Vidyavardhini's
College of Engineering & Technology

Vasai Road (W)

Department of Artificial Intelligence & Data Science

Laboratory ManualStudent Copy

Semester	III	Class	S.E.
Course Code	CSL304		
Course Name	Skill based Lab Course: Object Oriented Programming with Java		

Vidyavardhini's College of Engineering& Technology

Vision

To be a premier institution of technical education; always aiming at becoming a valuable resource for industry and society.

Mission

- To provide technologically inspiring environmentfor learning.
- To promote creativity, innovation and professional activities.
- To inculcate ethical and moral values.
- To cater personal, professional and societal needs through quality education.

Department Vision:

To foster proficient artificial intelligence and data science professionals, making remarkable contributions to industry and society.

Department Mission:

- To encourage innovation and creativity with rational thinking for solvingthe challenges in emerging areas.
- To inculcate standard industrial practices and security norms whiledealing with Data.
- To develop sustainable Artificial Intelligence systems for the benefit ofvarious sectors.

Program Specific Outcomes (PSOs):

PSO1: Analyze the current trends in the field of Artificial Intelligence & Data Science and convey their findings by presenting / publishing at a national / international forum.

PSO2: Design and develop Artificial Intelligence & Data Science based solutions and applications for the problems in the different domains catering to industry and society.

Program Outcomes (POs):

Engineering Graduates will be able to:

- **PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4. Conduct investigations of complex problems:** Use research-based knowledge andresearch methods including design of experiments, analysis and interpretation of data, andsynthesis of the information to provide valid conclusions.
- **PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **PO6. The engineer and society:** Apply reasoning informed by the contextual knowledgeto assess societal, health, safety, legal and cultural issues and the consequentresponsibilities relevant to the professional engineering practice.
- **PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO9. Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10. Communication:** Communicate effectively on complex engineering activitieswith the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12. Life-long learning:** Recognize the need for and have the preparation and ability toengage in independent and life-long learning in the broadest context of technological change.

Course Objective

1	To learn the basic concept of object-oriented programming
2	To study JAVA Programming language
3	To study various concepts of JAVA programming like multithreading, exception handling, packages etc.
4	To explain components of GUI based application.

Course Outcomes

CO	At the end of course students will be able to:	**Action verbs**	**Bloom's Level**
CSL304.1	Apply the Object Oriented Programming and basic programming constructs for solving problems using JAVA.	Apply	Apply (level 3)
CSL304.2	Apply the concept of packages, classes , objects and accept the input using Scanner and Buffered Reader Class.	Apply	Apply (level 3)
CSL304.3	Apply the concept of strings, arrays, and vectors to perform various operations on sequential data.	Apply	Apply (level 3)
CSL304.4	Apply the concept of inheritance as method overriding and interfaces for multiple inheritance.	Apply	Apply (level 3)
CSL304.5	Apply the concept of exception handling using try, catch, finally, throw and throws and multithreading for thread management.	Apply	Apply (level 3)
CSL304.6	Develop GUI based application using applets and AWT Controls.	Develop	Create (level 6)

Mapping of Experiments with Course Outcomes

List of Experiments	Course Outcomes					
	CSL304.1	CSL304.2	CSL304.3	CSL304.4	CSL304.5	CSL304.6
Implement a program using Basic programming constructs like branching and looping	3	-	-	-	-	-
Implement a program to accept the input from user using Scanner and Buffered Reader.	3	-	-	-	-	-
Implement a program that demonstrates the concepts of class and objects	-	3	-	-	-	-
Implement a program on method and constructor overloading.	-	3	-	-	-	-
Implement a program on Packages.	-	-	3	-	-	-
Implement a program on 2D array & strings functions.	-	-	3	-	-	-
Implement a program on single inheritance.	-	-	-	3	-	-
Implement a program on Multiple Inheritance with Interface.	-	-	-	3	-	-
Implement a program on Exception handling.	-	-	-	-	3	-

Implement a program on Multithreading.	-	-	-	-	3	-
Implement a program on Applet or AWT Controls.	-	-	-	-	-	3
Mini Project based on the content of the syllabus (Group of 2-3 students)	-	-	-	-	-	3

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Sr. No.	Name of Experiment	D.O.P.	D.O.C.	Page No.	Remark
1	Implement a program using Basic programming constructs like branching and looping				
2	Implement a program to accept the input from user using Scanner and Buffered Reader.				
3	Implement a program that demonstrates the concepts of class and objects				
4	Implement a program on method and constructor overloading.				
5	Implement a program on Packages.				
6	Implement a program on 2D array & strings functions.				
7	Implement a program on single inheritance.				
8	Implement a program on Multiple Inheritance with Interface.				
9	Implement a program on Exception Handling.				
10	Implement a program on Multithreading.				
11	Implement a program on Applet or AWT Controls				
12	Mini Project based on the content of the syllabus (Group of 2-3 students)				

D.O.P: Date of performance

D.O.C : Date of correction

Experiment No.1
Basic programming constructs like branching and looping
Date of Performance:
Date of Submission:

Aim :- To apply programming constructs of decision making and looping.

Objective :- To apply basic programming constructs like Branching and Looping for solving arithmetic problems like calculating factorial of a no entered by user at command prompt .

Theory :-

Programming constructs are basic building blocks that can be used to control computer programs. Most programs are built out of a fairly standard set of programming constructs. For example, to write a useful program, we need to be able to store values in variables, test these values against a condition, or loop through a set of instructions a certain number of times. Some of the basic program constructs include decision making and looping.

Decision Making in programming is similar to decision making in real life. In programming also we face some situations where we want a certain block of code to be executed when some condition is fulfilled. A programming language uses control statements to control the flow of execution of program based on certain conditions. These are used to cause the flow of execution to advance and branch based on changes to the state of a program.

- if
- if-else
- nested-if
- if-else-if
- switch-case
- break, continue

These statements allow you to control the flow of your program's execution based upon conditions known only during run time.

A loop is a programming structure that repeats a sequence of instructions until a specific condition is met. Programmers use loops to cycle through values, add sums of numbers, repeat functions, and many other things. ... Two of the most common types of loops are the while loop and the for loop. The different ways of looping in programming languages are

- while

- do-while

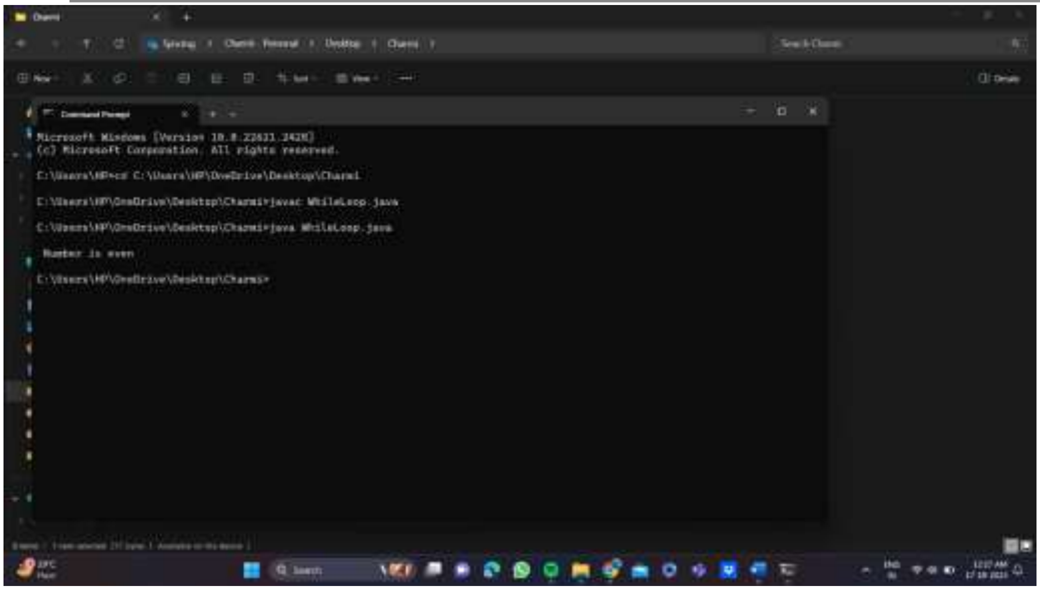
- for loop
- Some languages have modified for loops for more convenience eg :- Modified for loop in java.

For and while loop is entry-controlled loops. Do-while is an exit-controlled loop.

Code: -

1} while loop

```
class Whileloop
{
  public static void main(String args[])
       {
         int a=4;
         while(a%2==0)
         {
           System.out.println("\n Number is even");
           break;
         }
       } }
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac WhileLoop.java

C:\Users\HP\OneDrive\Desktop\Charmi>java WhileLoop.java

 Number is even

C:\Users\HP\OneDrive\Desktop\Charmi>
```
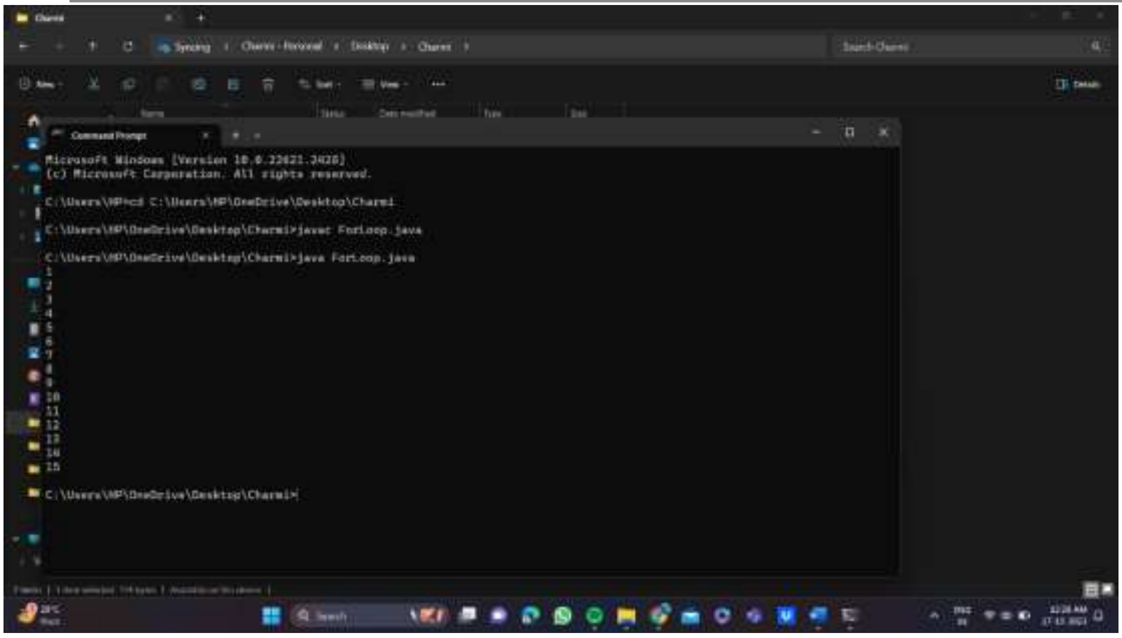

2} for loop

```
class Forloop
{
   public static void main(String args[])
     {
       int x;
       for(x=1;x<=10;x++)
       {
         System.out.println(x);
       }
     }
}
```



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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

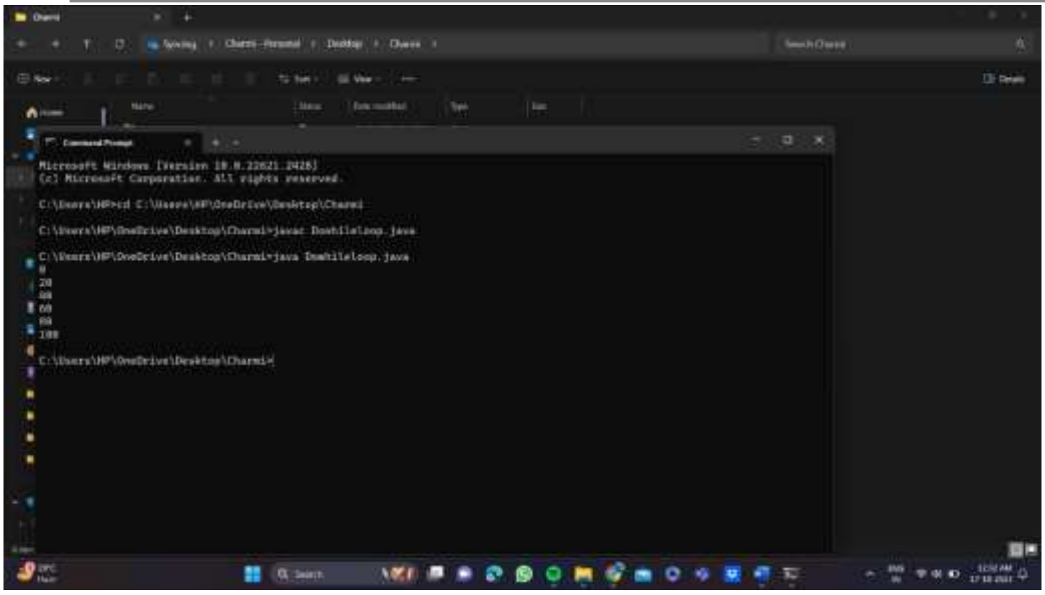
C:\Users\HP\OneDrive\Desktop\Charmi>javac ForLoop.java

C:\Users\HP\OneDrive\Desktop\Charmi>java ForLoop.java
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

C:\Users\HP\OneDrive\Desktop\Charmi>
```

3} dowhile loop

```
class Dowhileloop
{
   public static void main(String arg[])
  {
int a=0;
  do
 {
   if(a%20==0)
    {
    System.out.println(a);
    } a++;
 } while(a<=100);
 }
}
```



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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac DoWhileloop.java

C:\Users\HP\OneDrive\Desktop\Charmi>java DoWhileloop.java
0
20
40
60
80
100

C:\Users\HP\OneDrive\Desktop\Charmi>
```
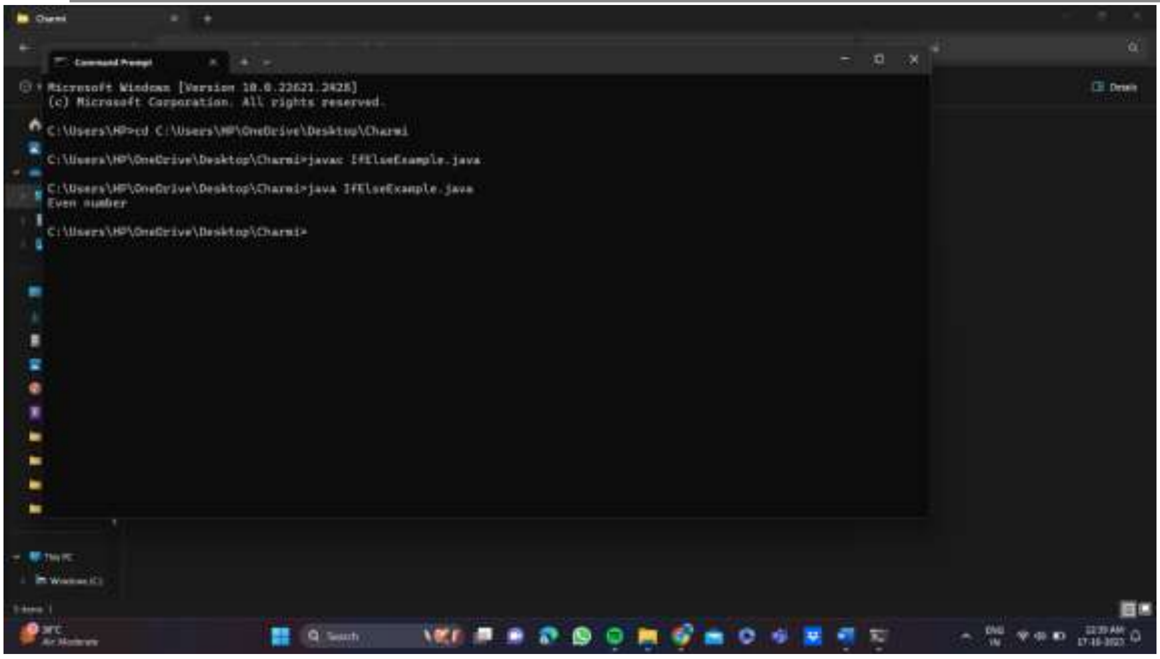

4}if else

```
public class IfElseExample {
public static void main(String[] args) {
   int number=10;
      if(number%2==0){
      System.out.println("Even number");
   }else{
      System.out.println("Odd number");
   }
}
}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac IfElseExample.java

C:\Users\HP\OneDrive\Desktop\Charmi>java IfElseExample.java
Even number

C:\Users\HP\OneDrive\Desktop\Charmi>
```
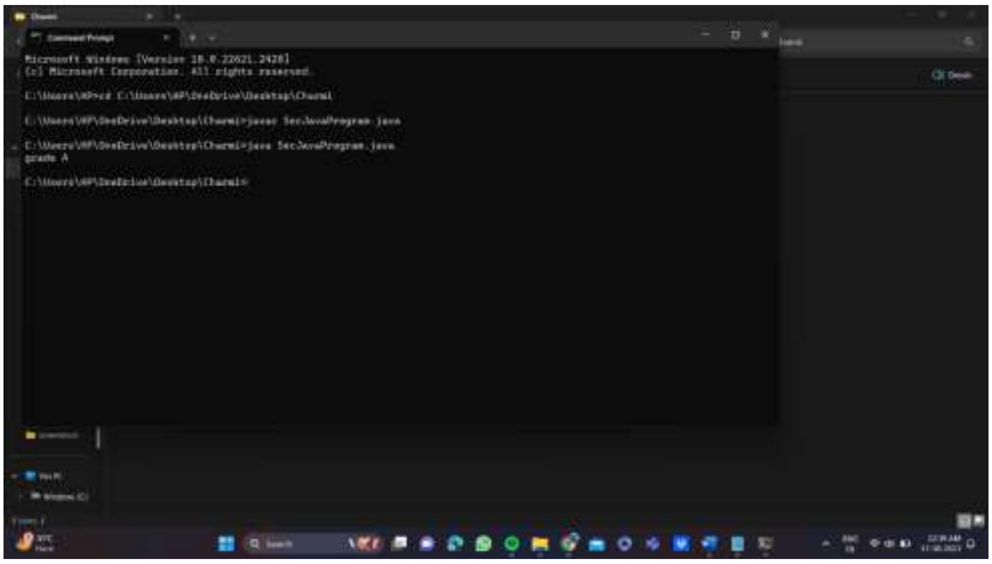

5} Ladder if else

```
class SecJavaProgram
{
 public static void main(String args[])
{
 int a=90;
if(a>=90)
{
System.out.println("grade A");
}
else if(a>=80)
{
System.out.println("grade B");
}
else if(a>=70)

{

System.out.println("grade c");

}

else if(a<70)

{

System.out.println("grade F");

}

}}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac SecJavaProgram.java

C:\Users\HP\OneDrive\Desktop\Charmi>java SecJavaProgram.java
grade A

C:\Users\HP\OneDrive\Desktop\Charmi>
```

6} nested if else

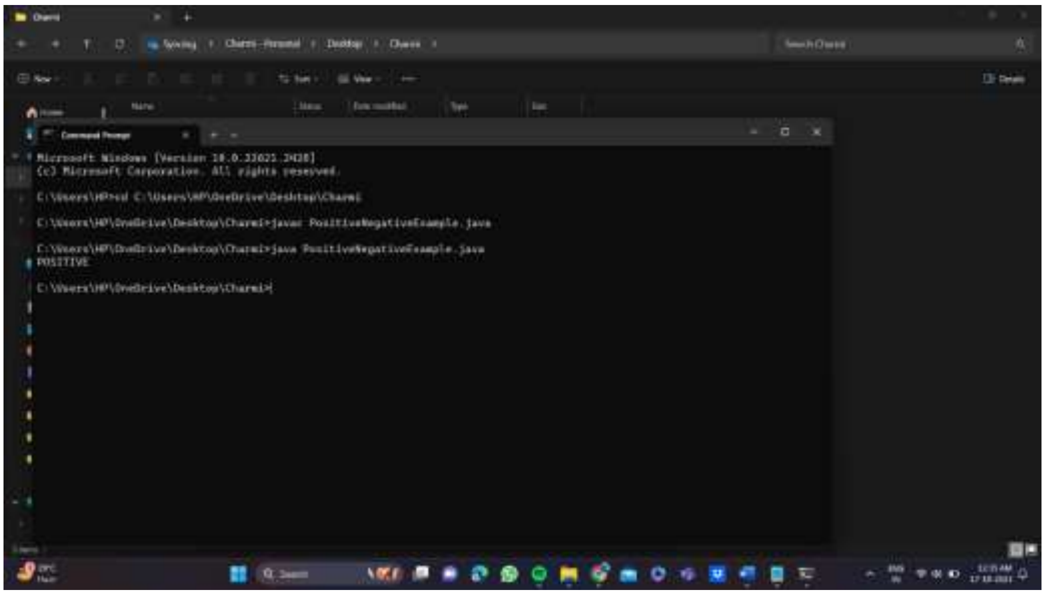
```
public class PositiveNegativeExample {

public static void main(String[] args) {

    int number=15;

    if(number>0){

    System.out.println("POSITIVE");
    }else if(number<0){
    System.out.println("NEGATIVE");
    }else{
    System.out.println("ZERO");
   }
}}
```



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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac PositiveNegativeExample.java

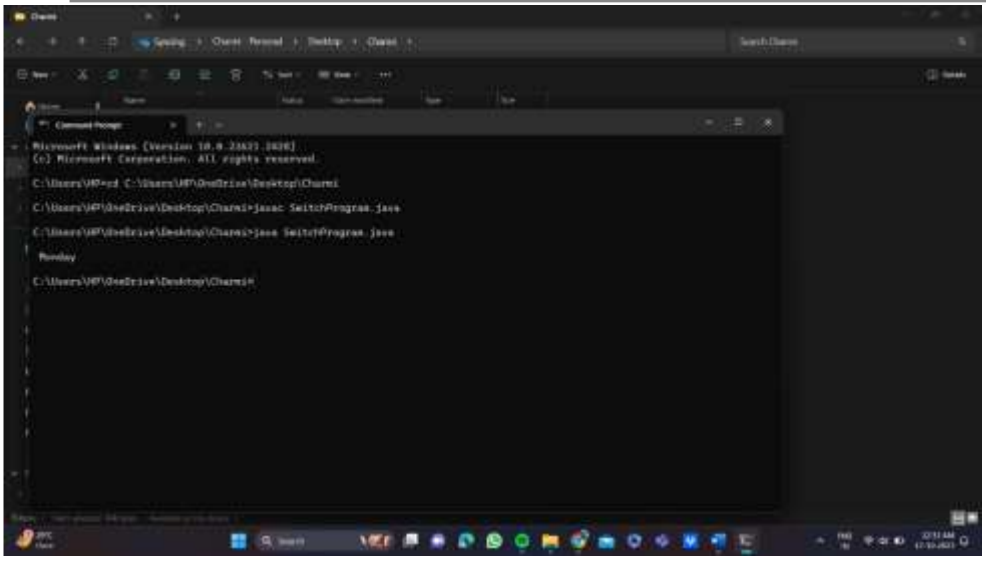
C:\Users\HP\OneDrive\Desktop\Charmi>java PositiveNegativeExample.java
POSITIVE

C:\Users\HP\OneDrive\Desktop\Charmi>
```

7} switch

```
class SwitchProgram
{
  public static void main(String args[])
         {
           int a = 1 ;
           switch(a)
           {
           case 1 :
```

```
    System.out.println("\n Monday");
    break;
  case 2 :
    System.out.println("\n Tuesday");
    break;
  case 3 :
    System.out.println("\n Wednesday");
    break;
  case 4 :
    System.out.println("\n Thursday");
    break;
  case 5 :
    System.out.println("\n Friday");
    break;
  case 6 :
    System.out.println("\n Saturday");
    break;
  case 7 :
    System.out.println("\n Sunday");
    break;
  default :
    System.out.println("\n Not Valid");
  }
} }
```



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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac SwitchProgram.java

C:\Users\HP\OneDrive\Desktop\Charmi>java SwitchProgram.java

 Monday

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

Branching and looping are essential control structures in Java and many other programming languages that are useful for solving a wide range of problems. They provide the means to make decisions and repeat actions, making your code more dynamic and adaptable.

Branching (if statements) allows you to make decisions in your code based on conditions. You can execute different blocks of code depending on whether a condition is true or false.

Loops (for, while, and do-while) enable you to repeat a block of code multiple times, which is useful for tasks like processing arrays, lists, and performing iterative calculations. This repetition can be used to perform the same operation on each element of an array or list, or to perform a calculation a certain number of times.

In summary, branching and looping are powerful tools that allow you to create dynamic and adaptable code that can solve a wide range of problems.

Experiment No.2
Accepting Input Through Keyboard
Date of Performance:
Date of Submission:

Aim: To apply basic programing for accepting input through keyboard.

Objective: To use the facility of java to read data from the keyboard for any program

Theory:

Java brings various Streams with its I/O package that helps the user perform all the Java input-output operations. These streams support all types of objects, data types, characters, files, etc. to fully execute the I/O operations. Input in Java can be with certain methods mentioned below in the article.

Methods to Take Input in Java

There are two ways by which we can take Java input from the user or from a file

1. BufferedReader Class
2. Scanner Class

Using BufferedReader Class for String Input In Java

It is a simple class that is used to read a sequence of characters. It has a simple function that reads a character another read which reads, an array of characters, and a readLine() function which reads a line.

InputStreamReader() is a function that converts the input stream of bytes into a stream of characters so that it can be read as BufferedReader expects a stream of characters. BufferedReader can throw checked Exceptions.

Using Scanner Class for Taking Input in Java

It is an advanced version of BufferedReader which was added in later versions of Java. The scanner can read formatted input. It has different functions for different types of data types.

The scanner is much easier to read as we don't have to write throws as there is no exception thrown by it.

It was added in later versions of Java

It contains predefined functions to read an Integer, Character, and other data types as well.

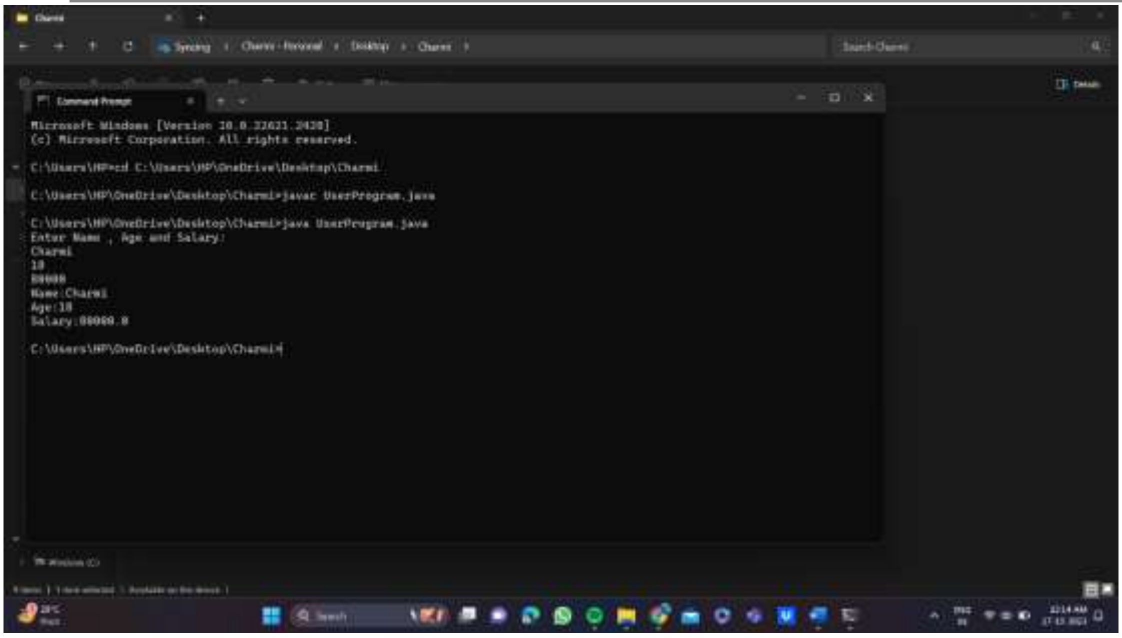
Syntax of Scanner class

Scanner scn = new Scanner(System.in);

Code:

1} Scanner class

```
import java.util.Scanner;

class UserProgram

{

  public static void main(String args[])

   {

     Scanner a = new Scanner(System.in);

     System.out.println("Enter Name , Age and Salary:");

     String str = a.nextLine();

     int age = a.nextInt();

     Double salary = a.nextDouble();

     System.out.println("Name:" + str);

     System.out.println("Age:" + age);

     System.out.println("Salary:" + salary);

   }

}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac UserProgram.java

C:\Users\HP\OneDrive\Desktop\Charmi>java UserProgram.java
Enter Name , Age and Salary:
Charmi
18
80000
Name:Charmi
Age:18
Salary:80000.0

C:\Users\HP\OneDrive\Desktop\Charmi>
```
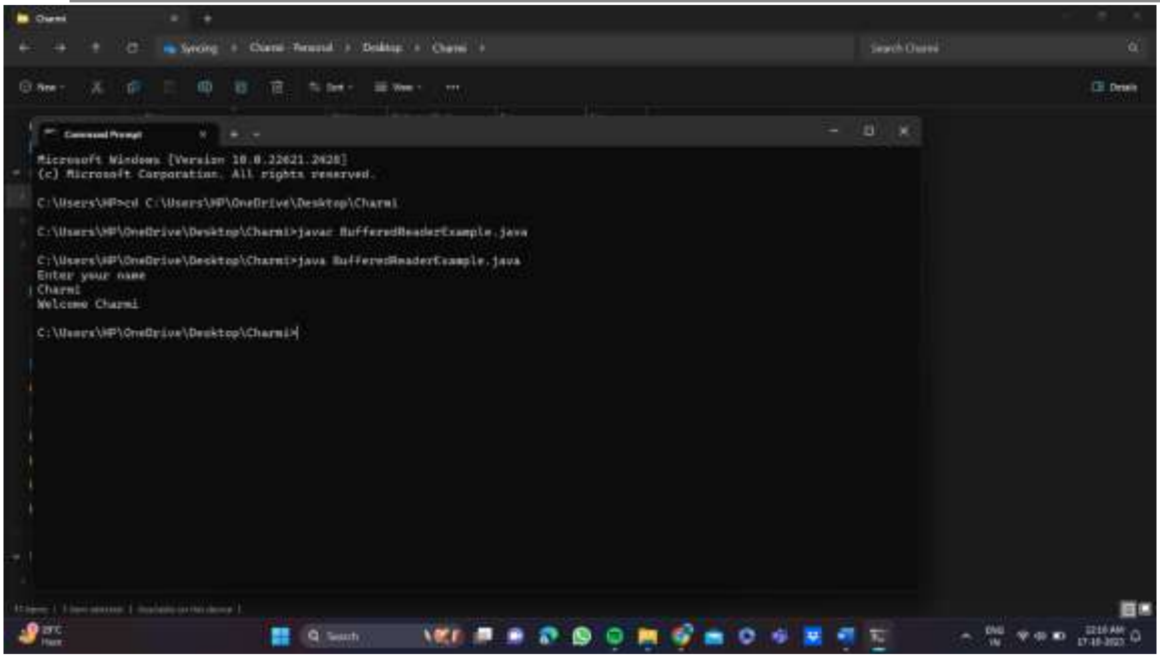

2} Buffer reader class

```
package com.javatpoint;

import java.io.*;

public class BufferedReaderExample{

public static void main(String args[])throws Exception{

   InputStreamReader r=new InputStreamReader(System.in);

   BufferedReader br=new BufferedReader(r);

   System.out.println("Enter your name");

   String name=br.readLine();

   System.out.println("Welcome "+name);

}

}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac BufferedReaderExample.java

C:\Users\HP\OneDrive\Desktop\Charmi>java BufferedReaderExample.java
Enter your name
Charmi
Welcome Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

In Java, both the BufferedReader and Scanner classes are commonly used for accepting user input from the command line or other input sources. Each of these classes has its own advantages and use cases.

The BufferedReader class is part of the java.io package and is primarily used for reading text from character input streams. It's efficient for reading large amounts of text efficiently. You can use BufferedReader to read input from a file or from the console by wrapping it around an InputStreamReader object.

The Scanner class is part of the java.util package and is a more high-level and user-friendly way to parse and tokenize input. It can be used for both reading from files and user input. Scanner is useful when you want to read input that is formatted in a particular way, such as a series of integers separated by commas. You can use Scanner to read input from the console or from a file.

In summary, both BufferedReader and Scanner classes are useful for accepting user input in Java, but they have different strengths and use cases.

Experiment No. 3
Implement a program that demonstrates the concepts of class and objects
Date of Performance:
Date of Submission:

Aim: Implement a program that demonstrates the concepts of class and objects

Objective: To develop the ability of converting real time entity into objects and create their classes.

Theory:

A class is a user defined blueprint or prototype from which objects are created. It represents the set of properties i.e., members and methods that are common to all objects of one type. In general, class declarations can include these components, in order:

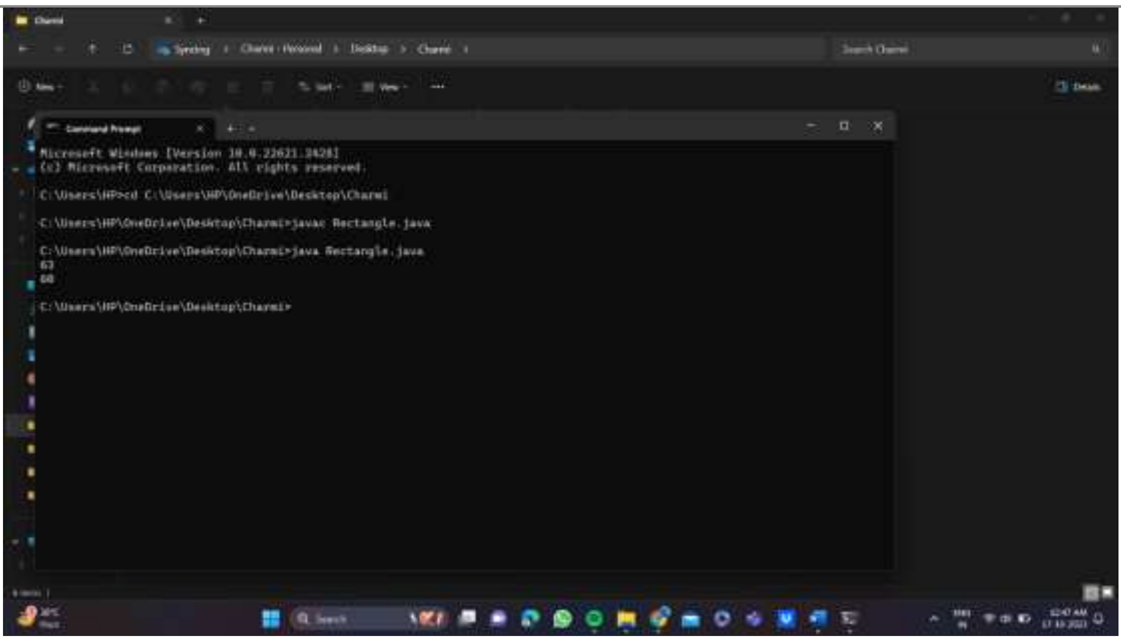
1. Modifiers: A class can be public or has default access.
2. class keyword: class keyword is used to create a class.
3. Class name: The name should begin with a initial letter (capitalized by convention).
4. Superclass (if any): The name of the class's parent (superclass), if any, preceded by the keyword extends. A class can only extend (subclass) one parent.
5. Interfaces (if any): A comma-separated list of interfaces implemented by the class, if any, preceded by the keyword implements. A class can implement more than one interface.
6. Body: The class body surrounded by braces, {}.

An OBJECT is a basic unit of Object-Oriented Programming and represents the real-life entities. A typical Java program creates many objects, which interact by invoking methods. An object consists of:

1. State: It is represented by attributes of an object. It also reflects the properties of an object.
2. Behavior: It is represented by methods of an object. It also reflects the response of an object with other objects.
3. Identity: It gives a unique name to an object and enables one object to interact with other objects.

Code:
1}

```
class Rectangle{
 int length;
 int width;
 void insert(int l, int w){
  length=l;
  width=w;
 }
 void calculateArea(){System.out.println(length*width);}
}
class TestRectangle1{
 public static void main(String args[]){
  Rectangle r1=new Rectangle();
  Rectangle r2=new Rectangle();
  r1.insert(7,9);
  r2.insert(5,12);
  r1.calculateArea();
  r2.calculateArea();
}
}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac Rectangle.java

C:\Users\HP\OneDrive\Desktop\Charmi>java Rectangle.java
63
60

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

In Java, you can create a class template by using the `class` keyword followed by the class name. Inside the class, you can declare fields (attributes) to represent the state of objects, define constructors to initialize the object's state, and add methods to define the behavior and actions of the objects.

To create objects from a class, you can use the `new` keyword followed by the class constructor. The created objects can be assigned to variables.

You can access fields and call methods of an object using the dot notation.

In summary, creating a class template and its objects in Java is a straightforward process that involves defining a class with fields and methods, creating objects from the class using the `new` keyword, and accessing fields and methods using the dot notation.

Experiment No. 4
Implement a program on method and constructor overloading.
Date of Performance:
Date of Submission:

Aim: Implement a program on method and constructor overloading.

Objective: To use concept of method overloading in a java program to create a class with same function name with different number of parameters.

Theory:

Method Overloading is a feature that allows a class to have more than one method having the same name, if their argument lists are different. It is similar to constructor overloading in Java, that allows a class to have more than one constructor having different argument lists.

Example: This example to show how method overloading is done by having different number of parameters for the same method name.

```
Class DisplayOverloading
{
    public void disp(char c)
    {
         System.out.println(c);
    }
    public void disp(char c, int num)
    {
         System.out.println(c + " "+num);
    }
}
Class Sample
{
   Public static void main(String args[])
   {
       DisplayOverloading obj = new DisplayOverloading();
       Obj.disp('a');
       Obj.disp('a',10);
   }
}
```

Output:

```
A
A 10
```

Java supports Constructor Overloading in addition to overloading methods. In Java, overloaded constructor is called based on the parameters specified when a new is executed.

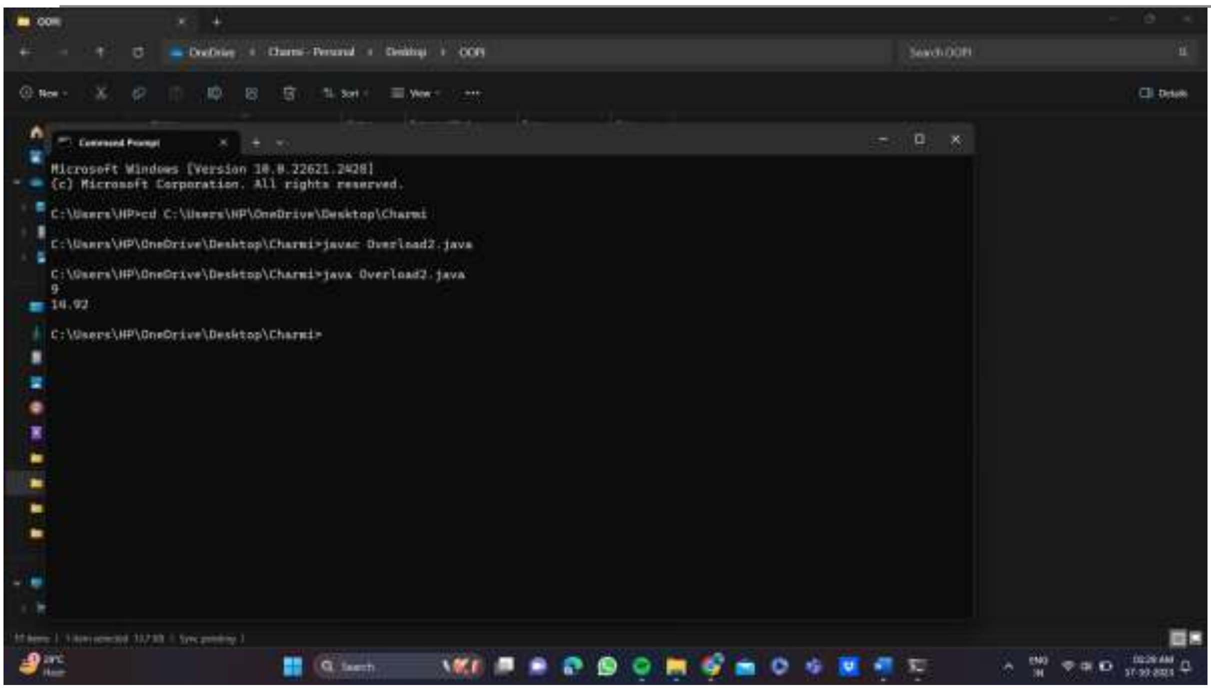
Sometimes there is a need of initializing an object in different ways. This can be done using constructor overloading.

For example, the Thread class has 8 types of constructors. If we do not want to specify anything about a thread then we can simply use the default constructor of the Thread class, however, if we need to specify the thread name, then we may call the parameterized constructor of the Thread class with a String args like this:

Thread t= new Thread (" MyThread ");

Code:

```
class Overload2
{
  public static void main(String args[])
   {
     System.out.println(Add.add(5,4));
     System.out.println(Add.add(2.80,3.12,9.00));
   }
}
class Add{
static int add(int a,int b) {return a+b;}
static double add(double a,double b,double c) {return a+b+c;}
}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac Overload2.java

C:\Users\HP\OneDrive\Desktop\Charmi>java Overload2.java
9
10.92

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

In Java, function and constructor overloading involves creating multiple methods or constructors with the same name within a class but with different parameter lists.

Function overloading allows you to define multiple methods in a class with the same name but different parameter lists (number or types of parameters). This way, you can provide different behavior for the same operation depending on the inputs. The choice of which method to call is made at compile-time based on the provided arguments.

Constructor overloading is similar to function overloading but is used to define multiple constructors within a class with different parameter lists. Constructor overloading enables the creation of objects in various ways, depending on the arguments provided during object instantiation. Like function overloading, constructors can have different parameter types, but the number and types of parameters should differ to distinguish between them.

In summary, function and constructor overloading are useful techniques in Java that allow you to create multiple methods or constructors with the same name but different parameter lists. This way, you can provide different behavior for the same operation depending on the inputs or create objects in various ways.

Experiment No. 5
Implement a program on Packages.
Date of Performance:
Date of Submission:

Aim: To use packages in java.

Objective: To use packages in java to use readymade classes available in them using square root method in math class.

Theory:

A java package is a group of similar types of classes, interfaces and sub-packages. Packages are used in Java in order to prevent naming conflicts, to control access, to make searching/locating and usage of classes, interfaces, enumerations and annotations easier, etc.

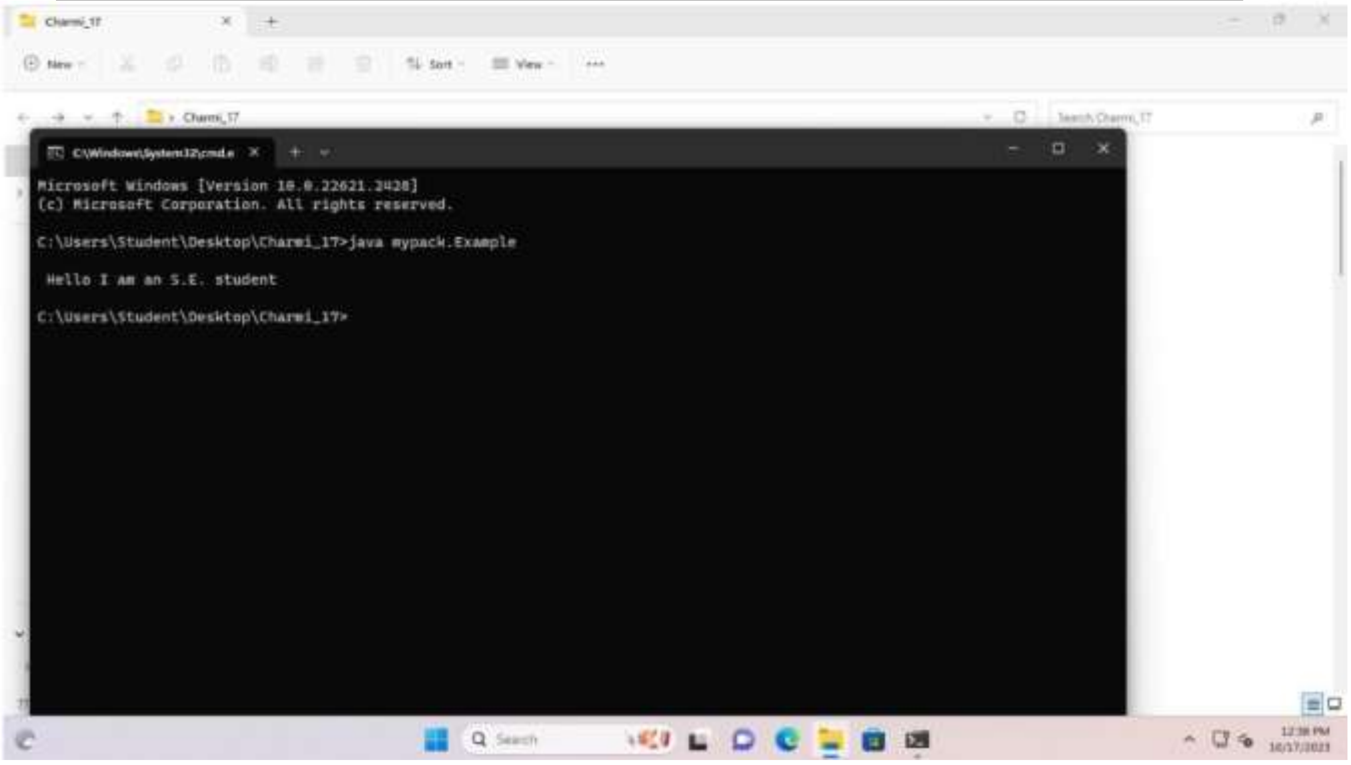
There are two types of packages-

1. Built-in package: The already defined package like java.io.*, java.lang.* etc are known as built-in packages.
2. User defined package: The package we create for is called user-defined package.

Programmers can define their own packages to bundle group of classes/interfaces, etc. While creating a package, the user should choose a name for the package and include a package statement along with that name at the top of every source file that contains the classes, interfaces, enumerations, and annotation types that you want to include in the package. If a package statement is not used then the class, interfaces, enumerations, and annotation types will be placed in the current default package.

Code:

1} package mypack;
```
  class Example
 {
   public static void main(String args[])
   {
     System.out.println("\n Hello I am an S.E. student");
   }
 }
```



```
Microsoft Windows [Version 10.0.22621.2428]
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C:\Users\Student\Desktop\Charmi_17>java mypack.Example

 Hello I am an S.E. student

C:\Users\Student\Desktop\Charmi_17>
```

Conclusion:

Autoencoders are a type of neural network used for data compression. They consist of an encoder that reduces the dimensions of the input data and a decoder that reconstructs the original data from the compressed representation. In Java, you can build an autoencoder for image compression. The results of image compression using autoencoders include smaller-sized images that maintain essential features, making them useful for storage and transmission. However, there is some loss of detail due to the compression process.

The architecture of an autoencoder typically consists of three main components: the encoder, the bottleneck layer, and the decoder. The encoder takes in the input data and compresses it into a lower-dimensional representation. The bottleneck layer is a compressed representation of the input data that is used as input to the decoder. The decoder takes in the compressed representation and reconstructs the original data.

In summary, autoencoders are a powerful tool for image compression that can produce smaller-sized images while maintaining essential features. However, there is some loss of detail due to the compression process.

Experiment No. 6
Implement a program on 2D array & strings functions.
Date of Performance:
Date of Submission:

Aim: To use 2D arrays and Strings for solving given problem.

Objective: To use 2D array concept and strings in java to solve real world problem

Theory:

- An array is used to store a fixed-size sequential collection of data of the same type.
- An array can be init in two ways:
  1. Initializing at the time of declaration:
     dataType[] myArray = {value0, value1, ..., valuek};
  2. Dynamic declaration:
     dataType[] myArray = new dataType[arraySize];
     myArray[index] = value;
- Two – dimensional array is the simplest form of a multidimensional array. Data of only same data type can be stored in a 2D array.Data in a 2D Array is stored in a tabular manner which can be represented as a matrix.
- A 2D Array can be declared in 2 ways:
  1. Intializing at the time of declaration:
     dataType[][] myArray = { {valueR1C1, valueR1C2...}, {valueR2C1, valueR2C2...},..}
  2. Dynamic declaration:
     dataType[][] myArray = new dataType[x][y];
     myArray[row_index][column_index] = value;

In Java, string is basically an object that represents sequence of char values. An array of characters works same as Java string. **Java String** class provides a lot of methods to perform operations on strings such as compare(), concat(), equals(), split(), length(), replace(), compareTo(), intern(), substring() etc.

1.String literal
To make Java more memory efficient (because no new objects are created if it exists already in the string constant pool).

Example:

String demoString = “GeeksforGeeks”;

2. Using new keyword

- String s = new String(“Welcome”);
- In such a case, JVM will create a new string object in normal (non-pool) heap memory and the literal “Welcome” will be placed in the string constant pool. The variable s will refer to the object in the heap (non-pool)

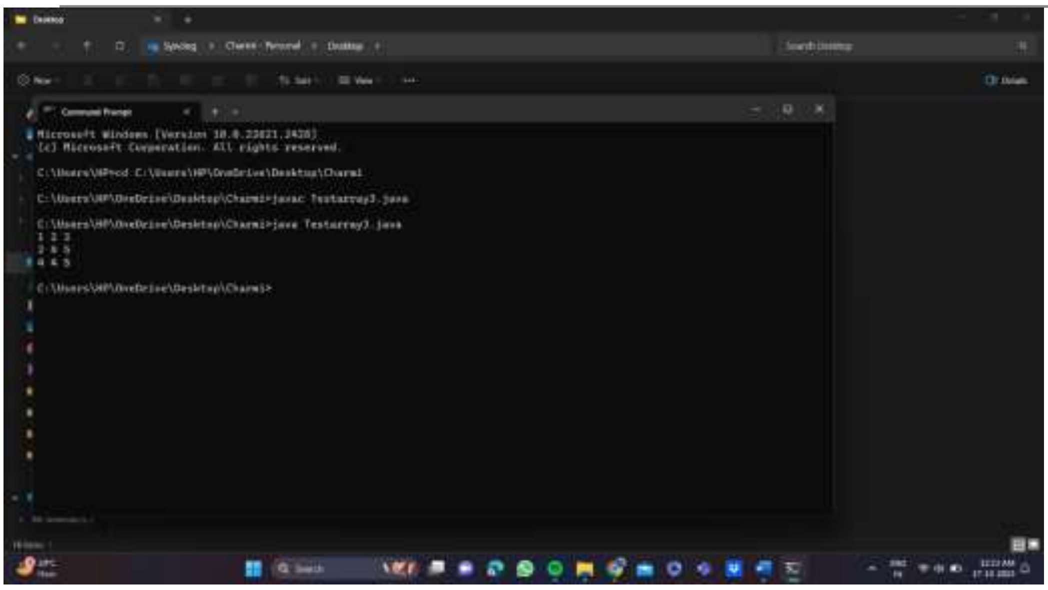
Example:

String demoString = new String (“GeeksforGeeks”);

Code:

1}

```
class Testarray3{
public static void main(String args[]){
int arr[][]={{1,2,3},{2,4,5},{4,4,5}};
for(int i=0;i<3;i++){
 for(int j=0;j<3;j++){
   System.out.print(arr[i][j]+" ");
 }
 System.out.println();
}
}}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac Testarray3.java

C:\Users\HP\OneDrive\Desktop\Charmi>java Testarray3.java
1 2 3
2 6 5
4 6 5

C:\Users\HP\OneDrive\Desktop\Charmi>
```
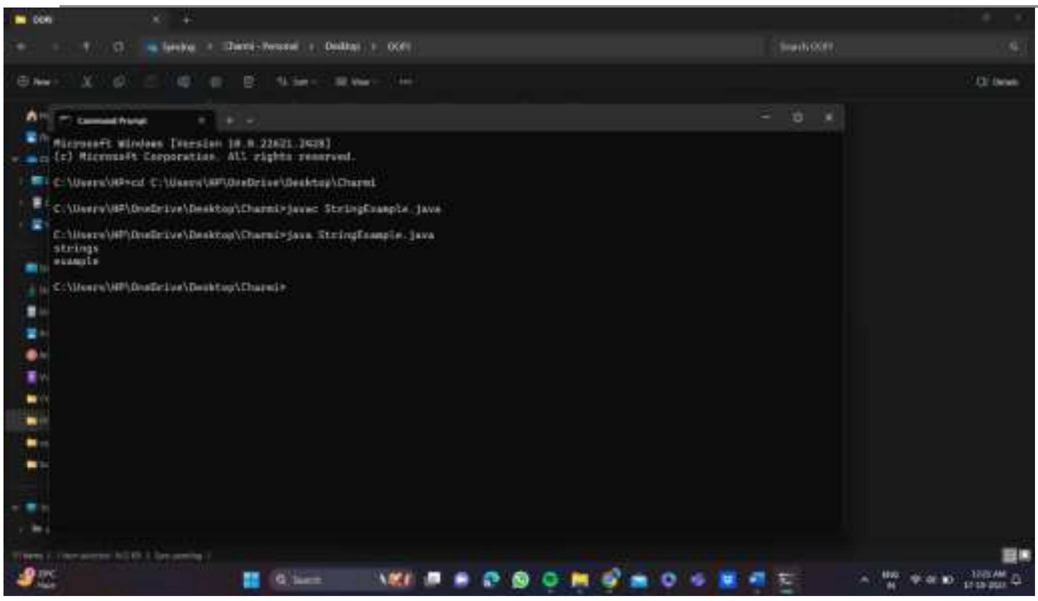

2}

```
class StringExample{
public static void main(String args[]){
String s1="java";
char ch[]={'s','t','r','i','n','g','s'};
String s2=new String(ch);
String s3=new String("example");
System.out.println(s2);
System.out.println(s3);
}}
```



```
Microsoft Windows [Version 10.0.22621.2428]
(c) Microsoft Corporation. All rights reserved.

C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac StringExample.java

C:\Users\HP\OneDrive\Desktop\Charmi>java StringExample.java
strings
example

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

Comment on how you have used the concept of string and 2D array.

String Usage:
String s1 = "java";: Here, we've created a string s1 using a string literal.
char ch[] = {'s','t','r','i','n','g','s'};: We've defined a character array ch, and then we've created a string s2 using this character array. This demonstrates the creation of a string from an array of characters.
String s3 = new String("example");: This is another way to create a string, using the new keyword and a constructor. We have created s3 from the string literal "example".

2D Array Usage:
int arr[][] = {{1,2,3},{2,4,5},{4,4,5}};: We defined a 2D integer array arr with three rows and three columns. This represents a 3x3 grid of integer values.
The nested loops (for loops) in the Testarray3 class are used to iterate through the elements of the 2D array and print them out. This demonstrates how to access and display elements from a 2D array.

Experiment No. 7
Implement a program on single inheritance.
Date of Performance:
Date of Submission:

Aim: To implement the concept of single inheritance.

Objective: Ability to design a base and child class relationship to increase reusability.

Theory:
Single inheritance can be defined as a derived class to inherit the basic methods (data members and variables) and behaviour from a superclass. It's a basic is-a relationship concept exists here. Basically, java only uses a single inheritance as a subclass cannot extend more superclass.
Inheritance is the basic properties of object-oriented programming. Inheritance tends to make use of the properties of a class object into another object. Java uses inheritance for the purpose of code-reusability to reduce time by then enhancing reliability and to achieve run time polymorphism. As the codes are reused it makes less development cost and maintenance. Java has different types of inheritance namely single inheritance, multilevel, multiple, hybrid. In this article, we shall go through on basic understanding of single inheritance concept briefly in java with a programming example. Here we shall have a complete implementation in java.

Syntax:

The general syntax for this is given below. The inheritance concepts use the keyword 'extend' to inherit a specific class. Here you will learn how to make use of extending keyword to derive a class. An extend keyword is declared after the class name followed by another class name. Syntax is,

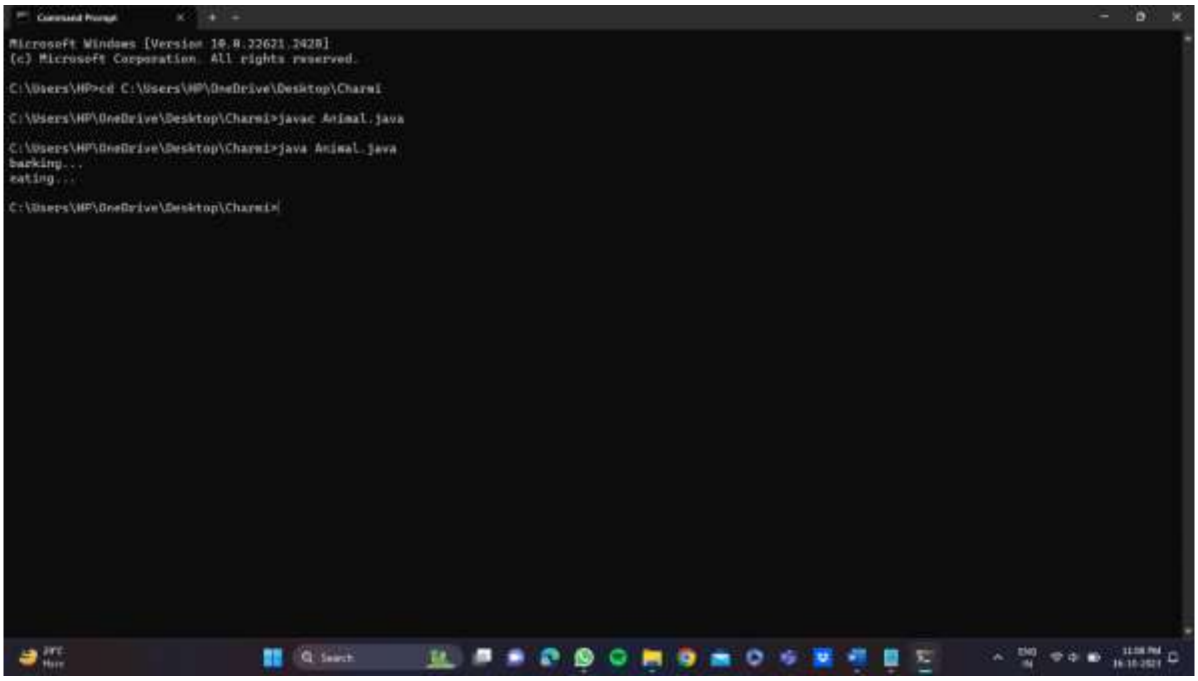
```
class base class
{…. methods
}
class derived class name extends base class
{
methods … along with this additional feature
}
```

Java uses a keyword 'extends' to make a new class that is derived from the existing class. The inherited class is termed as a base class or superclass, and the newly created class is called derived or subclass. The class which gives data members and methods known as the base class and the class which takes the methods is known as child class.

Code:

1} class Animal{

```
 void eat(){System.out.println("eating...");}
 }
 class Dog extends Animal{
 void bark(){System.out.println("barking...");}
 }
 class TestInheritance{
 public static void main(String args[]){
 Dog d=new Dog();
 d.bark();
 d.eat();
 }}
```



```
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(c) Microsoft Corporation. All rights reserved.

C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac Animal.java

C:\Users\HP\OneDrive\Desktop\Charmi>java Animal.java
barking...
eating...

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

Comment on the Single inheritance.

In Java, single inheritance refers to the concept where a class can inherit the properties and behaviors of only one superclass. In other words, a Java class can have at most one direct parent class. This is a key aspect of Java's class inheritance hierarchy. In a single inheritance scenario, a Java class (subclass or derived class) can extend only one other class (superclass or base class). This means that it can inherit the fields and methods of that specific superclass.

Single inheritance is useful when you want to create a simple and straightforward class hierarchy. It allows you to reuse code from an existing class without introducing unnecessary complexity. However, it also has some limitations. For example, if you need to add functionality from multiple classes, you cannot do so directly with single inheritance. Instead, you may need to use interfaces or other techniques to achieve the desired functionality.

In summary, single inheritance is an important concept in Java's class hierarchy that allows you to reuse code from an existing class. While it has some limitations, it is useful for creating simple and straightforward class hierarchies.

Experiment No. 8
Implement a program on multiple inheritance with interface.
Date of Performance:
Date of Submission:

Aim: Implement a program on multiple inheritance with interface.

Objective: Implement multiple inheritance in a program to perform addition, multiplication and transpose operations on a matrix. Create an interface to hold prototypes of these methods and create a class input to read input. Inherit a new class from this interface and class. In main class create object of this child class and invoke required methods.

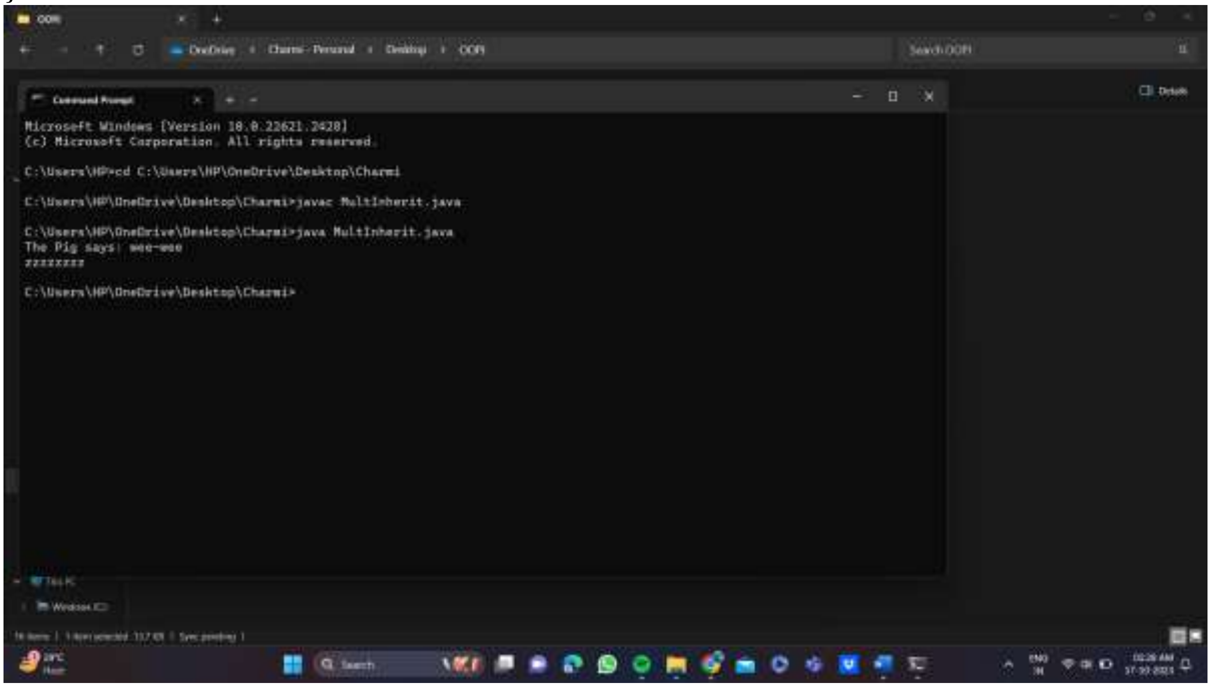
Theory:

- In Multiple inheritance, one class can have more than one superclass and inherit features from all parent classes. Java does not support multiple inheritance with classes. In java, we can achieve multiple inheritance only through Interfaces.
- An interface contains variables and methods like a class but the methods in an interface are abstract by default unlike a class. If a class implements multiple interfaces, or an interface extends multiple interfaces, it is known as multiple inheritance.
- However, Java supports multiple interface inheritance where an interface extends more than one super interfaces.
- A class implements an interface, but one interface extends another interface. Multiple inheritance by interface occurs if a class implements multiple interfaces or also if an interface itself extends multiple interfaces.
- The following is the syntax used to extend multiple interfaces in Java:

```
access_specifier interface subinterfaceName extends superinterface1, superinterface2, …… {
// Body
}
```

Code:

```
class MultInherit{
public static void main(String args[])
{
Pig a=new Pig();
a.animalsound();
a.sleep();
}
}
interface Animal{
public void animalsound();
public void sleep();
}
class Pig implements Animal{
public void animalsound(){
System.out.println("The Pig says: wee-wee");
}
public void sleep(){
System.out.println("zzzzzzzz");
}
}
```



```
Microsoft Windows [Version 10.0.22621.2428]
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac MultInherit.java

C:\Users\HP\OneDrive\Desktop\Charmi>java MultInherit.java
The Pig says: wee-wee
zzzzzzzz

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

Comment on how interface are useful and implemented using java.

Interfaces in Java are a fundamental concept that allows you to define a contract specifying a set of methods that implementing classes must adhere to.

Abstraction: Interfaces allow you to define a contract or a set of methods without specifying the implementation. This promotes abstraction, enabling you to focus on what a class should do rather than how it should do it.

Experiment No. 9
Implement a program on Exception handling.
Date of Performance:
Date of Submission:

Aim: Implement a program on Exception handling.

Objective: To able handle exceptions occurred and handle them using appropriate keyword

Theory:

The Exception Handling in Java is one of the powerful mechanisms to handle the runtime errors so that the normal flow of the application can be maintained.

Exception Handling is a mechanism to handle runtime errors such as ClassNotFoundException, IOException, SQLException, RemoteException, etc.

Java Exception Keywords

Java provides five keywords that are used to handle the exception. The following table describes each.

Keyword	**Description**
try	The "try" keyword is used to specify a block where we should place an exception code. It means we can't use try block alone. The try block must be followed by either catch or finally.
catch	The "catch" block is used to handle the exception. It must be preceded by try block which means we can't use catch block alone. It can be followed by finally block later.
finally	The "finally" block is used to execute the necessary code of the program. It is executed whether an exception is handled or not.
throw	The "throw" keyword is used to throw an exception.
throws	The "throws" keyword is used to declare exceptions. It specifies that there may occur an exception in the method. It doesn't throw an exception. It is always used with method signature.

```
public class JavaExceptionExample{

  public static void main(String args[]){

   try{

      //code that may raise exception

      int data=100/0;
```

```
        }catch(ArithmeticException e){System.out.println(e);}

         //rest code of the program

         System.out.println("rest of the code...");

        }

}
```

Output:

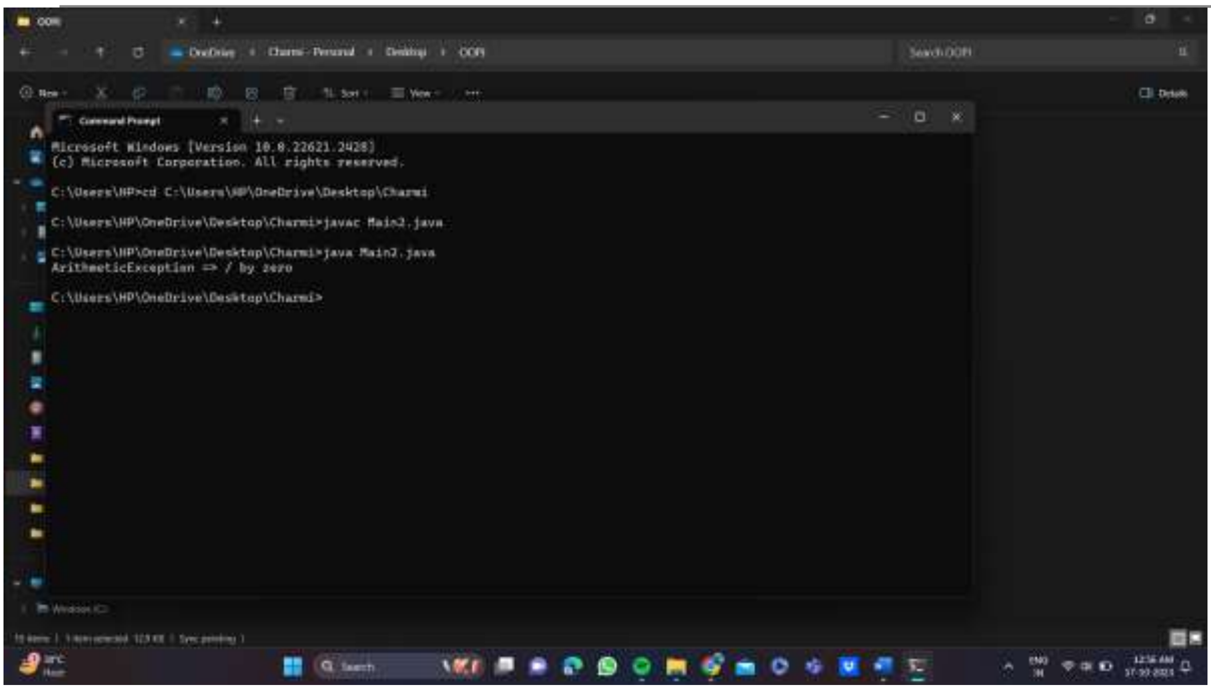
```
Exception in thread main java.lang.ArithmeticException:/ by zero
rest of the code...
```

Code:

1} Try-catch

```
class Main2
{
public static void main(String args[])
{
try{
  int divideByZero = 8/0;
  System.out.println("Rest of code in try block");
    }

    catch (ArithmeticException e) {
      System.out.println("ArithmeticException => " + e.getMessage());
    }
  }
}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac Main2.java

C:\Users\HP\OneDrive\Desktop\Charmi>java Main2.java
ArithmeticException => / by zero

C:\Users\HP\OneDrive\Desktop\Charmi>
```
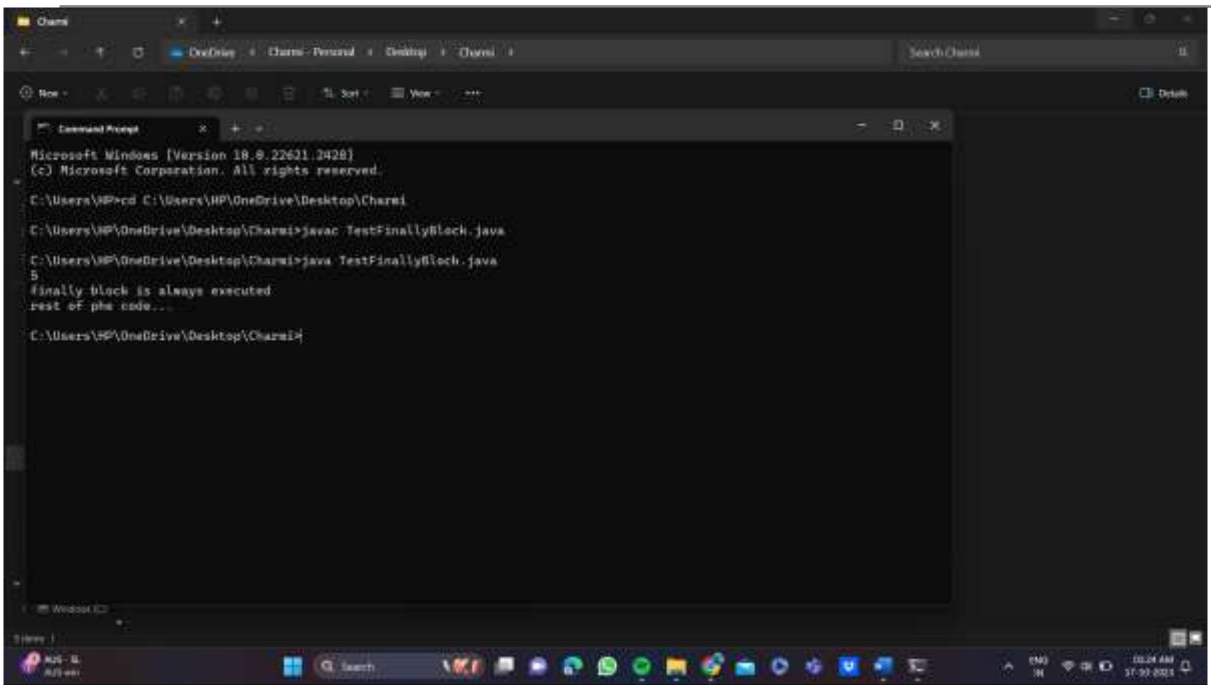

2} finally

```
class TestFinallyBlock {
  public static void main(String args[]){
  try{
   int data=25/5;
   System.out.println(data);
  }
  catch(NullPointerException e){
System.out.println(e);
}
 finally {
System.out.println("finally block is always executed");
}

System.out.println("rest of phe code...");
  }
}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac TestFinallyBlock.java

C:\Users\HP\OneDrive\Desktop\Charmi>java TestFinallyBlock.java
5
finally block is always executed
rest of phe code...

C:\Users\HP\OneDrive\Desktop\Charmi>
```
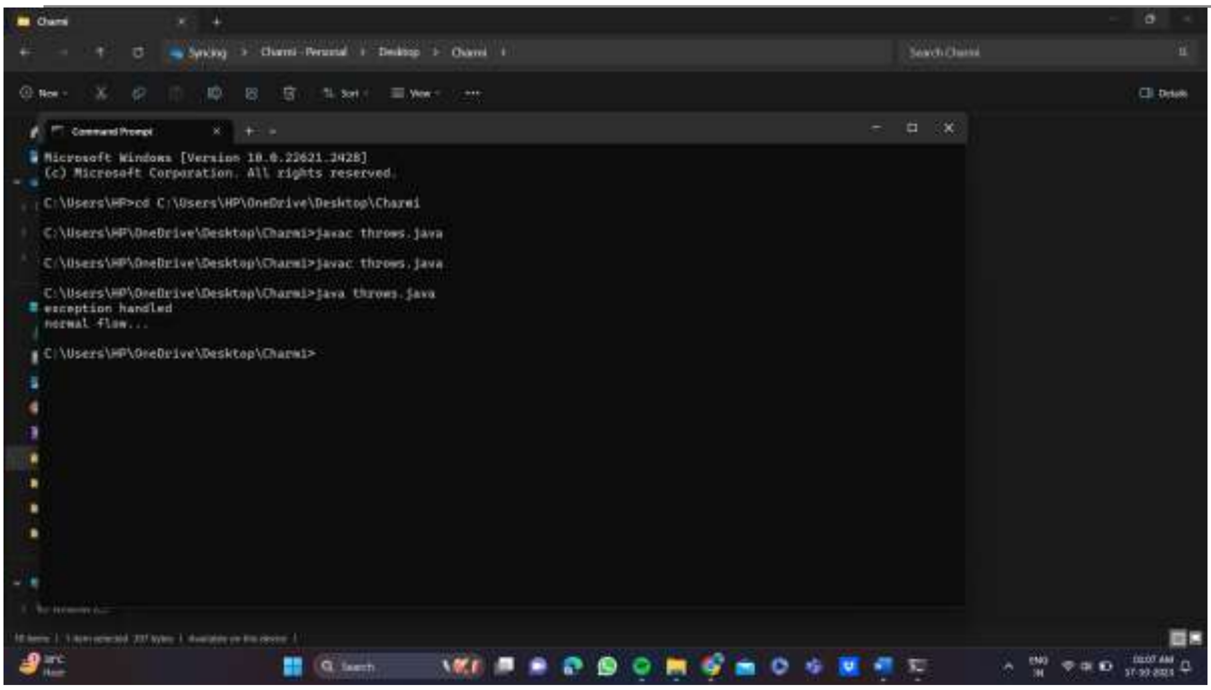

3}throws

```
import java.io.IOException;
 class Testthrows2{
   public static void main(String args[]){
    try{
     M m=new M();
     m.method();
    }catch(Exception e){System.out.println("exception handled");}

    System.out.println("normal flow...");
  }
}
class M {
    void method() throws IOException {
        throw new IOException("device error");
    }
}
```



```
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac throws.java

C:\Users\HP\OneDrive\Desktop\Charmi>javac throws.java

C:\Users\HP\OneDrive\Desktop\Charmi>java throws.java
exception handled
normal flow...

C:\Users\HP\OneDrive\Desktop\Charmi>
```
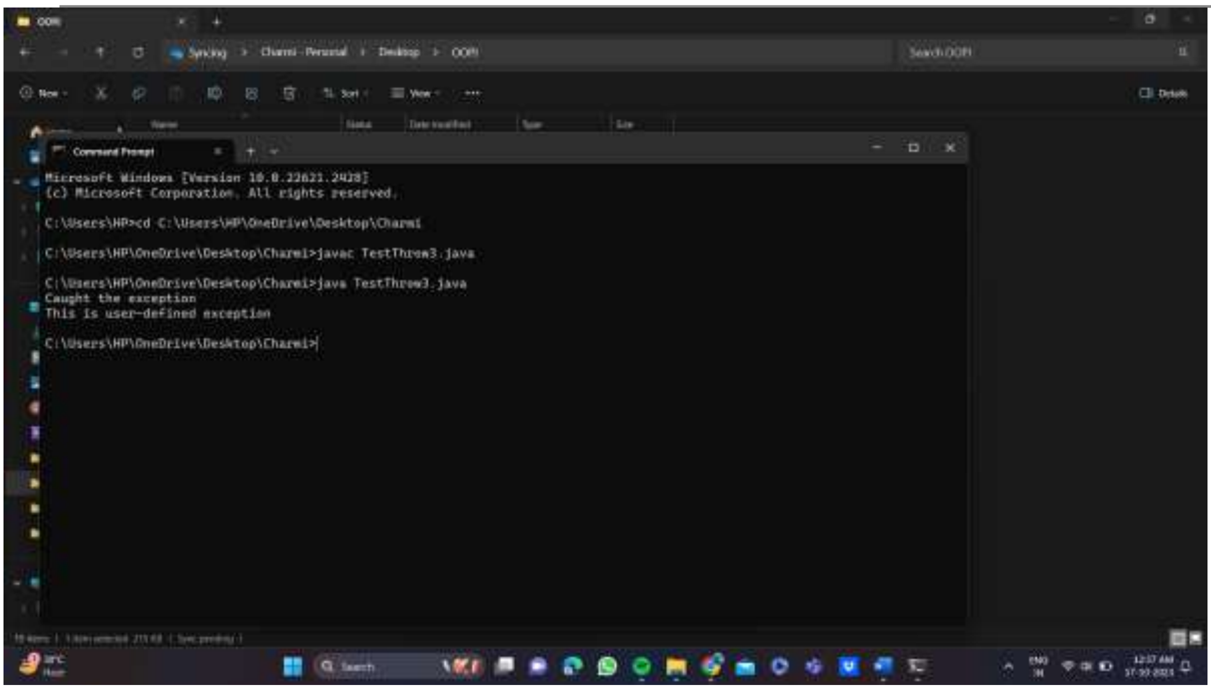

4} throw

```
 class TestThrow3
{
   public static void main(String args[])
   {
      try
      {
         throw new UserDefinedException("This is user-defined exception");
      }
      catch (UserDefinedException ude)
      {
         System.out.println("Caught the exception");
         System.out.println(ude.getMessage());
      }
   }
}
class UserDefinedException extends Exception
{
   public UserDefinedException(String str)
   {
      super(str);
   }
}
```



```
Microsoft Windows [Version 10.0.22621.2428]
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac TestThrow3.java

C:\Users\HP\OneDrive\Desktop\Charmi>java TestThrow3.java
Caught the exception
This is user-defined exception

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

In Java, exceptions are handled using a combination of the try, catch, finally, and throw keywords. The primary mechanism for handling exceptions is the try-catch block. Code that may potentially throw an exception is placed within a try block, and you provide one or more catch blocks to handle specific types of exceptions. You can also use a finally block after the try-catch blocks. Code within the finally block is executed regardless of whether an exception was thrown or not. It's typically used for cleanup actions (e.g., closing resources). You can use the throw keyword to explicitly throw an exception within your code. This is often done when you encounter an exceptional situation that your code can't handle, and you want to pass the control to an exception handler.

Experiment No. 10
Implement program on Multithreading
Date of Performance:
Date of Submission:

Aim: Implement program on Multithreading

Objective:

Theory:

Multithreading in Java is a process of executing multiple threads simultaneously.

A thread is a lightweight sub-process, the smallest unit of processing. Multiprocessing and multithreading, both are used to achieve multitasking.

However, we use multithreading than multiprocessing because threads use a shared memory area. They don't allocate separate memory area so saves memory, and context-switching between the threads takes less time than process.

Java Multithreading is mostly used in games, animation, etc.

Java provides **Thread class** to achieve thread programming. Thread class provides constructors and methods to create and perform operations on a thread. Thread class extends Object class and implements Runnable interface.

There are two ways to create a thread:

1. By extending Thread class
2. By implementing Runnable interface.

Thread class:
Thread class provide constructors and methods to create and perform operations on a thread.Thread class extends Object class and implements Runnable interface.

1) Java Thread Example by extending Thread class
FileName: Multi.java

```
class Multi extends Thread{
public void run(){
System.out.println("thread is running...");
}
public static void main(String args[]){
Multi t1=new Multi();
t1.start();
 }
}
```

Output:

```
thread is running...
```

2) Java Thread Example by implementing Runnable interface
FileName: Multi3.java

```
class Multi3 implements Runnable{
public void run(){
System.out.println("thread is running...");
}

public static void main(String args[]){
Multi3 m1=new Multi3();
Thread t1 =new Thread(m1);   // Using the constructor Thread(Runnable r)
t1.start();
 }
}
```

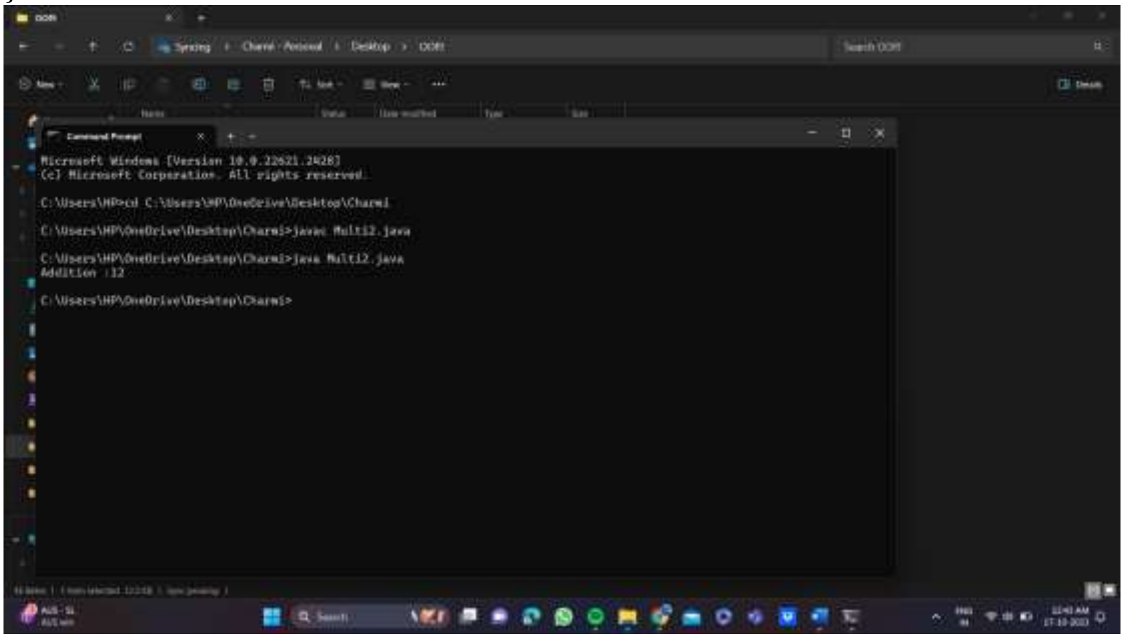
Output:

```
thread is running...
```

Code:

```
class Multi2 implements Runnable{
public void run()
{
    int a=5;
    int b=7;
    int c=a+b;
    System.out.println("Addition :"+c);
}

public static void main(String args[]){
Multi2 m1=new Multi2();
Thread t1=new Thread(m1);
t1.start();
}
}
```



```
Microsoft Windows [Version 10.0.22621.2428]
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C:\Users\HP>cd C:\Users\HP\OneDrive\Desktop\Charmi

C:\Users\HP\OneDrive\Desktop\Charmi>javac Multi2.java

C:\Users\HP\OneDrive\Desktop\Charmi>java Multi2.java
Addition :12

C:\Users\HP\OneDrive\Desktop\Charmi>
```

Conclusion:

Multithreading in Java is supported through the `Thread` class and the `Runnable` interface. You can create and manage threads by extending the `Thread` class or implementing the `Runnable` interface. Java provides thread synchronization, management, and various thread states to enable concurrent execution of tasks. It's a fundamental feature for efficient resource utilization, improved application responsiveness, and better performance in multi-tasking environments.

In Java, you can create a new thread by extending the `Thread` class and overriding its `run()` method. Alternatively, you can implement the `Runnable` interface and pass an instance of the implementing class to a new `Thread` object. The `Thread` class provides several methods for managing threads, such as starting, stopping, pausing, and resuming threads.

Java also provides thread synchronization mechanisms such as locks and semaphores to ensure that multiple threads can access shared resources safely. This is important to avoid race conditions and other concurrency issues.

In summary, multithreading is a fundamental feature of Java that enables concurrent execution of tasks. It's supported through the `Thread` class and the `Runnable` interface, and Java provides several mechanisms for managing threads and ensuring thread safety.

Experiment No. 11
Implement a program on Applet or AWT Controls
Date of Performance:
Date of Submission:

Aim: Implement a program on Applet or AWT Controls

Objective:

To develop application like Calculator, Games, Animation using AWT Controls.

Theory:

Java AWT (Abstract Window Toolkit) is an API to develop Graphical User Interface (GUI) or windows-based applications in Java.

Java AWT components are platform-dependent i.e. components are displayed according to the view of operating system. AWT is heavy weight i.e. its components are using the resources of underlying operating system (OS).

The java.awt package provides classes for AWT API such as TextField, Label, TextArea, RadioButton, CheckBox, Choice, List etc.

1. A general interface between Java and the native system, used for windowing, events and layout managers. This API is at the core of Java GUI programming and is also used by Swing and Java 2D. It contains the interface between the native windowing system and the Java application1.
2. A basic set of GUI widgets such as buttons, text boxes, and menus1. AWT also provides Graphics and imaging tools, such as shape, color, and font classes2. AWT also avails layout managers which helps

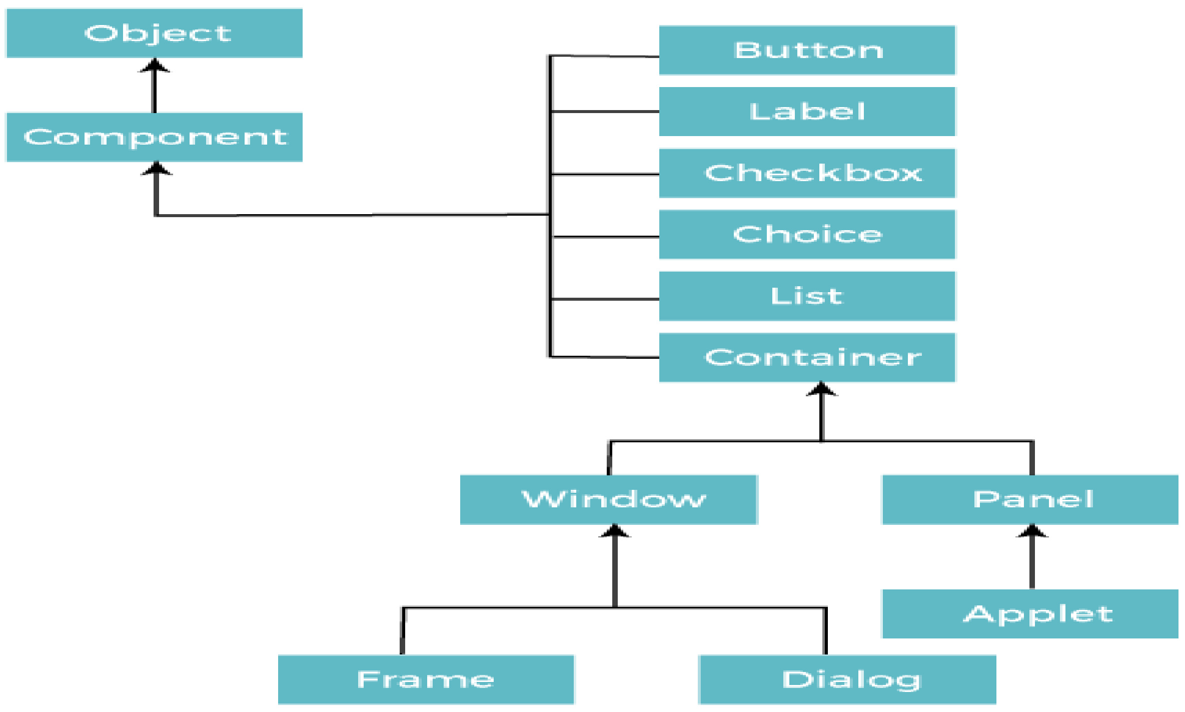
in increasing the flexibility of the window layouts2

Java AWT calls the native platform calls the native platform (operating systems) subroutine for creating API components like TextField, ChechBox, button, etc.

For example, an AWT GUI with components like TextField, label and button will have different look and feel for the different platforms like Windows, MAC OS, and Unix. The reason for this is the platforms have different view for their native components and AWT directly calls the native subroutine that creates those components.

In simple words, an AWT application will look like a windows application in Windows OS whereas it will look like a Mac application in the MAC OS.

Java AWT Hierarchy

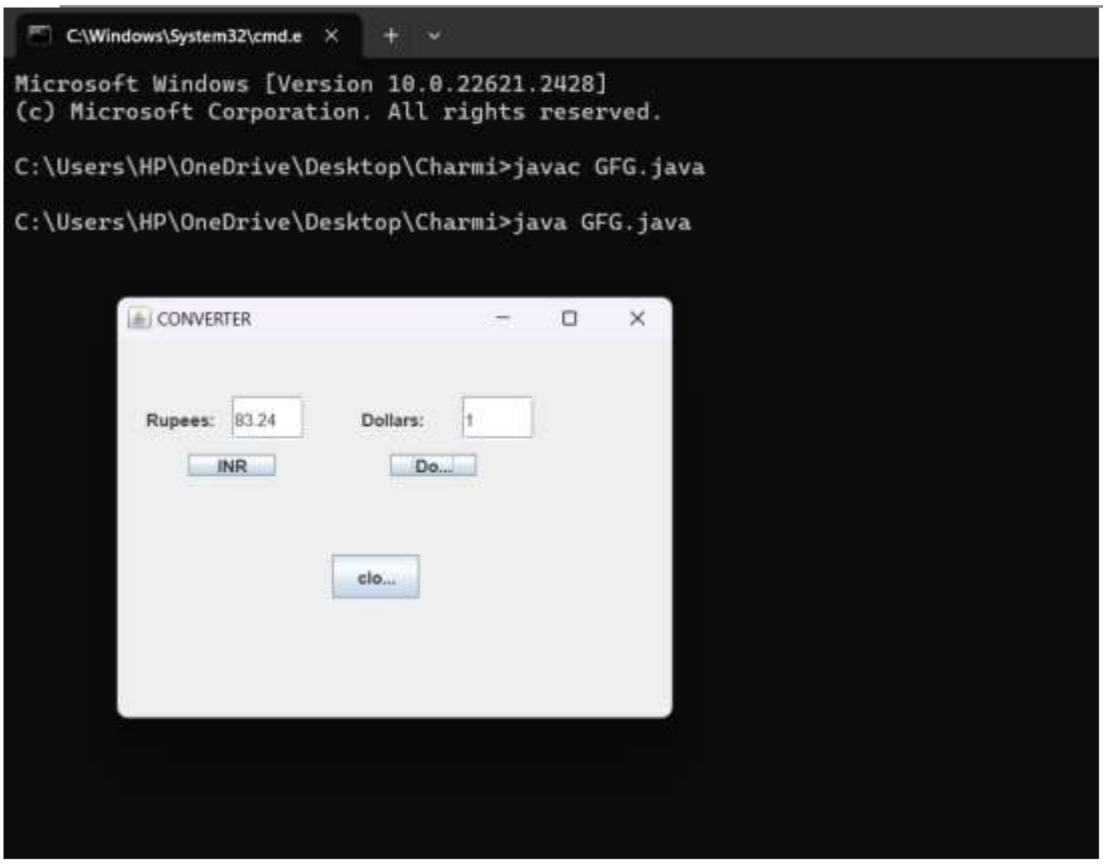


Code:

```
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;
public class GFG {
        public static void converter()
        {
                JFrame f = new JFrame("CONVERTER");
                JLabel l1, l2;
                JTextField t1, t2;
                JButton b1, b2, b3;
                l1 = new JLabel("Rupees:");
                l1.setBounds(20, 40, 60, 30);
                l2 = new JLabel("Dollars:");
                l2.setBounds(170, 40, 60, 30);
                t1 = new JTextField("0");
                t1.setBounds(80, 40, 50, 30);
                t2 = new JTextField("0");
                t2.setBounds(240, 40, 50, 30);
                b1 = new JButton("INR");
                b1.setBounds(50, 80, 60, 15);
                b2 = new JButton("Dollar");
                b2.setBounds(190, 80, 60, 15);
                b3 = new JButton("close");
                b3.setBounds(150, 150, 60, 30);


                b1.addActionListener(new ActionListener() {
                        public void actionPerformed(ActionEvent e)
                        {
                                double d
                                        = Double.parseDouble(t1.getText());
                                double d1 = (d / 83.24);
                                String str1 = String.valueOf(d1);
                                t2.setText(str1);
                        }
                });
                b2.addActionListener(new ActionListener() {
                        public void actionPerformed(ActionEvent e)
                        {
                                double d2
                                        = Double.parseDouble(t2.getText());
                                double d3 = (d2 * 83.24);
                                String str2 = String.valueOf(d3);
                                t1.setText(str2);
                        }
                });
                b3.addActionListener(new ActionListener() {
                        public void actionPerformed(ActionEvent e)
                        {
                                f.dispose();
                        }
                });
                f.addWindowListener(new WindowAdapter() {
                        public void windowClosing(WindowEvent e)
                        {
                                System.exit(0);
                        }
                });
                f.add(l1);
                f.add(t1);
                f.add(l2);
                f.add(t2);
                f.add(b1);
                f.add(b2);
                f.add(b3);

                f.setLayout(null);
                f.setSize(400, 300);
                f.setVisible(true);
        }
        public static void main(String args[])
        {
                converter();
        } }
```



```
Microsoft Windows [Version 10.0.22621.2428]
(c) Microsoft Corporation. All rights reserved.

C:\Users\HP\OneDrive\Desktop\Charmi>javac GFG.java

C:\Users\HP\OneDrive\Desktop\Charmi>java GFG.java
```

Conclusion:

In Java, AWT (Abstract Window Toolkit) controls are used to create graphical user interfaces (GUIs) for desktop applications. AWT provides a set of basic GUI components, such as buttons, labels, text fields, and more. AWT also provides layout managers to arrange and position controls within your GUI. You can customize the appearance and behavior of AWT controls. AWT is platform-independent but may not provide the most modern look and feel. AWT allows you to create top-level containers (e.g., `Frame`) as the main windows for your application.

Experiment No. 12
Course Project based on the content of the syllabus.
Date of Performance:
Date of Submission: