 1\n");
            writer.write("Original content line 2\n");
            writer.close();

            // Display file content
            System.out.println("Original file content:");
            readFile("example.txt");

            // Append to file
            FileWriter appendWriter = new FileWriter("example.txt", true);
            appendWriter.write("Appended content line 1\n");
            appendWriter.write("Appended content line 2\n");
            appendWriter.close();

            // Display updated content
            System.out.println("\nFile content after append:");
            readFile("example.txt");

        } catch (IOException e) {
            System.out.println("An error occurred: " + e.getMessage());
        }
    }

    // Method to read and display file content
    public static void readFile(String fileName) {
        try {
            BufferedReader reader = new BufferedReader(new FileReader(fileName));
            String line;
            while ((line = reader.readLine()) != null) {
                System.out.println(line);
            }
            reader.close();
        } catch (IOException e) {
            System.out.println("Error reading file: " + e.getMessage());
        }
    }
}
```

Listing 21: File Display and Append Operations

- **FileWriter(file, true)**: Second parameter enables append mode
- **BufferedReader**: Efficiently reads text by lines
- **Reusable Method**: Encapsulates reading functionality

Mnemonic

”CAD: Create Append Display file operations”