Object Oriented Programming with Java (4341602) - Winter 2023 Solution

Milav Dabgar

January 19, 2024

Question 1(a) [3 marks]

List out basic concepts of oop. Explain any one in detail.

Solution

Table 1. Basic OOP Concepts

Basic OOP Concepts	**Description**
Class	Blueprint for objects
Object	Instance of a class
Encapsulation	Data hiding mechanism
Inheritance	Acquiring properties from parent
Polymorphism	One interface, multiple forms
Abstraction	Hiding implementation details

Encapsulation is the process of binding data and methods together within a class and hiding internal implementation from outside world. It provides data security by making variables private and accessing them through public methods.

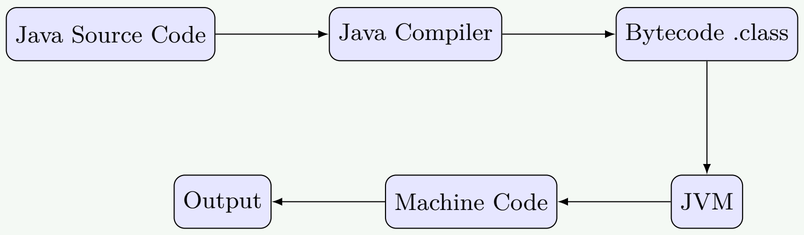
Mnemonic

"CEO-IPA" (Class, Encapsulation, Object, Inheritance, Polymorphism, Abstraction)

Question 1(b) [4 marks]

Explain JVM in detail.

Solution



JVM (Java Virtual Machine) is a runtime environment that executes Java bytecode. It provides platform independence by converting bytecode to machine-specific code.

- **Class Loader**: Loads class files into memory
- **Memory Management**: Handles heap and stack memory

- **Execution Engine**: Executes bytecode instructions
- **Garbage Collector**: Automatically manages memory

Mnemonic

"CMEG" (Class loader, Memory, Execution, Garbage collection)

Question 1(c) [7 marks]

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

Solution

Listing 1. Fibonacci Series Program

```java
public class Fibonacci {
    public static void main(String[] args) {
        int n = 10, first = 0, second = 1;
        System.out.print("Fibonacci Series: " + first + " " + second);

        for(int i = 2; i < n; i++) {
            int next = first + second;
            System.out.print(" " + next);
            first = second;
            second = next;
        }
    }
}
```

- **Logic**: Start with 0,1 and add previous two numbers
- **Loop**: Continues for n terms
- **Variables**: first, second, next for calculation

Mnemonic

"FSN" (First, Second, Next)

Question 1(c OR) [7 marks]

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

Solution

Listing 2. Find Minimum using CommandLine Arguments

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

        int min = Integer.parseInt(args[0]);
        for(int i = 1; i < args.length; i++) {
            int num = Integer.parseInt(args[i]);
            if(num < min) {
                min = num;
            }
        }
        System.out.println("Minimum number: " + min);
    }
}
```

- **Command Line**: `java FindMinimum 5 3 8 1 9 2 7 4 6 0`
- **Logic**: Compare each number with current minimum
- **Method**: `Integer.parseInt()` converts string to integer

Mnemonic

"CIM" (Check, Integer.parseInt, Minimum)

Question 2(a) [3 marks]

What is wrapper class? Explain with example.

Solution

Table 2. Wrapper Classes

Primitive	Wrapper Class
int	Integer
char	Character
boolean	Boolean
double	Double

Wrapper classes convert primitive data types into objects. They provide utility methods and enable primitives to be used in collections.
Example: `Integer obj = new Integer(25);` or `Integer obj = 25;` (autoboxing)

Mnemonic

"POC" (Primitive to Object Conversion)

Question 2(b) [4 marks]

List out different features of java. Explain any two.

Solution

Table 3. Java Features

Java Features	Description
Platform Independent	Write once, run anywhere
Object Oriented	Everything is an object
Simple	Easy syntax, no pointers
Secure	Bytecode verification
Robust	Strong memory management
Multithreaded	Concurrent execution

Platform Independence: Java source code compiles to bytecode which runs on any platform with JVM installed.
Object Oriented: Java follows OOP principles like encapsulation, inheritance, and polymorphism for better code organization.

Mnemonic

"POSSMR" (Platform, Object, Simple, Secure, Multithreaded, Robust)

Question 2(c) [7 marks]

What is method overload? Explain with example.

Solution

Method Overloading allows multiple methods with same name but different parameters in the same class.

Listing 3. Method Overloading

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

    public double add(double a, double b) {
        return a + b;
    }

    public int add(int a, int b, int c) {
        return a + b + c;
    }
}
```

- **Rules**: Different parameter types or number of parameters
- **Compile Time**: Decision made during compilation
- **Return Type**: Cannot be only difference

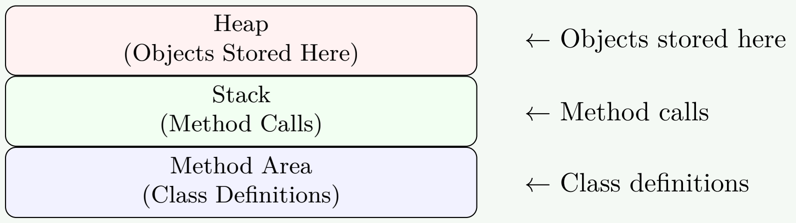
Mnemonic

"SNRT" (Same Name, different paRameters, compile Time)

Question 2(a OR) [3 marks]

Explain Garbage collection in java.

Solution



Garbage Collection automatically deallocates memory of unreferenced objects. JVM runs garbage collector periodically to free up heap memory.

- **Automatic**: No manual memory management needed
- **Mark and Sweep**: Marks unreferenced objects, then removes them

Mnemonic

"ARMS" (Automatic Reference Management System)

Question 2(b OR) [4 marks]

Explain final keyword with example.

Solution

Table 4. Final Keyword Usage

Usage	Description	Example
final variable	Cannot be changed	`final int x = 10;`
final method	Cannot be overridden	`final void display()`
final class	Cannot be inherited	`final class MyClass`

Listing 4. Final Keyword Example

```java
final class FinalClass {
    final int value = 100;
    final void show() {
        System.out.println("Final method");
    }
}
```

Mnemonic

"VCM" (Variable constant, Class not inherited, Method not overridden)

Question 2(c OR) [7 marks]

What is constructor? Explain parameterized constructor with example.

Solution

Constructor is a special method that initializes objects when created. It has same name as class and no return type.

Listing 5. Parameterized Constructor

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

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

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

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

- **Purpose**: Initialize object with specific values
- **Parameters**: Accepts arguments to set initial state
- **Automatic**: Called automatically when object is created

Mnemonic

"SPA" (Same name, Parameters, Automatic call)

Question 3(a) [3 marks]

Explain super keyword with example.

Solution

super keyword refers to parent class members and constructor. It resolves naming conflicts between parent and child classes.

Listing 6. Super Keyword Example

```java
class Parent {
    int x = 10;
}
class Child extends Parent {
    int x = 20;
    void display() {
        System.out.println(super.x); // 10
        System.out.println(x);       // 20
    }
}
```

- **super.variable**: Access parent class variable
- **super.method()**: Call parent class method
- **super()**: Call parent class constructor

Mnemonic

"VMC" (Variable, Method, Constructor)

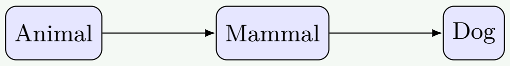
Question 3(b) [4 marks]

List out different types of inheritance. Explain multilevel inheritance.

Solution

Table 5. Inheritance Types

Inheritance Types	Description
Single	One parent, one child
Multilevel	Chain of inheritance
Hierarchical	One parent, multiple children
Multiple	Multiple parents (via interfaces)



Multilevel Inheritance: Class inherits from another class which itself inherits from another class, forming a chain.

Listing 7. Multilevel Inheritance

```java
class Animal {
    void eat() { System.out.println("Eating"); }
}
class Mammal extends Animal {
    void walk() { System.out.println("Walking"); }
}
class Dog extends Mammal {
    void bark() { System.out.println("Barking"); }
}
```

Mnemonic

"SMHM" (Single, Multilevel, Hierarchical, Multiple)

Question 3(c) [7 marks]

What is interface? Explain multiple inheritance with example.

Solution

Interface is a contract that defines what methods a class must implement. It contains only abstract methods and constants.

Listing 8. Multiple Inheritance with Interface

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

```

```java
interface Swimmable {
    void swim();
}

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

    public void swim() {
        System.out.println("Duck is swimming");
    }
}
```

Multiple Inheritance: A class can implement multiple interfaces, achieving multiple inheritance of behavior.

- **Abstract Methods**: All methods are abstract by default
- **Constants**: All variables are public, static, final
- **implements**: Keyword to implement interface

Mnemonic

"ACI" (Abstract methods, Constants, implements keyword)

Question 3(a OR) [3 marks]

Explain static keyword with example.

Solution

static keyword creates class-level members that belong to class rather than instances. Memory allocated once when class loads.

Listing 9. Static Keyword

```java
class Counter {
    static int count = 0;
    static void increment() {
        count++;
    }
}
```

- **static variable**: Shared among all objects
- **static method**: Called without object creation
- **Memory**: Allocated in method area

Mnemonic

"SOM" (Shared, Object not needed, Method area)

Question 3(b OR) [4 marks]

Explain different access controls in Java.

Solution

Table 6. Access Modifiers

Access Modifier	Same Class	Same Package	Subclass	Diff Package
private	✓	✗	✗	✗
default	✓	✓	✗	✗
protected	✓	✓	✓	✗
public	✓	✓	✓	✓

Access Control determines visibility and accessibility of classes, methods, and variables.

Mnemonic

"PriDef ProPub" (Private, Default, Protected, Public)

Question 3(c OR) [7 marks]

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

Solution

Package is a namespace that organizes related classes and interfaces. It provides access protection and namespace management.

Steps to create package:

1. Use `package` statement at top of file
2. Create directory structure matching package name
3. Compile with `-d` option
4. Import package in other files

Listing 10. Package creation and usage

```java
// File: com/mycompany/MyClass.java
package com.mycompany;

public class MyClass {
    public void display() {
        System.out.println("Package example");
    }
}

// Using the package
import com.mycompany.MyClass;

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

Compilation: `javac -d . MyClass.java`

Mnemonic

"PDCI" (Package statement, Directory, Compile, Import)

Question 4(a) [3 marks]

Explain thread priorities with suitable example.

Solution

Thread Priority determines execution order of threads. Java provides 10 priority levels from 1 (lowest) to 10 (highest).

Listing 11. Thread Priority

```java
class MyThread extends Thread {
    public void run() {
        System.out.println(getName() + " Priority: " + getPriority());
    }
}

class Main {
    public static void main(String[] args) {
        MyThread t1 = new MyThread();
        MyThread t2 = new MyThread();

        t1.setPriority(Thread.MIN_PRIORITY); // 1
        t2.setPriority(Thread.MAX_PRIORITY); // 10

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

Priority Constants: MIN_PRIORITY (1), NORM_PRIORITY (5), MAX_PRIORITY (10)

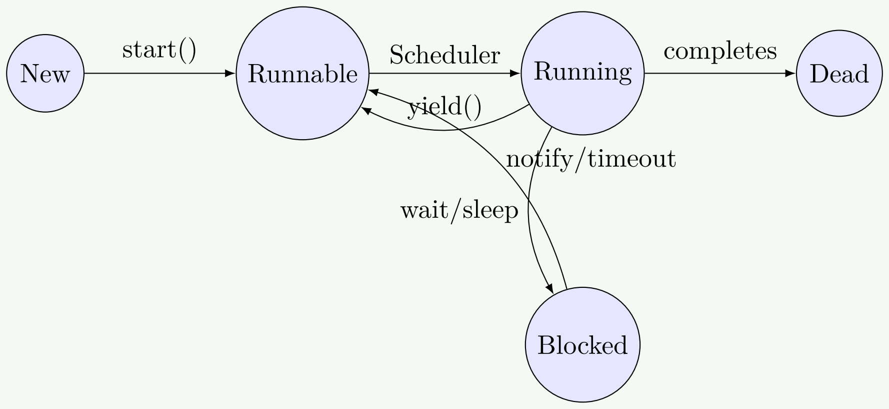
Mnemonic

"MNM" (MIN, NORM, MAX)

Question 4(b) [4 marks]

What is Thread? Explain Thread life cycle.

Solution



Thread is a lightweight subprocess that enables concurrent execution within a program.
Thread Life Cycle States:

- **New**: Thread created but not started

- **Runnable**: Ready to run, waiting for CPU
- **Running**: Currently executing
- **Blocked**: Waiting for resource or I/O
- **Dead**: Thread execution completed

Mnemonic

"NRRBD" (New, Runnable, Running, Blocked, Dead)

Question 4(c) [7 marks]

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

Solution

Listing 12. Multiple Threads

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

    public MyThread(String name) {
        threadName = name;
        setName(threadName);
    }

    public void run() {
        for(int i = 1; i <= 5; i++) {
            System.out.println(threadName + " - Count: " + i);
            try {
                Thread.sleep(1000);
            } catch(InterruptedException e) {
                System.out.println(threadName + " interrupted");
            }
        }
        System.out.println(threadName + " completed");
    }
}

class Main {
    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();
    }
}
```

- **extends Thread**: Inherit Thread class functionality
- **Override run()**: Define thread execution logic
- **start()**: Begin thread execution

Mnemonic

"EOS" (Extends, Override run, Start method)

Question 4(a OR) [3 marks]

List four different inbuilt exceptions. Explain any one inbuilt exception.

Solution

Table 7. Inbuilt Exceptions

Inbuilt Exceptions	Description
NullPointerException	Null reference access
ArrayIndexOutOfBoundsException	Invalid array index
NumberFormatException	Invalid number format
ClassCastException	Invalid type casting

NullPointerException occurs when trying to access methods or variables of a null reference.

Listing 13. NullPointerException

```java
String str = null;
int length = str.length(); // Throws NullPointerException
```

Mnemonic

"NANC" (NullPointer, ArrayIndex, NumberFormat, ClassCast)

Question 4(b OR) [4 marks]

Explain multiple catch with suitable example.

Solution

Multiple catch blocks handle different types of exceptions that might occur in try block. Each catch handles specific exception type.

Listing 14. Multiple Catch Blocks

```java
class MultipleCatch {
    public static void main(String[] args) {
        try {
            int[] arr = {1, 2, 3};
            System.out.println(arr[5]); // ArrayIndexOutOfBoundsException
            int result = 10/0;          // ArithmeticException
        }
        catch(ArrayIndexOutOfBoundsException e) {
            System.out.println("Array index error: " + e.getMessage());
        }
        catch(ArithmeticException e) {
            System.out.println("Arithmetic error: " + e.getMessage());
        }
        catch(Exception e) {
            System.out.println("General error: " + e.getMessage());
        }
    }
}
```

Order: Specific exceptions first, general exceptions last

Mnemonic

"SGO" (Specific first, General last, Ordered)

Question 4(c OR) [7 marks]

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

Solution

Exception is an abnormal condition that disrupts normal program flow. It's an object representing an error condition.

Listing 15. ArithmeticException Handling

```java
class ArithmeticExceptionDemo {
    public static void main(String[] args) {
        int numerator = 100;
        int[] denominators = {5, 0, 2, 0, 10};

        for(int i = 0; i < denominators.length; i++) {
            try {
                int result = numerator / denominators[i];
                System.out.println(numerator + " / " + denominators[i] + " = " + result);
            }
            catch(ArithmeticException e) {
                System.out.println("Error: Cannot divide by zero!");
                System.out.println("Exception message: " + e.getMessage());
            }
        }

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

ArithmeticException thrown when mathematical error occurs like division by zero.
Exception Hierarchy: Object → Throwable → Exception → RuntimeException → ArithmeticException

Mnemonic

"OTERRA" (Object, Throwable, Exception, RuntimeException, ArithmeticException)

Question 5(a) [3 marks]

Explain ArrayIndexOutOfBound Exception in Java with example.

Solution

ArrayIndexOutOfBoundsException occurs when accessing array element with invalid index (negative or >= array length).

Listing 16. ArrayIndexOutOfBoundsException

```java
class ArrayException {
    public static void main(String[] args) {
        int[] numbers = {10, 20, 30};

        try {
            System.out.println(numbers[5]); // Invalid index
        }
        catch(ArrayIndexOutOfBoundsException e) {
            System.out.println("Invalid array index: " + e.getMessage());
        }
    }
}
```

- **Valid Range**: 0 to (length-1)
- **Runtime Exception**: Unchecked exception
- **Common Cause**: Loop condition errors

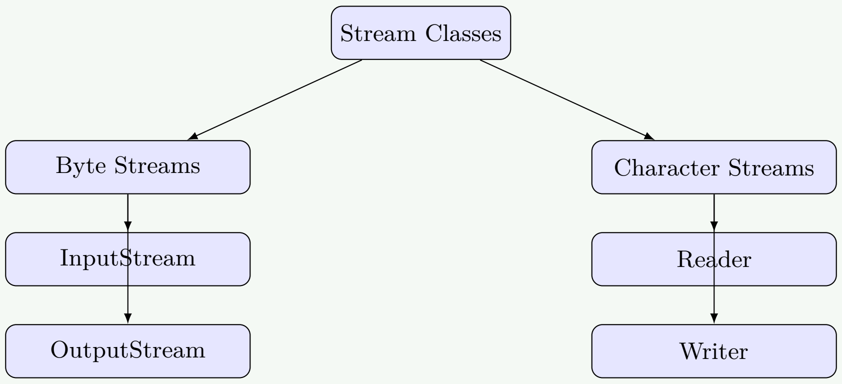
Mnemonic

"VRC" (Valid range, Runtime exception, Common in loops)

Question 5(b) [4 marks]

Explain basics of stream classes.

Solution



Stream Classes provide input/output operations for reading and writing data.

Table 8. Stream Classes

Stream Type	Purpose	Base Classes
Byte Streams	Binary data	InputStream, OutputStream
Character Streams	Text data	Reader, Writer

- **Input Streams**: Read data from source
- **Output Streams**: Write data to destination
- **Buffered Streams**: Improve performance with buffering

Mnemonic

"BIOC" (Byte, Input/Output, Character streams)

Question 5(c) [7 marks]

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

Solution

Listing 17. File Create and Read

```java
import java.io.*;

class FileOperations {
    public static void main(String[] args) {
        // Create and write to file
        try {
            FileWriter writer = new FileWriter("sample.txt");
            writer.write("Hello World!\n");
            writer.write("This is Java file handling example.\n");
            writer.write("Learning Input/Output operations.");
            writer.close();
            System.out.println("File created and written successfully.");
        }
        catch(IOException e) {
            System.out.println("Error creating file: " + e.getMessage());
        }

        // Read from file
        try {
            FileReader reader = new FileReader("sample.txt");
            BufferedReader bufferedReader = new BufferedReader(reader);
            String line;

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

            bufferedReader.close();
            reader.close();
        }
        catch(IOException e) {
            System.out.println("Error reading file: " + e.getMessage());
        }
    }
}
```

- **FileWriter**: Creates and writes to text file
- **FileReader**: Reads from text file
- **BufferedReader**: Efficient line-by-line reading

Mnemonic

"WRB" (Writer creates, Reader reads, Buffered for efficiency)

Question 5(a OR) [3 marks]

Explain Divide by Zero Exception in Java with example.

Solution

ArithmeticException (Divide by Zero) occurs when integer is divided by zero. Floating-point division by zero returns Infinity.

Listing 18. Divide By Zero

```java
class DivideByZeroExample {
    public static void main(String[] args) {
        try {
            int result = 10 / 0; // Throws ArithmeticException
            System.out.println("Result: " + result);
        }
        catch(ArithmeticException e) {
            System.out.println("Cannot divide by zero!");
        }

        // Floating point division
        double floatResult = 10.0 / 0.0; // Returns Infinity
        System.out.println("Float result: " + floatResult);
    }
}
```

- **Integer Division**: Throws ArithmeticException
- **Float Division**: Returns Infinity or NaN

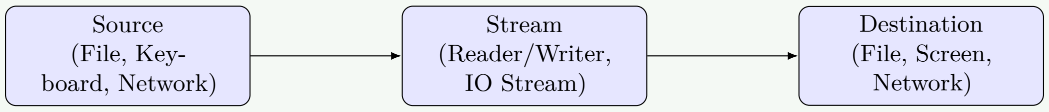
Mnemonic

"IFI" (Integer throws exception, Float returns Infinity)

Question 5(b OR) [4 marks]

Explain java I/O process.

Solution


Source (File, Keyboard, Network)
Stream (Reader/Writer, IO Stream)
Destination (File, Screen, Network)

Java I/O Process handles data transfer between program and external sources using streams.

Table 9. I/O Process Components

Component	Purpose
Source	Data origin (file, keyboard, network)
Stream	Data pathway (byte/character streams)
Destination	Data target (file, screen, network)

Process Steps:
1. **Open Stream**: Create connection to source/destination
2. **Process Data**: Read/write operations
3. **Close Stream**: Release resources

Mnemonic

"OPC" (Open, Process, Close)

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

Listing 19. File Append Operation

```java
import java.io.*;

class FileAppendExample {
    public static void main(String[] args) {
        String fileName = "data.txt";

        // Create initial file content
        try {
            FileWriter writer = new FileWriter(fileName);
            writer.write("Initial content line 1\n");
            writer.write("Initial content line 2\n");
            writer.close();
            System.out.println("Initial file created.");
        }
        catch(IOException e) {
            System.out.println("Error creating file: " + e.getMessage());
        }

        // Display file content
        displayFileContent(fileName);

        // Append to file
        try {
            FileWriter appendWriter = new FileWriter(fileName, true); // true for append
            appendWriter.write("Appended line 1\n");
            appendWriter.write("Appended line 2\n");
            appendWriter.close();
            System.out.println("\nContent appended successfully.");
        }
        catch(IOException e) {
            System.out.println("Error appending to file: " + e.getMessage());
        }

        // Display updated content
        System.out.println("\nFile content after append:");
        displayFileContent(fileName);
    }

    static void displayFileContent(String fileName) {
        try {
            BufferedReader reader = new BufferedReader(new FileReader(fileName));
            String line;
            System.out.println("\nFile contents:");
            while((line = reader.readLine()) != null) {
                System.out.println(line);
            }
            reader.close();
        }
        catch(IOException e) {
            System.out.println("Error reading file: " + e.getMessage());
        }
    }
}
```

- **FileWriter(filename, true)**: Append mode enabled
- **displayFileContent()**: Reusable method for reading
- **BufferedReader**: Efficient line reading

Mnemonic

"ARB" (Append mode, Reusable method, Buffered reading)