Subject Name Solutions

4341602 – Summer 2023

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

Differentiate between Procedure-Oriented Programming (POP) and Object-Oriented Programming (OOP).

Solution

Aspect	POP	OOP
Focus	Functions/Procedures	Objects and Classes
Data Security	Less secure, global data	More secure, data encapsulation
Problem Solving	Top-down approach	Bottom-up approach
Code Reusability	Limited	High through inheritance
Examples	C, Pascal	Java, C++, Python

- **POP**: Program divided into functions, data flows between functions
- **OOP**: Program organized around objects that contain both data and methods

Mnemonic

"POP Functions, OOP Objects"

Question 1(b) [4 marks]

Explain Super keyword in inheritance with suitable example.

Solution

Super keyword is used to access parent class members from child class.

Table 1: Super keyword uses

Use	Purpose	Example
super()	Call parent constructor	super(name, age)
super.method()	Call parent method	super.display()
super.variable	Access parent variable	super.name

Code Block:

```
class Animal \{
    String name = "Animal";
    void eat() \{ System.out.println("Animal eats"); \}
\}

class Dog extends Animal \{
    String name = "Dog";
    void eat() \{
        super.eat(); // calls parent method
        System.out.println("Dog eats bones");
    \}
    void display() \{
        System.out.println(super.name); // prints "Animal"
    \}
\}
```

Mnemonic

"Super calls Parent"

Question 1(c) [7 marks]

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

Solution

Method Overriding: Child class provides specific implementation of parent class method with same signature.

Table 2: Method Overriding Rules

Rule	Description
Same name	Method name must be identical
Same parameters	Parameter list must match exactly
IS-A relationship	Must have inheritance
Access modifier	Cannot reduce visibility
Return type	Must be same or covariant

Code Block:

```
class Shape \{
    void draw() \{
        System.out.println("Drawing a shape");
    \}
\}

class Circle extends Shape \{
    @Override
    void draw() \{
        System.out.println("Drawing a circle");
    \}
\}

class Main \{
    public static void main(String[] args) \{
        Shape s = new Circle();
        s.draw(); // Output: Drawing a circle
    \}
\}
```

Mnemonic

"Override Same Signature"

Question 1(c OR) [7 marks]

Describe: Interface. Write a java program using interface to demonstrate multiple inheritance.

Solution

Interface: Blueprint containing abstract methods and constants. Classes implement interfaces to achieve multiple inheritance.

Table 3: Interface Features

Feature	Description
Abstract methods	No implementation (before Java 8)
Constants	All variables are public static final
Multiple inheritance	Class can implement multiple interfaces
Default methods	Concrete methods (Java 8+)

Code Block:

```
interface Flyable \{
    void fly();
\}

interface Swimmable \{
    void swim();
\}

class Duck implements Flyable, Swimmable \{
    public void fly() \{
        System.out.println("Duck flies");
    \}

    public void swim() \{
        System.out.println("Duck swims");
    \}
\}

class Main \{
    public static void main(String[] args) \{
        Duck d = new Duck();
        d.fly();
        d.swim();
    \}
\}
```

Mnemonic

"Interface Multiple Implementation"

Question 2(a) [3 marks]

Explain the Java Program Structure with example.

Solution

Java Program Structure consists of package, imports, class declaration, and main method.
Diagram:

```
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
| Package statement|
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
| Import statements|
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
| Class declaration|
| +{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+  |}
| | Variables   |  |
| +{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+  |}
| | Methods     |  |
| +{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+  |}
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
```

Code Block:

```
package com.example;        // Package
import java.util.*;         // Import

public class HelloWorld \{   // Class
    static int count = 0;   // Variable
```

```
    public static void main(String[] args) \{ // Main method
        System.out.println("Hello World");
    \}
\}
```

Mnemonic

"Package Import Class Main"

Question 2(b) [4 marks]

Explain static keyword with suitable example.

Solution

Static keyword belongs to class rather than instance. Memory allocated once.

Table 4: Static Uses

Type	Description	Example
Static variable	Shared by all objects	static int count
Static method	Called without object	static void display()
Static block	Executes before main	static { }

Code Block:

```
class Student \{
    static String college = "GTU";  // static variable
    String name;

    static void showCollege() \{     // static method
        System.out.println(college);
    \}

    static \{                        // static block
        System.out.println("Static block executed");
    \}
\}

class Main \{
    public static void main(String[] args) \{
        Student.showCollege(); // No object needed
    \}
\}
```

Mnemonic

"Static Shared by Class"

Question 2(c) [7 marks]

Define: Constructor. List out types of it. Explain Parameterized and copy constructor with suitable example.

Solution

Constructor: Special method to initialize objects, same name as class, no return type.

Table 5: Constructor Types

Type	Description	Example
Default	No parameters	Student()
Parameterized	With parameters	Student(String name)
Copy	Creates copy of object	Student(Student s)

Code Block:

```
class Student \{
    String name;
    int age;

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

    // Copy constructor
    Student(Student s) \{
        name = s.name;
        age = s.age;
    \}

    void display() \{
        System.out.println(name + " " + age);
    \}
\}

class Main \{
    public static void main(String[] args) \{
        Student s1 = new Student("John", 20);  // Parameterized
        Student s2 = new Student(s1);          // Copy
        s1.display();
        s2.display();
    \}
\}
```

Mnemonic

"Constructor Initializes Objects"

Question 2(a OR) [3 marks]

Explain the Primitive Data Types and User Defined Data Types in java.

Solution

Primitive Data Types: Built-in types provided by Java language. **User Defined Types**: Custom types created by programmer using classes.

Table 6: Data Types

Category	Types	Size	Example
Primitive	byte, short, int, long	1,2,4,8 bytes	int x = 10;
Primitive	float, double	4,8 bytes	double d = 3.14;

Primitive	char, boolean	2,1 bytes	char c = 'A';
User Defined	Class, Interface, Array	Variable	Student s;

- **Primitive**: Stored in stack, faster access
- **User Defined**: Stored in heap, complex operations

Mnemonic

"Primitive Built-in, User Custom"

Question 2(b OR) [4 marks]

Explain this keyword with suitable example.

Solution

This keyword refers to current object instance, used to distinguish between instance and local variables.

Table 7: This keyword uses

Use	Purpose	Example
this.variable	Access instance variable	this.name = name;
this.method()	Call instance method	this.display();
this()	Call constructor	this(name, age);

Code Block:

```
class Student \{
    String name;
    int age;

    Student(String name, int age) \{
        this.name = name;    // this distinguishes
        this.age = age;      // instance from parameter
    \}

    void setData(String name) \{
        this.name = name;    // this refers to current object
    \}

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

Mnemonic

"This Current Object"

Question 2(c OR) [7 marks]

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

Solution

Inheritance: Mechanism where child class acquires properties and methods of parent class.

Table 8: Inheritance Types

Type	Description	Structure
Single	One parent, one child	A $\rightarrow B$
Multilevel	Chain of inheritance	A $\rightarrow B \rightarrow C$
Hierarchical	One parent, multiple children	A $\rightarrow B, A \rightarrow C$
Multiple	Multiple parents (via interfaces)	B,C $\rightarrow A$

Diagram - Multilevel:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph LR
    A[Animal] {-{-}{} B[Mammal]}
    B {-{-}{} C[Dog]}
{Highlighting}
{Shaded}
```

Code Block - Multilevel:

```
class Animal \{
    void eat() \{ System.out.println("Animal eats"); \}
\}

class Mammal extends Animal \{
    void breathe() \{ System.out.println("Mammal breathes"); \}
\}

class Dog extends Mammal \{
    void bark() \{ System.out.println("Dog barks"); \}
\}
```

Diagram - Hierarchical:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[Shape] {-{-}{} B[Circle]}
    A {-{-}{} C[Rectangle]}
    A {-{-}{} D[Triangle]}
{Highlighting}
{Shaded}
```

Code Block - Hierarchical:

```
class Shape \{
    void draw() \{ System.out.println("Drawing shape"); \}
\}

class Circle extends Shape \{
    void drawCircle() \{ System.out.println("Drawing circle"); \}
\}

class Rectangle extends Shape \{
    void drawRectangle() \{ System.out.println("Drawing rectangle"); \}
\}
```

Mnemonic

"Inheritance Shares Properties"

Question 3(a) [3 marks]

Explain Type Conversion and Casting in java.

Solution

Type Conversion: Converting one data type to another. **Casting**: Explicit type conversion by programmer.

Table 9: Type Conversion

Type	Description	Example
Implicit (Widening)	Automatic, smaller to larger	int to double
Explicit (Narrowing)	Manual, larger to smaller	double to int

Code Block:

```
// Implicit conversion
int i = 10;
double d = i;        // int to double (automatic)

// Explicit casting
double x = 10.5;
int y = (int) x;     // double to int (manual)

// String conversion
String s = String.valueOf(i);    // int to String
int z = Integer.parseInt("123"); // String to int
```

Mnemonic

"Implicit Auto, Explicit Manual"

Question 3(b) [4 marks]

Explain different visibility controls used in Java.

Solution

Visibility Controls (Access Modifiers): Control access to classes, methods, and variables.

Table 10: Access Modifiers

Modifier	Same Class	Same Package	Subclass	Different Package
private				
default				
protected				
public				

Code Block:

```
class Example \{
    private int x = 10;      // Only within class
    int y = 20;              // Package level
    protected int z = 30;    // Package + subclass
    public int w = 40;       // Everywhere

    private void method1() \{ \}    // Private method
    public void method2() \{ \}     // Public method
\}
```

Mnemonic

"Private Package Protected Public"

Question 3(c) [7 marks]

Define: Thread. List different methods used to create Thread. Explain Thread life cycle in detail.

Solution

Thread: Lightweight subprocess that allows concurrent execution of multiple parts of program.

Table 11: Thread Creation Methods

Method	Description	Example
Extending Thread	Inherit Thread class	class MyThread extends Thread
Implementing Runnable	Implement Runnable interface	class MyTask implements Runnable

Diagram: Thread Life Cycle

```
stateDiagram{-v2}
        direction LR
    [*] {-{-} NEW}
    NEW {-{-} RUNNABLE : start()}
    RUNNABLE {-{-} RUNNING : CPU allocation}
    RUNNING {-{-} RUNNABLE : yield()}
    RUNNING {-{-} BLOCKED : wait()/sleep()}
    BLOCKED {-{-} RUNNABLE : notify()/interrupt()}
    RUNNING {-{-} TERMINATED : completion}
    TERMINATED {-{-} [*]}
```

Table 12: Thread States

State	Description
NEW	Thread created but not started
RUNNABLE	Ready to run, waiting for CPU
RUNNING	Currently executing
BLOCKED	Waiting for resource or sleep
TERMINATED	Execution completed

Code Block:

```
// Method 1: Extending Thread
class MyThread extends Thread \{
    public void run() \{
        System.out.println("Thread running");
    \}
\}

// Method 2: Implementing Runnable
class MyTask implements Runnable \{
    public void run() \{
        System.out.println("Task running");
    \}
\}

class Main \{
    public static void main(String[] args) \{
        MyThread t1 = new MyThread();
        Thread t2 = new Thread(new MyTask());
        t1.start();
        t2.start();
    \}
\}
```

Mnemonic

"Thread Concurrent Execution"

Question 3(a OR) [3 marks]

Explain the purpose of JVM in java.

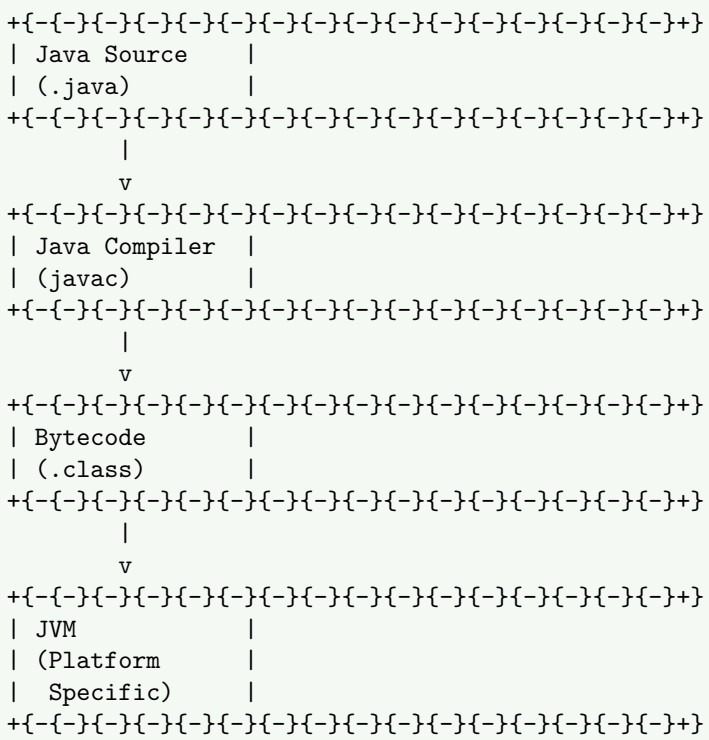
Solution

JVM (Java Virtual Machine): Runtime environment that executes Java bytecode and provides platform independence.

Table 13: JVM Components

Component	Purpose
Class Loader	Loads .class files into memory
Execution Engine	Executes bytecode
Memory Area	Manages heap and stack memory
Garbage Collector	Automatic memory management

Diagram:



- **Platform Independence**: "Write Once, Run Anywhere"
- **Memory Management**: Automatic garbage collection
- **Security**: Bytecode verification

Mnemonic

"JVM Java Virtual Machine"

Question 3(b OR) [4 marks]

Define: Package. Write the steps to create a Package with suitable example.

Solution

Package: Collection of related classes and interfaces grouped together, providing namespace and access control.

Table 14: Package Benefits

Benefit	Description
Namespace	Avoid name conflicts
Access Control	Better encapsulation
Organization	Logical grouping
Reusability	Easy to maintain

Steps to create Package:

1. **Declare package** at top of file
2. **Create directory** structure matching package name
3. **Compile** with package structure
4. **Import** in other classes

Code Block:

```
// File: com/company/utilities/Calculator.java
package com.company.utilities;

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

// File: Main.java
import com.company.utilities.Calculator;

class Main \{
    public static void main(String[] args) \{
        Calculator calc = new Calculator();
        System.out.println(calc.add(5, 3));
    \}
\}
```

Directory Structure:

```
com/
  company/
    utilities/
      Calculator.class
Main.class
```

Mnemonic

"Package Groups Classes"

Question 3(c OR) [7 marks]

Explain Synchronization in Thread with suitable example.

Solution

Synchronization: Mechanism to control access to shared resources by multiple threads to avoid data inconsistency.

Table 15: Synchronization Types

Type	Description	Usage
Synchronized method	Entire method locked	synchronized void method()
Synchronized block	Specific code block locked	synchronized(object) { }
Static synchronization	Class level locking	synchronized static void method()

Diagram: Without vs With Synchronization

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    subgraph "Without Sync"
        T1[Thread 1] {-{-}{} R[Shared Resource]}
        T2[Thread 2] {-{-}{} R}
        R {-{-}{} C[Data Corruption]}
    end

    subgraph "With Sync"
        T3[Thread 1] {-{-}{} L[Lock]}
        T4[Thread 2] {-{-}{} W[Wait]}
        L {-{-}{} R2[Shared Resource]}
        R2 {-{-}{} S[Safe Access]}
    end
{Highlighting}
{Shaded}
```

Code Block:

```
class Counter \{
    private int count = 0;

    // Synchronized method
    public synchronized void increment() \{
        count++;
    \}

    // Synchronized block
    public void decrement() \{
        synchronized(this) \{
            count{-{-};}
        \}
    \}

    public int getCount() \{
        return count;
    \}
\}

class CounterThread extends Thread \{
    Counter counter;

    CounterThread(Counter c) \{
        counter = c;
    \}

    public void run() \{
        for(int i = 0; i {} 1000; i++) \{
            counter.increment();
        \}
    \}
\}

class Main \{
    public static void main(String[] args) throws InterruptedException \{
        Counter c = new Counter();
        CounterThread t1 = new CounterThread(c);
        CounterThread t2 = new CounterThread(c);
```

```
        t1.start();
        t2.start();

        t1.join();
        t2.join();

        System.out.println("Final count: " + c.getCount());
    \}
\}
```

Mnemonic

"Synchronization Prevents Race Conditions"

Question 4(a) [3 marks]

Differentiate between String class and StringBuffer class.

Solution

Table 16: String vs StringBuffer

Aspect	String	StringBuffer
Mutability	Immutable (cannot change)	Mutable (can change)
Performance	Slower for concatenation	Faster for concatenation
Memory	Creates new object each time	Modifies existing object
Thread Safety	Thread safe	Thread safe
Methods	concat(), substring()	append(), insert(), delete()

Code Block:

```
// String {- Immutable}
String s1 = "Hello";
s1 = s1 + " World";  // Creates new String object

// StringBuffer {- Mutable}
StringBuffer sb = new StringBuffer("Hello");
sb.append(" World");  // Modifies existing object
```

- **String**: Use when content doesn't change frequently
- **StringBuffer**: Use when frequent modifications needed

Mnemonic

"String Immutable, StringBuffer Mutable"

Question 4(b) [4 marks]

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

Solution

Code Block:

```
class ArraySum \{
```

```
    public static void main(String[] args) \{
        // Initialize array with 10 numbers
        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;

        // Display results
        System.out.println("Array elements: ");
        for(int num : numbers) \{
            System.out.print(num + " ");
        \}

        System.out.println("{n}Sum: " + sum);
        System.out.println("Average: " + average);
    \}
\}
```

Output:

```
Array elements: 10 20 30 40 50 60 70 80 90 100
Sum: 550
Average: 55.0
```

Logic Steps:

1. **Initialize** array with 10 numbers
2. **Loop** through array to calculate sum
3. **Calculate** average = sum / length
4. **Display** results

Mnemonic

"Loop Sum Divide Average"

Question 4(c) [7 marks]

I) Explain abstract class with suitable example. II) Explain final class with suitable example.

Solution

I) Abstract Class: Class that cannot be instantiated, contains abstract methods that must be implemented by subclasses.

Table 17: Abstract Class Features

Feature	Description
Cannot instantiate	No object creation
Abstract methods	Methods without implementation
Concrete methods	Methods with implementation
Inheritance	Subclasses must implement abstract methods

Code Block - Abstract Class:

```
abstract class Shape \{
    String color;

    // Abstract method
    abstract void draw();

    // Concrete method
    void setColor(String c) \{
        color = c;
    \}
\}

class Circle extends Shape \{
    void draw() \{
        System.out.println("Drawing Circle");
    \}
\}

class Main \{
    public static void main(String[] args) \{
        // Shape s = new Shape(); // Error: Cannot instantiate
        Circle c = new Circle();
        c.draw();
    \}
\}
```

II) Final Class: Class that cannot be extended (no inheritance allowed).

Table 18: Final Class Features

Feature	Description
No inheritance	Cannot be extended
Security	Prevents modification
Performance	Better optimization
Examples	String, Integer, System

Code Block - Final Class:

```
final class FinalClass \{
    void display() \{
        System.out.println("This is final class");
    \}
\}

// class SubClass extends FinalClass \{ \ // Error: Cannot extend}

class Main \{
    public static void main(String[] args) \{
        FinalClass obj = new FinalClass();
        obj.display();
    \}
\}
```

Mnemonic

"Abstract Incomplete, Final Complete"

Question 4(a OR) [3 marks]

Explain Garbage Collection in Java.

Solution

Garbage Collection: Automatic memory management process that removes unused objects from heap memory.

Table 19: GC Benefits

Benefit	Description
Automatic	No manual memory management
Memory leak prevention	Removes unreferenced objects
Performance	Optimizes memory usage
Safety	Prevents memory errors

Diagram:

- **When occurs**: When heap memory is low or System.gc() called
- **Process**: Mark and Sweep algorithm
- **Cannot guarantee**: Exact timing of garbage collection

Mnemonic

"GC Automatic Memory Cleanup"

Question 4(b OR) [4 marks]

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

Solution

Code Block:

```
// User defined exception class
class DivideByZeroException extends Exception \{
    public DivideByZeroException(String message) \{
        super(message);
```

```
    \}
\}

class Calculator \{
    public static double divide(int a, int b) throws DivideByZeroException \{
        if(b == 0) \{
            throw new DivideByZeroException("Cannot divide by zero!");
        \}
        return (double) a / b;
    \}
\}

class Main \{
    public static void main(String[] args) \{
        try \{
            int num1 = 10;
            int num2 = 0;

            double result = Calculator.divide(num1, num2);
            System.out.println("Result: " + result);

        \} catch(DivideByZeroException e) \{
            System.out.println("Error: " + e.getMessage());
        \}
    \}
\}
```

Output:

```
Error: Cannot divide by zero!
```

Steps:

1. **Create** custom exception class extending Exception
2. **Throw** exception when condition occurs
3. **Handle** exception with try-catch block

Mnemonic

"Custom Exception Handle Error"

Question 4(c OR) [7 marks]

Write a java program to demonstrate multiple try block and multiple catch block exception.

Solution

Code Block:

```
class MultipleExceptionDemo \{
    public static void main(String[] args) \{
        // First try block
        try \{
            int[] arr = \{1, 2, 3\;}
            System.out.println("Array element: " + arr[5]); // ArrayIndexOutOfBounds
        \}
        catch(ArrayIndexOutOfBoundsException e) \{
            System.out.println("Array index error: " + e.getMessage());
        \}
        catch(Exception e) \{
            System.out.println("General exception: " + e.getMessage());
```

```
        \}

        // Second try block
        try \{
            String str = null;
            System.out.println("String length: " + str.length()); // NullPointer
        \}
        catch(NullPointerException e) \{
            System.out.println("Null pointer error: " + e.getMessage());
        \}

        // Third try block with multiple catch
        try \{
            int a = 10;
            int b = 0;
            int result = a / b;  // ArithmeticException

            String s = "abc";
            int num = Integer.parseInt(s);  // NumberFormatException
        \}
        catch(ArithmeticException e) \{
            System.out.println("Arithmetic error: " + e.getMessage());
        \}
        catch(NumberFormatException e) \{
            System.out.println("Number format error: " + e.getMessage());
        \}
        catch(Exception e) \{
            System.out.println("Other error: " + e.getMessage());
        \}
        finally \{
            System.out.println("Program completed");
        \}
    \}
\}
```

Output:

```
Array index error: Index 5 out of bounds for length 3
Null pointer error: null
Arithmetic error: / by zero
Program completed
```

Features demonstrated:

- **Multiple try blocks**: Each handles different operations
- **Multiple catch blocks**: Each handles specific exception type
- **Exception hierarchy**: General Exception catches all
- **Finally block**: Always executes

Mnemonic

"Multiple Try Multiple Catch"

Question 5(a) [3 marks]

Write a program in Java to create a file and perform write operation on this file.

Solution

Code Block:

```
import java.io.*;

class FileWriteDemo \{
    public static void main(String[] args) \{
        try \{
            // Create file
            File file = new File("demo.txt");

            // Create FileWriter object
            FileWriter writer = new FileWriter(file);

            // Write data to file
            writer.write("Hello World!{n}");
            writer.write("This is Java file writing demo.{n}");
            writer.write("File created successfully.");

            // Close the writer
            writer.close();

            System.out.println("File created and data written successfully!");

        \} catch(IOException e) \{
            System.out.println("Error: " + e.getMessage());
        \}
    \}
\}
```

Steps:

1. **Import** java.io package
2. **Create** File object with filename
3. **Create** FileWriter object
4. **Write** data using write() method
5. **Close** writer to save changes

Mnemonic

"File Writer Write Close"

Question 5(b) [4 marks]

Explain throw and finally in Exception Handling with example.

Solution

Throw: Keyword used to explicitly throw an exception. **Finally**: Block that always executes regardless of exception occurrence.

Table 20: Throw vs Finally

Keyword	Purpose	Usage
throw	Explicitly throw exception	throw new Exception()
finally	Always execute cleanup code	finally { }

Code Block:

```
class ThrowFinallyDemo \{
    public static void checkAge(int age) throws Exception \{
        if(age {} 18) \{
            throw new Exception("Age must be 18 or above");
        \}
        System.out.println("Valid age: " + age);
    \}

    public static void main(String[] args) \{
        try \{
            checkAge(15);  // Will throw exception
        \}
        catch(Exception e) \{
            System.out.println("Error: " + e.getMessage());
        \}
        finally \{
            System.out.println("Finally block always executes");
        \}
    \}
\}
```

Output:

```
Error: Age must be 18 or above
Finally block always executes
```

- **Throw**: Forces exception to occur
- **Finally**: Cleanup code, closes resources

Mnemonic

"Throw Exception, Finally Always"

Question 5(c) [7 marks]

Describe: Polymorphism. Explain run time polymorphism with suitable example in java.

Solution

Polymorphism: One interface, multiple implementations. Object behaves differently based on its actual type.

Table 21: Polymorphism Types

Type	Description	When Decided
Compile-time	Method overloading	At compilation
Run-time	Method overriding	At execution

Run-time Polymorphism: Method call resolved at runtime based on actual object type.
Diagram:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph LR
    A[Animal reference] {-{-}{} B[Dog object]}
    A {-{-}{} C[Cat object]}
    B {-{-}{} D[Dog sound]}
    C {-{-}{} E[Cat sound]}
{Highlighting}
{Shaded}
```

Code Block:

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

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

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

class Main \{
    public static void main(String[] args) \{
        Animal animal1 = new Dog();  // Upcasting
        Animal animal2 = new Cat();  // Upcasting

        animal1.makeSound();  // Output: Dog barks
        animal2.makeSound();  // Output: Cat meows

        // Array of animals
        Animal[] animals = \{new Dog(), new Cat(), new Dog()\;}
        for(Animal a : animals) \{
            a.makeSound();  // Dynamic method dispatch
        \}
    \}
\}
```

Output:

```
Dog barks
Cat meows
Dog barks
Cat meows
Dog barks
```

Features:

- **Dynamic Method Dispatch**: JVM decides which method to call at runtime
- **Upcasting**: Child object referenced by parent reference
- **Flexibility**: Same code works with different object types

Mnemonic

"Polymorphism Many Forms Runtime"

Question 5(a OR) [3 marks]

Write a program in Java that read the content of a file byte by byte and copy it into another file.

Solution

Code Block:

```
import java.io.*;

class FileCopyDemo \{
    public static void main(String[] args) \{
        try \{
            // Create input stream to read from source file
            FileInputStream input = new FileInputStream("source.txt");

            // Create output stream to write to destination file
            FileOutputStream output = new FileOutputStream("destination.txt");

            int byteData;

            // Read byte by byte and copy
            while((byteData = input.read()) != {-}1) \{
                output.write(byteData);
            \}

            // Close streams
            input.close();
            output.close();

            System.out.println("File copied successfully!");

        \} catch(IOException e) \{
            System.out.println("Error: " + e.getMessage());
        \}
    \}
\}
```

Steps:

1. **Create** FileInputStream for reading
2. **Create** FileOutputStream for writing
3. **Read** byte by byte using read()
4. **Write** each byte using write()
5. **Close** both streams

Mnemonic

"Read Byte Write Byte"

Question 5(b OR) [4 marks]

Explain the different I/O Classes available with Java.

Solution

Table 22: Java I/O Classes

Class Type	Class Name	Purpose
Byte Stream	FileInputStream	Read bytes from file
Byte Stream	FileOutputStream	Write bytes to file
Character Stream	FileReader	Read characters from file
Character Stream	FileWriter	Write characters to file
Buffered	BufferedReader	Efficient character reading
Buffered	BufferedWriter	Efficient character writing

Diagram: I/O Class Hierarchy

```
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
|    InputStream   |
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
        |
        +{-{-} FileInputStream}
        +{-{-} BufferedInputStream}

+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
|   OutputStream   |
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
        |
        +{-{-} FileOutputStream}
        +{-{-} BufferedOutputStream}

+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
|      Reader      |
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
        |
        +{-{-} FileReader}
        +{-{-} BufferedReader}

+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
|      Writer      |
+{-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+}
        |
        +{-{-} FileWriter}
        +{-{-} BufferedWriter}
```

Code Example:

```
// Byte streams
FileInputStream fis = new FileInputStream("file.txt");
FileOutputStream fos = new FileOutputStream("output.txt");

// Character streams
FileReader fr = new FileReader("file.txt");
FileWriter fw = new FileWriter("output.txt");

// Buffered streams
BufferedReader br = new BufferedReader(new FileReader("file.txt"));
BufferedWriter bw = new BufferedWriter(new FileWriter("output.txt"));
```

Mnemonic

"Byte Character Buffered Streams"

Question 5(c OR) [7 marks]

Write a java program that executes two threads. One thread displays "Java Programming" every 3 seconds, and the other displays "Semester - 4th IT" every 6 seconds.(Create the threads by extending the Thread class)

Solution

Code Block:

```
class JavaThread extends Thread \{
    public void run() \{
        try \{
            while(true) \{
                System.out.println("Java Programming");
                Thread.sleep(3000);  // Sleep for 3 seconds
            \}
        \} catch(InterruptedException e) \{
            System.out.println("JavaThread interrupted");
        \}
    \}
\}

class SemesterThread extends Thread \{
    public void run() \{
        try \{
            while(true) \{
                System.out.println("Semester {- 4th IT"});
                Thread.sleep(6000);  // Sleep for 6 seconds
            \}
        \} catch(InterruptedException e) \{
            System.out.println("SemesterThread interrupted");
        \}
    \}
\}

class Main \{
    public static void main(String[] args) \{
        // Create thread objects
        JavaThread javaThread = new JavaThread();
        SemesterThread semesterThread = new SemesterThread();

        // Start both threads
        javaThread.start();
        semesterThread.start();

        // Let threads run for 20 seconds then stop
        try \{
            Thread.sleep(20000);
            javaThread.interrupt();
            semesterThread.interrupt();
        \} catch(InterruptedException e) \{
            System.out.println("Main thread interrupted");
        \}
    \}
\}
```

Sample Output:

```
Java Programming
Semester - 4th IT
Java Programming
Java Programming
Semester - 4th IT
```

```
Java Programming
Java Programming
Semester - 4th IT
...
```

Features:

- **Two separate threads**: Each with different timing
- **Thread.sleep()**: Pauses execution for specified milliseconds
- **Concurrent execution**: Both threads run simultaneously
- **Extending Thread class**: Override run() method

Execution Pattern:

- JavaThread: Displays every 3 seconds
- SemesterThread: Displays every 6 seconds
- Both run concurrently showing different timing

Mnemonic

"Two Threads Different Timing"