

Object Oriented Programming with JAVA (4341602) - Winter 2024 Solution

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Question 1(a) [3 marks]

Write down the difference between oop and pop.

Solution

Table 1. OOP vs POP

Aspect	OOP	POP
Approach	Bottom-up approach	Top-down approach
Focus	Objects and classes	Functions and procedures
Data Security	Data hiding through encapsulation	No data hiding
Problem Solving	Divide problem into objects	Divide problem into functions

Mnemonic

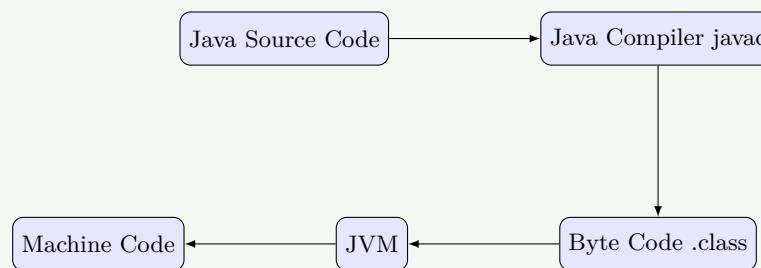
“Objects Bottom, Procedures Top”

Question 1(b) [4 marks]

What is byte code? Explain JVM in detail.

Solution

Byte Code: Platform-independent intermediate code generated by Java compiler from source code.



JVM Components:

- **Class Loader:** Loads .class files into memory
- **Memory Area:** Heap, stack, method area storage
- **Execution Engine:** Interprets and executes bytecode
- **Garbage Collector:** Automatic memory management

Mnemonic

“Byte Code Runs Everywhere”

Question 1(c) [7 marks]

Write a program in Java to sort the elements of an array in ascending order

Solution**Listing 1.** Array Sort

```

1 import java.util.Arrays;
2
3 public class ArraySort {
4     public static void main(String[] args) {
5         int[] arr = {64, 34, 25, 12, 22, 11, 90};
6
7         // Bubble Sort
8         for(int i = 0; i < arr.length-1; i++) {
9             for(int j = 0; j < arr.length-i-1; j++) {
10                 if(arr[j] > arr[j+1]) {
11                     int temp = arr[j];
12                     arr[j] = arr[j+1];
13                     arr[j+1] = temp;
14                 }
15             }
16         }
17
18         System.out.println("Sorted array: " + Arrays.toString(arr));
19     }
20 }
```

Key Points:

- **Bubble Sort:** Compares adjacent elements
- **Time Complexity:** $O(n^2)$
- **Space Complexity:** $O(1)$

Mnemonic

“Bubble Up The Smallest”

Question 1(c OR) [7 marks]

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

Solution**Listing 2.** Find Maximum from Command Line

```

1 public class FindMaximum {
2     public static void main(String[] args) {
3         if(args.length != 10) {
4             System.out.println("Please enter exactly 10 numbers");
5             return;
6         }
7     }
8 }
```

```

6 }
7
8     int max = Integer.parseInt(args[0]);
9
10    for(int i = 1; i < args.length; i++) {
11        int num = Integer.parseInt(args[i]);
12        if(num > max) {
13            max = num;
14        }
15    }
16
17    System.out.println("Maximum number: " + max);
18 }
19

```

Key Points:

- **Command Line:** args[] array stores arguments
- **parseInt():** Converts string to integer
- **Validation:** Check array length

Mnemonic

“Arguments Maximum Search”

Question 2(a) [3 marks]

What is wrapper class? Explain with example.

Solution

Wrapper Class: Converts primitive data types into objects.

Table 2. Wrapper Classes

Primitive	Wrapper Class
int	Integer
char	Character
boolean	Boolean
double	Double

Listing 3. Wrapper Class Example

```

1 // Boxing
2 Integer obj = Integer.valueOf(10);
3 // Unboxing
4 int value = obj.intValue();

```

Mnemonic

“Wrap Primitives Into Objects”

Question 2(b) [4 marks]

List out different features of java. Explain any two.

Solution

Java Features:

- **Simple:** Easy syntax, no pointers
- **Platform Independent:** Write once, run anywhere
- **Object Oriented:** Based on objects and classes
- **Secure:** No explicit pointers, bytecode verification

Detailed Explanation:

- **Platform Independence:** Java bytecode runs on any platform with JVM
- **Object Oriented:** Supports inheritance, encapsulation, polymorphism, abstraction

Mnemonic

“Simple Platform Object Security”

Question 2(c) [7 marks]

What is method overriding? Explain with example.

Solution

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

Listing 4. Method Overriding

```

1  class Animal {
2      public void sound() {
3          System.out.println("Animal makes sound");
4      }
5  }
6
7  class Dog extends Animal {
8      @Override
9      public void sound() {
10         System.out.println("Dog barks");
11     }
12 }
13
14 public class Test {
15     public static void main(String[] args) {
16         Animal a = new Dog();
17         a.sound(); // Output: Dog barks
18     }
19 }
```

Key Points:

- **Runtime Polymorphism:** Method called based on object type
- **@Override:** Annotation for method overriding
- **Dynamic Binding:** Method resolution at runtime

Mnemonic

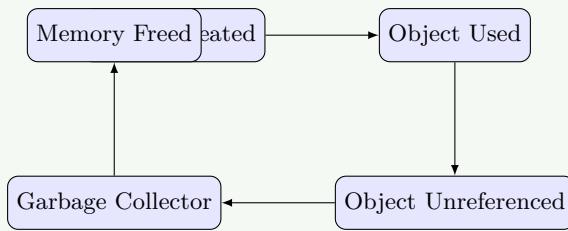
“Child Changes Parent Method”

Question 2(a OR) [3 marks]

Explain Garbage collection in java.

Solution

Garbage Collection: Automatic memory management that removes unused objects.



Key Points:

- **Automatic:** No manual memory deallocation
- **Mark and Sweep:** Identifies and removes unused objects
- **Heap Memory:** Works on heap memory area

Mnemonic

“Auto Clean Unused Objects”

Question 2(b OR) [4 marks]

Explain static keyword with example.

Solution

Static Keyword: Belongs to class rather than instance.

Listing 5. Static Example

```

1 class Student {
2     static String college = "GTU"; // Static variable
3     String name;
4
5     static void showCollege() { // Static method
6         System.out.println("College: " + college);
7     }
8 }
```

Static Features:

- **Memory:** Loaded at class loading time
- **Access:** Can be accessed without object
- **Sharing:** Shared among all instances

Mnemonic

“Class Level Memory Sharing”

Question 2(c OR) [7 marks]

What is constructor? Explain copy constructor with example.

Solution

Constructor: Special method to initialize objects.

Listing 6. Constructor Types

```

1  class Person {
2      String name;
3      int age;
4
5      // Default constructor
6      Person() {
7          name = "Unknown";
8          age = 0;
9      }
10
11     // Parameterized constructor
12     Person(String n, int a) {
13         name = n;
14         age = a;
15     }
16
17     // Copy constructor
18     Person(Person p) {
19         name = p.name;
20         age = p.age;
21     }
22 }
```

Constructor Types:

- **Default:** No parameters
- **Parameterized:** Takes parameters
- **Copy:** Creates object from existing object

Mnemonic

“Default Parameter Copy”

Question 3(a) [3 marks]

Explain super keyword with example.

Solution

Super Keyword: References parent class members.

Listing 7. Super Keyword

```

1  class Vehicle {
2      String brand = "Generic";
3  }
4
5  class Car extends Vehicle {
6      String brand = "Toyota";
7
8      void display() {
9          System.out.println("Child: " + brand);
10         System.out.println("Parent: " + super.brand);
11     }
12 }
```

Super Uses:

- **Variables:** Access parent class variables
- **Methods:** Call parent class methods
- **Constructor:** Call parent class constructor

Mnemonic

“Super Calls Parent”

Question 3(b) [4 marks]

List out different types of inheritance. Explain multilevel inheritance.

Solution**Inheritance Types:**

Table 3. Inheritance Types

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

Multilevel Inheritance:

Listing 8. Multilevel Inheritance

```

1  class Animal {
2      void eat() { System.out.println("Eating"); }
3  }
4
5  class Mammal extends Animal {
6      void breathe() { System.out.println("Breathing"); }
7  }
8
9  class Dog extends Mammal {
10     void bark() { System.out.println("Barking"); }
11 }
```

Mnemonic

“Single Multi Hierarchical Multiple”

Question 3(c) [7 marks]

What is interface? Explain multiple inheritance with example.

Solution

Interface: Contract that defines what class must do, not how.

Listing 9. Multiple Inheritance with Interface

```

1 interface Flyable {
2     void fly();
3 }
4
5 interface Swimmable {
6     void swim();
7 }
8
9 class Duck implements Flyable, Swimmable {
10    public void fly() {
11        System.out.println("Duck is flying");
12    }
13
14    public void swim() {
15        System.out.println("Duck is swimming");
16    }
17 }
```

Interface Features:

- **Multiple Inheritance:** Class can implement multiple interfaces
- **Abstract Methods:** All methods are abstract by default
- **Constants:** All variables are public, static, final

Mnemonic

“Multiple Abstract Constants”

Question 3(a OR) [3 marks]

Explain final keyword with example.

Solution

Final Keyword: Restricts modification, inheritance, or overriding.

Listing 10. Final Keyword

```

1 final class Math {           // Cannot be inherited
2     final int PI = 3.14;      // Cannot be modified
3
4     final void calculate() { // Cannot be overridden
5         System.out.println("Calculating");
6     }
7 }
```

Final Uses:

- **Class:** Cannot be extended
- **Method:** Cannot be overridden
- **Variable:** Cannot be reassigned

Mnemonic

“Final Stops Changes”

Question 3(b OR) [4 marks]

Explain different access controls in Java.

Solution

Access Modifiers:

Table 4. Access Modifiers

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

Mnemonic

“Public Protected Default Private”

Question 3(c OR) [7 marks]

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

Solution

Package: Group of related classes and interfaces.

Steps to Create Package:

1. **Declare:** Use package statement at top
2. **Compile:** javac -d . ClassName.java
3. **Run:** java packagename.ClassName

Listing 11. Package Example

```

1 // File: mypack/Calculator.java
2 package mypack;
3
4 public class Calculator {
5     public int add(int a, int b) {
6         return a + b;
7     }
8 }
9
10 // File: Test.java
11 import mypack.Calculator;
12
13 public class Test {
14     public static void main(String[] args) {
15         Calculator calc = new Calculator();
16         System.out.println(calc.add(5, 3));
17     }
18 }
```

Package Benefits:

- **Organization:** Groups related classes
- **Access Control:** Package-level protection
- **Namespace:** Avoids naming conflicts

Mnemonic

“Declare Compile Run”

Question 4(a) [3 marks]

Explain thread priorities with suitable example.

Solution

Thread Priority: Determines thread execution order (1-10 scale).

Listing 12. Thread Priority

```

1  class MyThread extends Thread {
2      public void run() {
3          System.out.println(getName() + " Priority: " + getPriority());
4      }
5  }
6
7  public class ThreadPriorityExample {
8      public static void main(String[] args) {
9          MyThread t1 = new MyThread();
10         MyThread t2 = new MyThread();
11
12         t1.setPriority(Thread.MIN_PRIORITY); // 1
13         t2.setPriority(Thread.MAX_PRIORITY); // 10
14
15         t1.start();
16         t2.start();
17     }
18 }
```

Priority Constants:

- **MIN_PRIORITY:** 1
- **NORM_PRIORITY:** 5
- **MAX_PRIORITY:** 10

Mnemonic

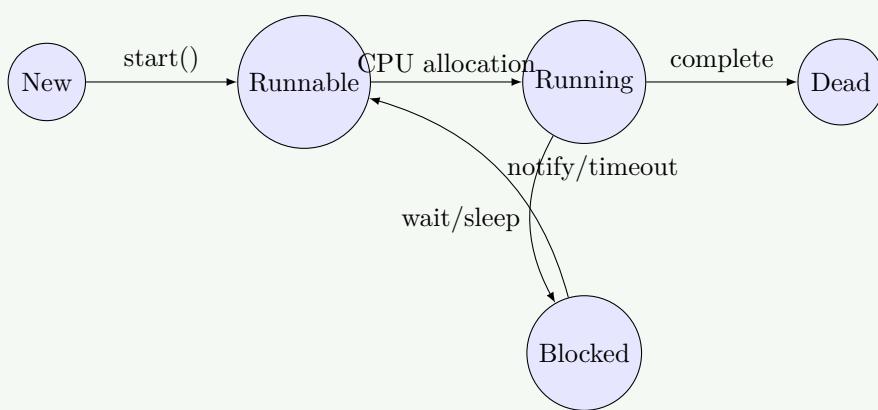
“Min Normal Max”

Question 4(b) [4 marks]

What is Thread? Explain Thread life cycle.

Solution

Thread: Lightweight process for concurrent execution.



Thread States:

- **New:** Thread created but not started
- **Runnable:** Ready to run
- **Running:** Currently executing
- **Blocked:** Waiting for resource
- **Dead:** Execution completed

Mnemonic

“New Runnable Running Blocked Dead”

Question 4(c) [7 marks]

Write a program in java that create the multiple threads by implementing the Runnable interface.

Solution

Listing 13. Multiple Threads

```

1  class MyRunnable implements Runnable {
2      private String threadName;
3
4      MyRunnable(String name) {
5          threadName = name;
6      }
7
8      public void run() {
9          for(int i = 1; i <= 5; i++) {
10             System.out.println(threadName + " - Count: " + i);
11             try {
12                 Thread.sleep(1000);
13             } catch(InterruptedException e) {
14                 e.printStackTrace();
15             }
16         }
17     }
18 }
19
20 public class MultipleThreads {
21     public static void main(String[] args) {
22         Thread t1 = new Thread(new MyRunnable("Thread-1"));
23         Thread t2 = new Thread(new MyRunnable("Thread-2"));
24         Thread t3 = new Thread(new MyRunnable("Thread-3"));
25
26         t1.start();
27         t2.start();
28         t3.start();
29     }
30 }
```

Key Points:

- **Runnable Interface:** Better than extending Thread class
- **Thread.sleep():** Pauses thread execution
- **Multiple Threads:** Run concurrently

Mnemonic

“Implement Runnable Start Multiple”

Question 4(a OR) [3 marks]

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

Solution**Inbuilt Exceptions:**

- **NullPointerException**: Accessing null object
- **ArrayIndexOutOfBoundsException**: Invalid array index
- **ArithmaticException**: Division by zero
- **NumberFormatException**: Invalid number format

ArithmaticException: Thrown when arithmetic operation fails.

Listing 14. ArithmaticException

```
1 int result = 10 / 0; // Throws ArithmaticException
```

Mnemonic

“Null Array Arithmetic Number”

Question 4(b OR) [4 marks]

Explain Try and Catch with suitable example.

Solution

Try-Catch: Exception handling mechanism.

Listing 15. Try Catch Example

```
1 public class TryCatchExample {
2     public static void main(String[] args) {
3         try {
4             int[] arr = {1, 2, 3};
5             System.out.println(arr[5]); // Index out of bounds
6         }
7         catch(ArrayIndexOutOfBoundsException e) {
8             System.out.println("Array index error: " + e.getMessage());
9         }
10        finally {
11            System.out.println("Always executed");
12        }
13    }
14 }
```

Exception Handling Flow:

- **Try**: Code that may throw exception
- **Catch**: Handles specific exceptions
- **Finally**: Always executes

Mnemonic

“Try Catch Finally”

Question 4(c OR) [7 marks]

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

Solution

Exception: Runtime error that disrupts normal program flow.

Listing 16. ArithmeticException Example

```

1  public class ArithmeticExceptionExample {
2      public static void main(String[] args) {
3          Scanner sc = new Scanner(System.in);
4
5          try {
6              System.out.print("Enter first number: ");
7              int num1 = sc.nextInt();
8
9              System.out.print("Enter second number: ");
10             int num2 = sc.nextInt();
11
12             int result = num1 / num2;
13             System.out.println("Result: " + result);
14         }
15         catch(ArithmaticException e) {
16             System.out.println("Error: Cannot divide by zero!");
17         }
18         catch(Exception e) {
19             System.out.println("General error: " + e.getMessage());
20         }
21         finally {
22             sc.close();
23         }
24     }
25 }
```

Exception Types:

- **Checked:** Compile-time exceptions
- **Unchecked:** Runtime exceptions
- **Error:** System-level problems

Mnemonic

“Runtime Error Disrupts Flow”

Question 5(a) [3 marks]

Explain **ArrayIndexOutOfBoundsException** in Java with example.

Solution

ArrayIndexOutOfBoundsException: Thrown when accessing invalid array index.

Listing 17. ArrayIndexOutOfBoundsException

```

1  public class ArrayIndexExample {
2      public static void main(String[] args) {
3          int[] numbers = {10, 20, 30};
4
5          try {
6              System.out.println(numbers[5]); // Invalid index
7          }
8          catch(ArrayIndexOutOfBoundsException e) {
9              System.out.println("Invalid array index: " + e.getMessage());
10         }
11     }
12 }
```

Key Points:

- **Valid Range:** 0 to array.length-1
- **Negative Index:** Also throws exception
- **Runtime Exception:** Unchecked exception

Mnemonic

“Array Index Range Check”

Question 5(b) [4 marks]

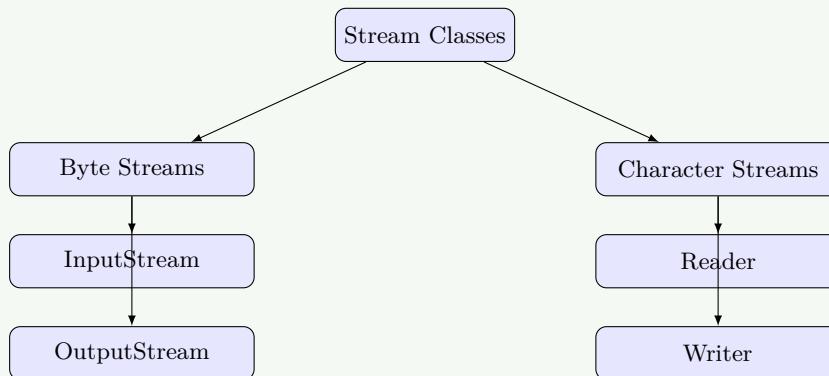
Explain basics of stream classes.

Solution

Stream Classes: Handle input/output operations.

Table 5. Stream Classes

Stream Type	Classes
Byte Streams	InputStream, OutputStream
Character Streams	Reader, Writer
File Streams	FileInputStream, FileOutputStream
Buffered Streams	BufferedReader, BufferedWriter

**Stream Features:**

- **Sequential:** Data flows in sequence
- **One Direction:** Either input or output
- **Automatic:** Handles low-level details

Mnemonic

“Byte Character File Buffered”

Question 5(c) [7 marks]

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

Solution**Listing 18.** File Create and Read

```

1 import java.io.*;
2
3 public class FileReadExample {
4     public static void main(String[] args) {
5         // Create and write to file
6         try {
7             FileWriter writer = new FileWriter("sample.txt");
8             writer.write("Hello World!\n");
9             writer.write("Java File Handling\n");
10            writer.write("GTU Exam 2024");
11            writer.close();
12            System.out.println("File created successfully");
13        }
14        catch(IOException e) {
15            System.out.println("Error creating file: " + e.getMessage());
16        }
17
18        // Read from file
19        try {
20            BufferedReader reader = new BufferedReader(new FileReader("sample.txt"));
21            String line;
22
23            System.out.println("\nFile contents:");
24            while((line = reader.readLine()) != null) {
25                System.out.println(line);
26            }
27            reader.close();
28        }
29        catch(IOException e) {
30            System.out.println("Error reading file: " + e.getMessage());
31        }
32    }
33 }
```

Key Points:

- **FileWriter:** Creates and writes to file
- **BufferedReader:** Efficient reading
- **Exception Handling:** Handle IOException

Mnemonic

“Create Write Read Close”

Question 5(a OR) [3 marks]

Explain Divide by Zero Exception in Java with example.

Solution

ArithmaticException: Thrown during divide by zero operation.

Listing 19. Divide by Zero

```

1  public class DivideByZeroExample {
2      public static void main(String[] args) {
3          try {
4              int a = 10;
5              int b = 0;
6              int result = a / b; // Throws ArithmaticException
7              System.out.println("Result: " + result);
8          }
9          catch(ArithmaticException e) {
10              System.out.println("Cannot divide by zero: " + e.getMessage());
11          }
12      }
13  }
```

Key Points:

- **Integer Division:** Only integer division by zero throws exception
- **Floating Point:** Returns Infinity for floating point division
- **Runtime Exception:** Unchecked exception

Mnemonic

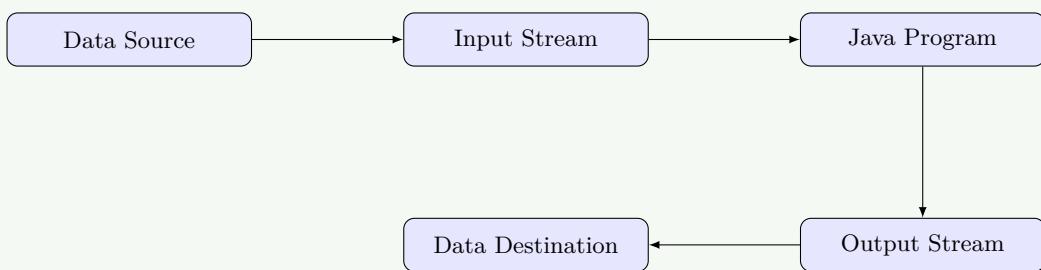
“Zero Division Arithmetic Error”

Question 5(b OR) [4 marks]

Explain java I/O process.

Solution

Java I/O Process: Mechanism for reading and writing data.



I/O Components:

- **Stream:** Sequence of data
- **Buffer:** Temporary storage for efficiency
- **File:** Persistent storage
- **Network:** Remote data transfer

I/O Types:

- **Byte-oriented:** Raw data (images, videos)
- **Character-oriented:** Text data
- **Synchronous:** Blocking operations
- **Asynchronous:** Non-blocking operations

Mnemonic

“Stream Buffer File Network”

Question 5(c OR) [7 marks]

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

Solution

Listing 20. File Write Example

```

1 import java.io.*;
2 import java.util.Scanner;
3
4 public class FileWriteExample {
5     public static void main(String[] args) {
6         Scanner sc = new Scanner(System.in);
7
8         try {
9             // Create file with FileWriter
10            FileWriter writer = new FileWriter("student.txt");
11
12            System.out.println("Enter student details:");
13            System.out.print("Name: ");
14            String name = sc.nextLine();
15
16            System.out.print("Roll Number: ");
17            String rollNo = sc.nextLine();
18
19            System.out.print("Branch: ");
20            String branch = sc.nextLine();
21
22            // Write data to file
23            writer.write("Student Information\n");
24            writer.write("=====\\n");
25            writer.write("Name: " + name + "\\n");
26            writer.write("Roll Number: " + rollNo + "\\n");
27            writer.write("Branch: " + branch + "\\n");
28            writer.write("Date: " + new java.util.Date() + "\\n");
29
30            writer.close();
31            System.out.println("\\nData written to file successfully!");
32
33        }
34        catch(IOException e) {
35            System.out.println("Error writing to file: " + e.getMessage());
36        }
37        finally {
38            sc.close();
39        }
40    }
41 }
```

Key Points:

- **FileWriter:** Writes character data to file
- **BufferedWriter:** More efficient for large data
- **Auto-close:** Use try-with-resources for automatic closing

Mnemonic

“Create Write Close Handle”