LAB RECORD

23CSE111- Object Oriented Programming

Submitted by

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IN

COMPUTER SCIENCE AND ENGINEERING

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BONAFIDE CERTIFICATE

This is to certify that the Lab Record work for 23CSE111-Object Oriented Programming Subject submitted by ***CH.SC.U4CSE24102 Agneay B Nair*** in **"Computer Science and Engineering"** is a Bonafide record of the work carried out under my guidance and supervision at Amrita School of Computing, Chennai.

This Lab examination held on / /2025

Internal Examiner 1 Internal Examiner 2

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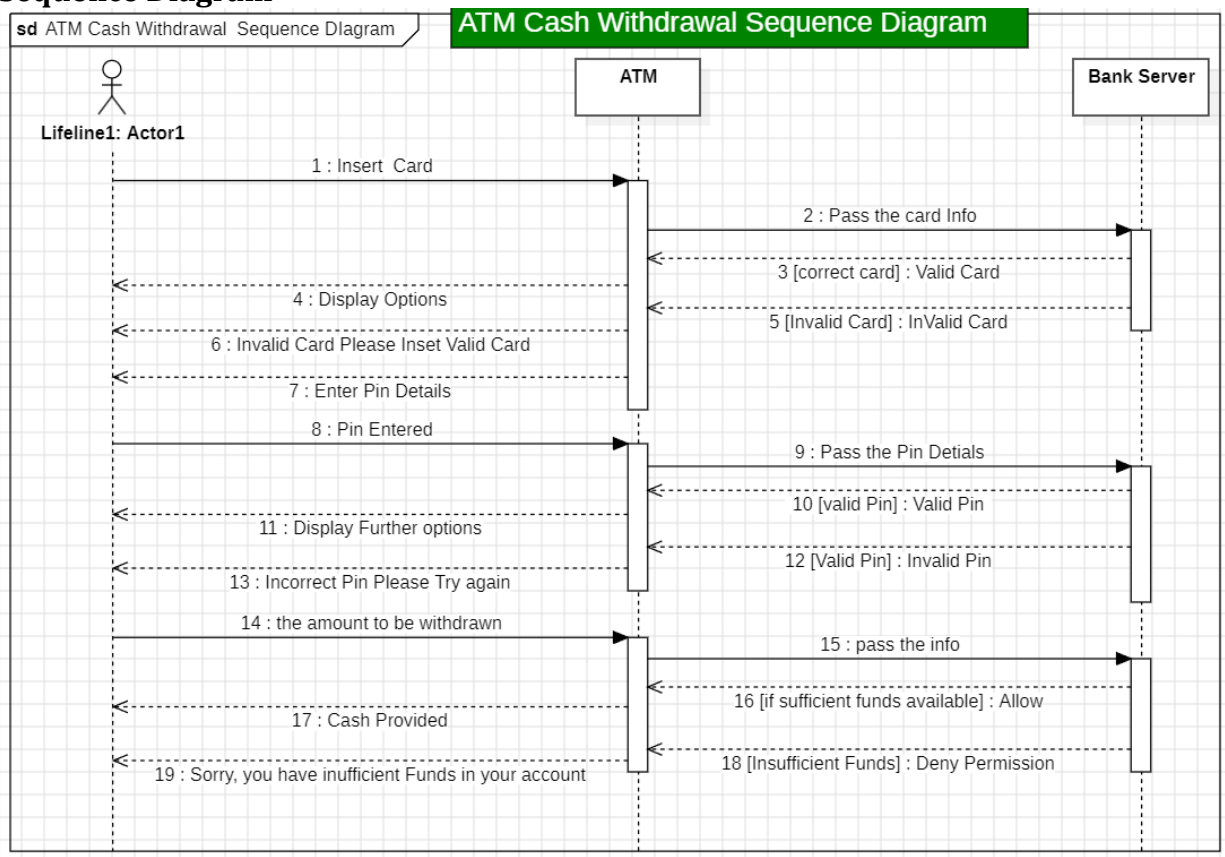
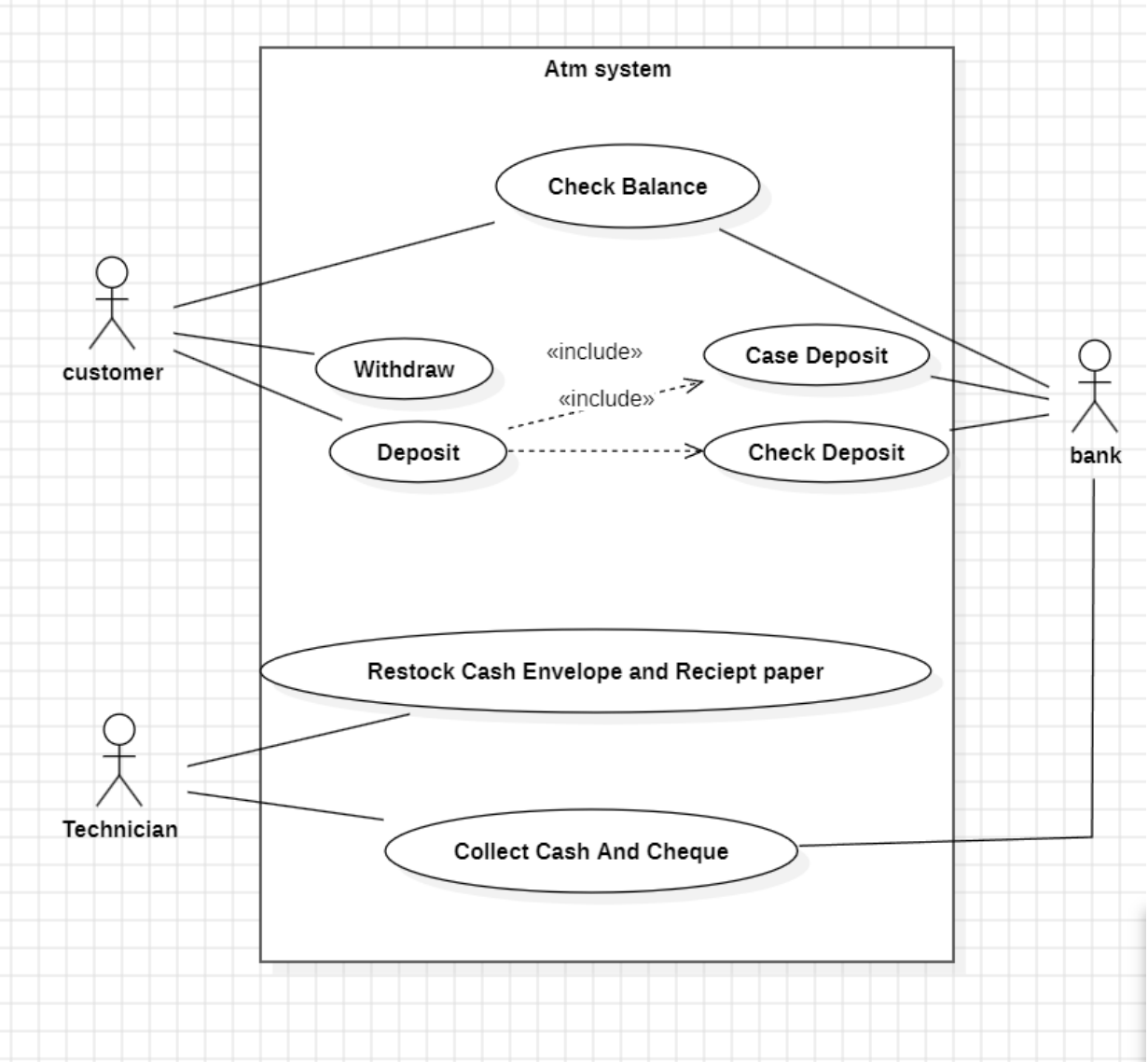
UML Diagrams

1. ATM

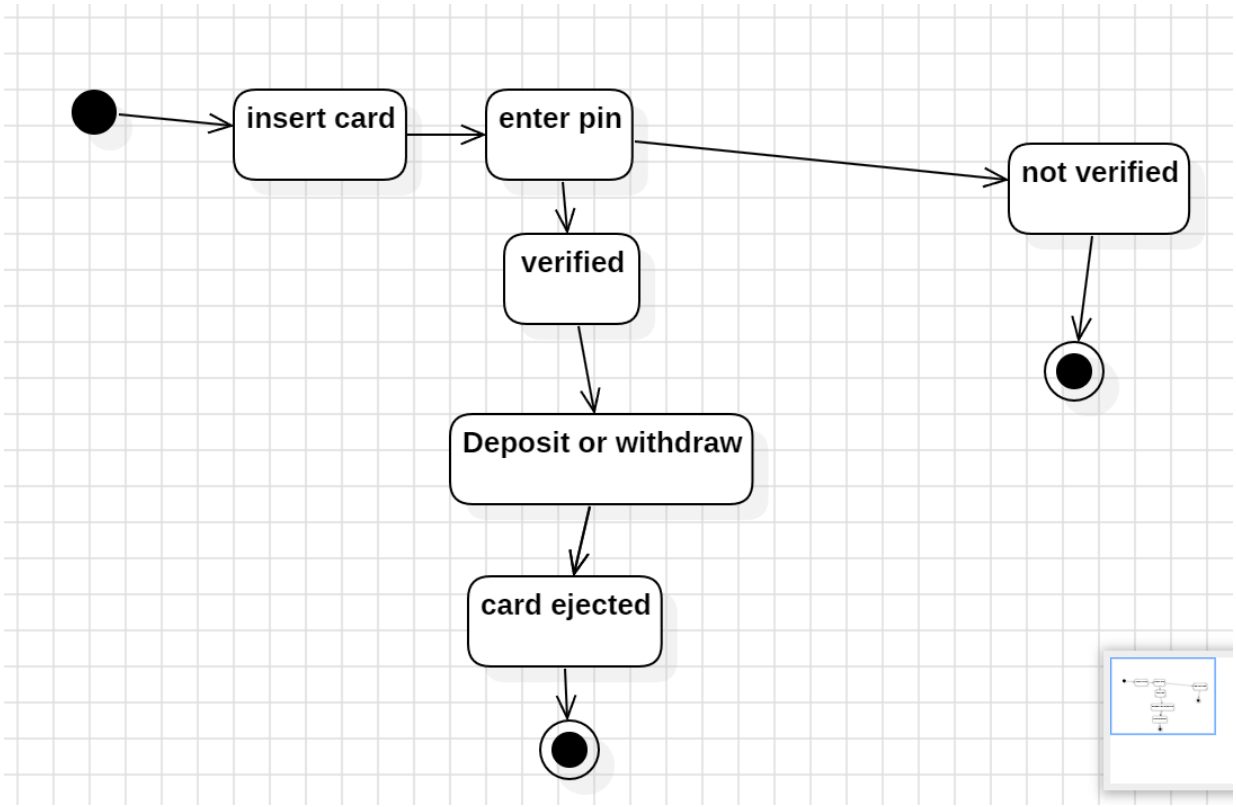
Sequence Diagram



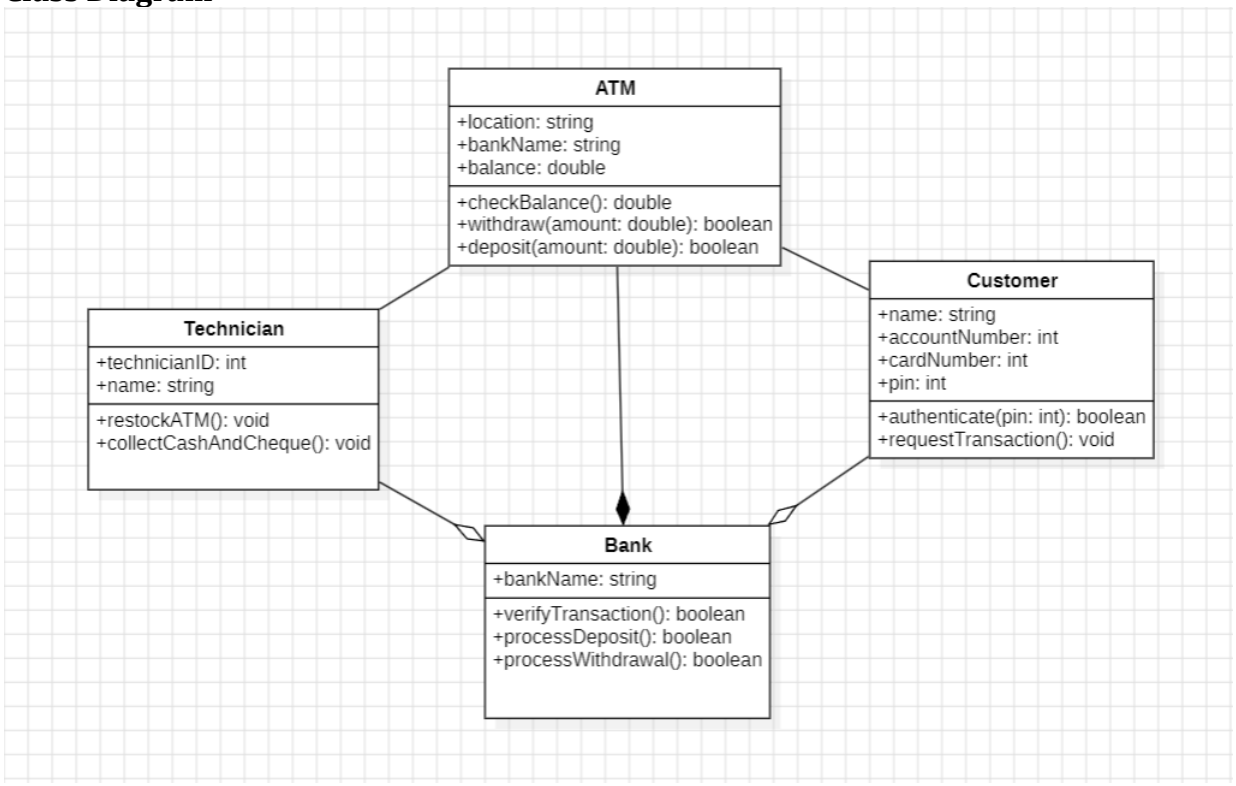
Use Case Diagram



State Chart Diagram

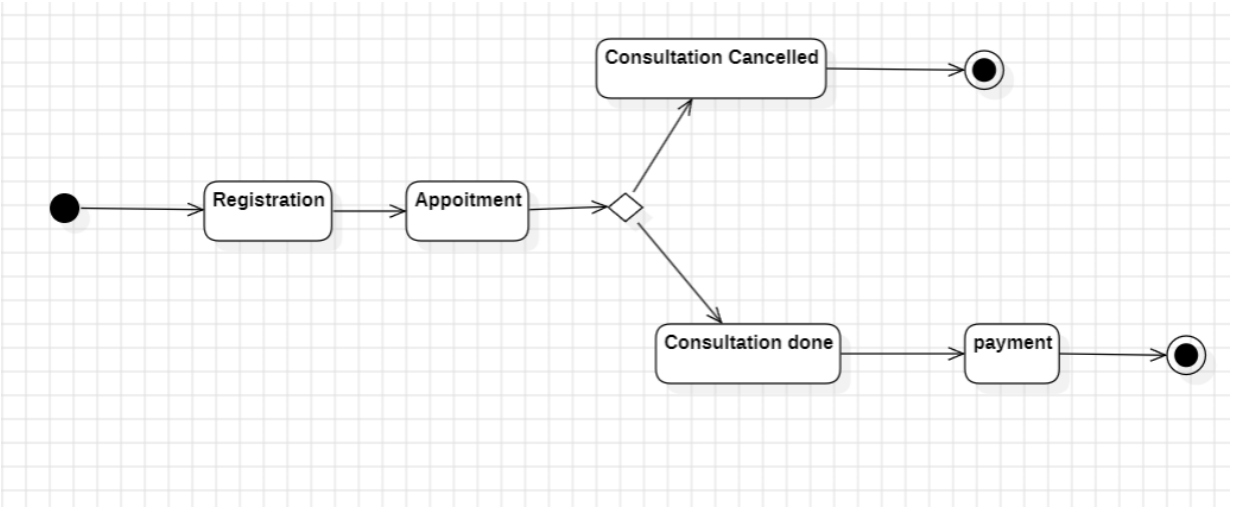


Class Diagram

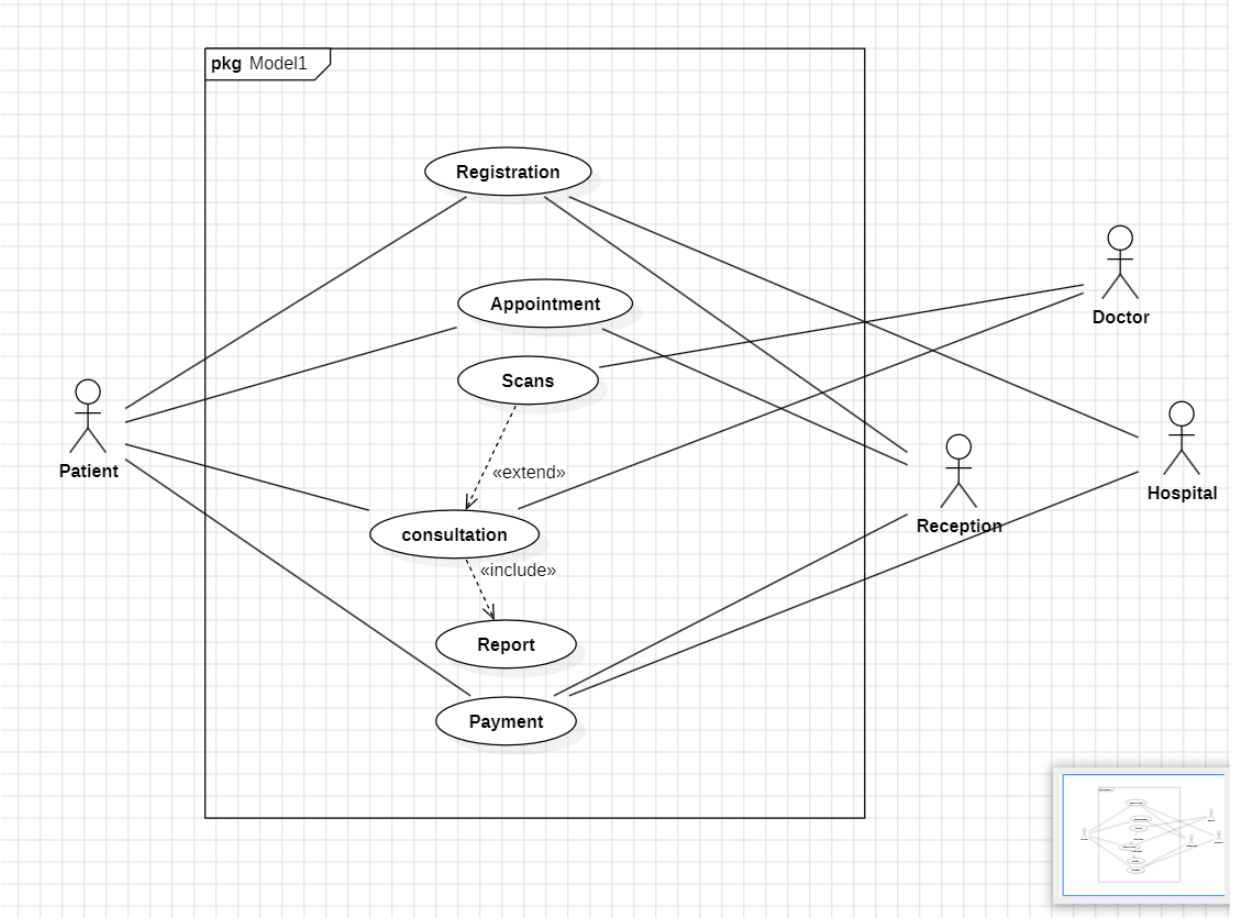


Hospital

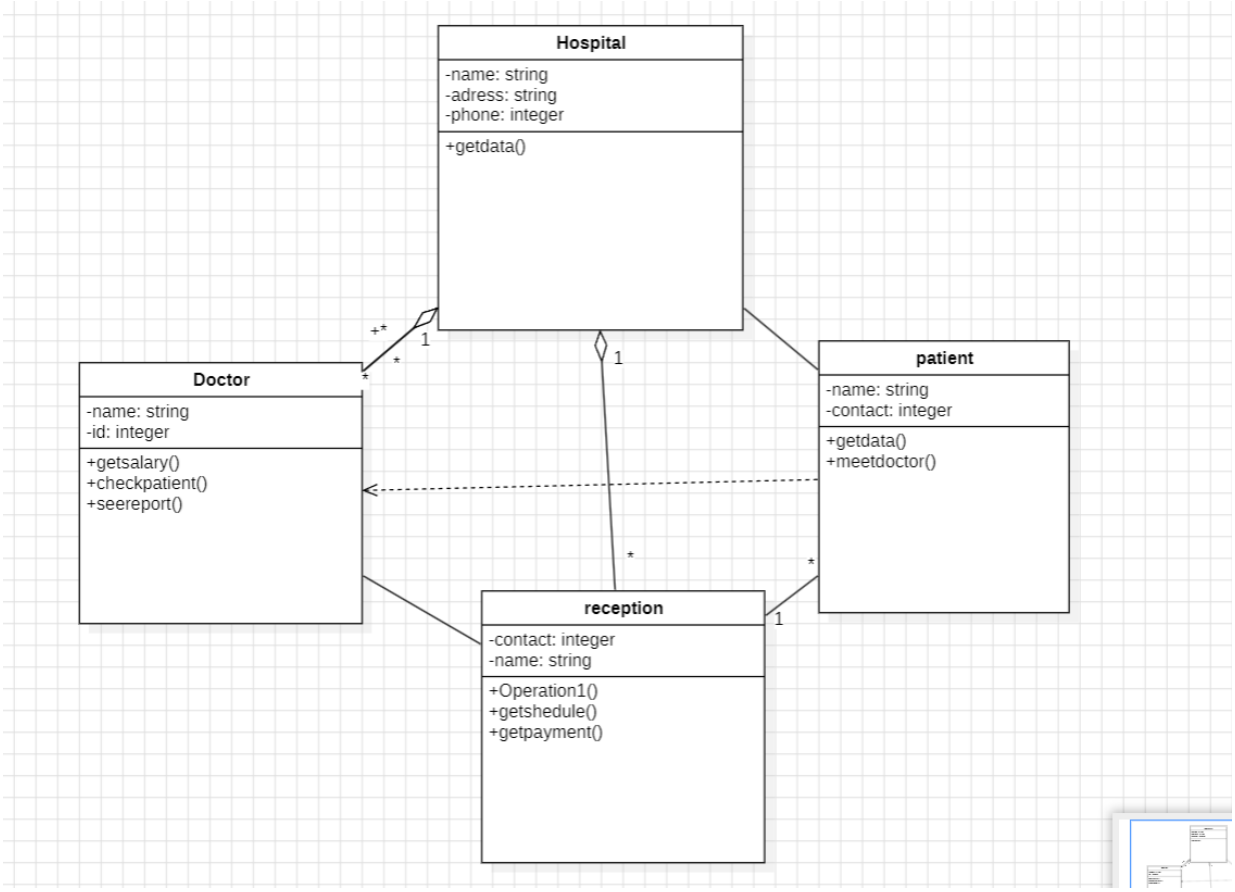
1. StateChart



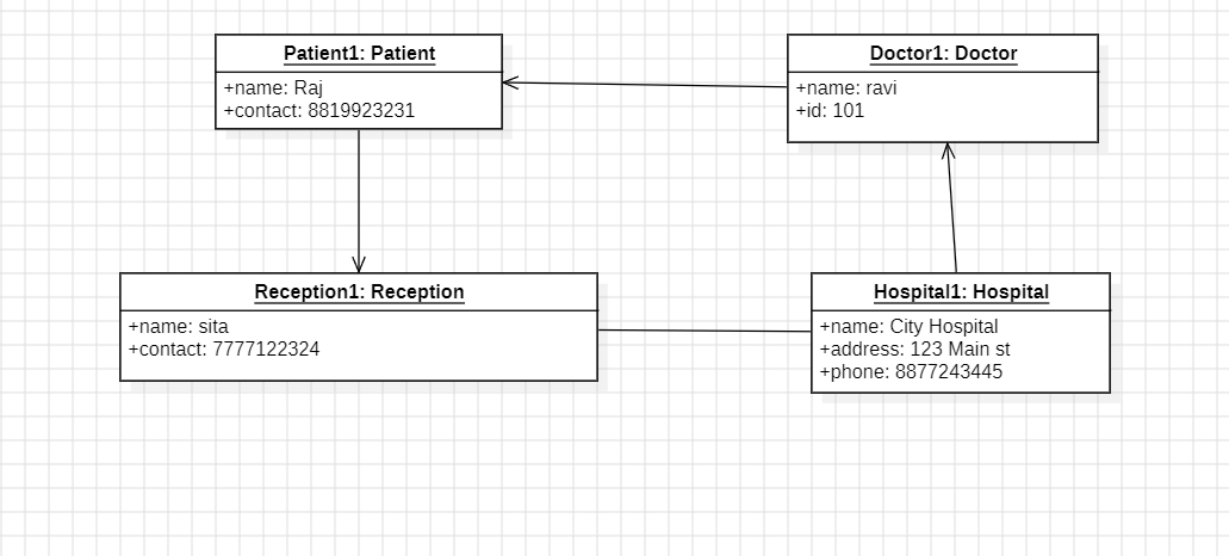
2. UseCase



3. Class Diagram



4. Object Diagram



J ava Codes

List of Programs

1. **Calculator.java**
2. **EvenOdd.java**
3. **Fibonacci.java**
4. **LargestOfThreeNums.java**
5. **ReverseString.java**
6. **PrimeCheck.java**
7. **PalindromeCheck.java**
8. **SimpleInterestCalculator.java**
9. **SumOfDigits.java**
10. **TemperatureConverter.java**

Calculator.java

```
import java.util.Scanner;

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

        System.out.print("Enter two numbers: ");
        double num1 = sc.nextDouble(), num2 = sc.nextDouble();

        System.out.print("Choose an operation (+, -, *, /): ");
        char op = sc.next().charAt(0);

        switch (op) {
            case '+':
                System.out.println("Result: " + (num1 + num2));
                break;
            case '-':
                System.out.println("Result: " + (num1 - num2));
                break;
            case '*':
                System.out.println("Result: " + (num1 * num2));
                break;
            case '/':
                if (num2 != 0)
                    System.out.println("Result: " + (num1 / num2));
                else
                    System.out.println("Division by zero is not
allowed.");
                break;
            default:
                System.out.println("Invalid operation.");
        }
```

```
        sc.close();
    }
}
```

Output:

```
Enter two numbers: 10 5

Choose an operation (+, -, *, /): +

Result: 15.0
```

EvenOdd.java

```
import java.util.Scanner;

public class EvenOdd {
    public static void main(String[] args) {
        System.out.println("Input Enter the number:");
        Scanner myScannerObj = new Scanner(System.in);
        int num = myScannerObj.nextInt();
        if (num % 2 == 0) {
            System.out.println("Even");
        } else {
            System.out.println("Odd");
        }
        myScannerObj.close();
    }
}
```

Output:

```
Input Enter the number:

10

Even
```

Fibonacci.java

```
import java.util.Scanner;

public class Fibonacci {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter the number of terms: ");
        int n = sc.nextInt();

        int a = 0, b = 1, count = 0;
        System.out.print("Fibonacci Series: ");
        while (count < n) {
            System.out.print(a + " ");
            int temp = a + b;
            a = b;
```

```
            b = temp;
            count++;
        }
        sc.close();
    }
}
```

Output:

```
Enter the number of terms: 5

Fibonacci Series: 0 1 1 2 3
```

LargestOfThreeNums

```
import java.util.Scanner;

public class LargestOfThreeNums {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter three numbers: ");
        int a = sc.nextInt(), b = sc.nextInt(), c = sc.nextInt();

        if (a > b && a > c) {
            System.out.println(a + " is the largest.");
        } else if (b > c) {
            System.out.println(b + " is the largest.");
        } else {
            System.out.println(c + " is the largest.");
        }
        sc.close();
    }
}
```

Output:

```
Enter three numbers: 10 20 15

20 is the largest.
```

ReverseString.java

```
// Description: A program that reverses a string.
import java.util.Scanner;

public class ReverseString {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter a string: ");
        String str = sc.nextLine();

        String reversed = "";
```

```
        for (int i = str.length() - 1; i >= 0; i--) {
            reversed += str.charAt(i);
        }

        System.out.println("Reversed string: " + reversed);
        sc.close();
    }
}
```

Output:

Enter a string: Hello

Reversed string: olleH

PrimeCheck.java

```
import java.util.Scanner;

public class PrimeCheck {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter a number: ");
        int n = sc.nextInt();

        boolean isPrime = true;
        if (n <= 1)
            isPrime = false;

        for (int i = 2; i <= Math.sqrt(n); i++) {
            if (n % i == 0) {
                isPrime = false;
                break;
            }
        }

        System.out.println(n + " is " + (isPrime ? "Prime" : "Not
Prime"));
        sc.close();
    }

}
```

Output:

Enter a number: 7

7 is prime

PalindromeCheck.java

```
import java.util.Scanner;
```

```java
public class PalindromeCheck {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter a number: ");
        int num = sc.nextInt();

        int original = num, reversed = 0;
        while (num != 0) {
            int digit = num % 10;
            reversed = reversed * 10 + digit;
            num /= 10;
        }

        System.out.println(original + (original == reversed ? " is "
: " is not ") + "a palindrome.");
        sc.close();
    }
}
```

Output:

```
Enter a number: 121

11 is a pallindrome
```

SimpleInterestCalculator.java

```java
import java.util.Scanner;

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

        // Input
        System.out.print("Enter Principal amount: ");
        double principal = sc.nextDouble();

        System.out.print("Enter Rate of Interest (%): ");
        double rate = sc.nextDouble();

        System.out.print("Enter Time (in years): ");
        double time = sc.nextDouble();

        // Calculation
        double simpleInterest = (principal * rate * time) / 100;

        // Output
        System.out.println("Simple Interest: " + simpleInterest);
        System.out.println("Total Amount: " + (principal +
simpleInterest));
        sc.close();
```

```
    }
}
```

Output:

```
Enter Principal amount: 1000

Enter Rate of Interest (%): 5

Enter Time (in years): 2

Simple Interest: 100.0

Total Amount: 1100.0
```

SumOfDigits.java

```
import java.util.Scanner;

public class SumOfDigits {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter a number: ");
        int num = sc.nextInt();

        int sum = 0;
        while (num != 0) {
            sum += num % 10;
            num /= 10;
        }

        System.out.println("Sum of digits: " + sum);
        sc.close();
    }
}
```

Output:

```
Enter a number: 1234

Sum of digits: 10
```

TemperatureConverter.java

```
import java.util.Scanner;

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

        // Display menu
        System.out.println("Choose conversion type:");
        System.out.println("1. Celsius to Fahrenheit");
        System.out.println("2. Fahrenheit to Celsius");
```

```
        // Choice input
        System.out.print("Enter your choice (1 or 2): ");
        int choice = sc.nextInt();

        if (choice == 1) {
            // Celsius to Fahrenheit
            System.out.print("Enter temperature in Celsius: ");
            double celsius = sc.nextDouble();
            double fahrenheit = (9.0 / 5.0) * celsius + 32;
            System.out.println("Temperature in Fahrenheit: " +
fahrenheit);
        } else if (choice == 2) {
            // Fahrenheit to Celsius
            System.out.print("Enter temperature in Fahrenheit: ");
            double fahrenheit = sc.nextDouble();
            double celsius = (5.0 / 9.0) * (fahrenheit - 32);
            System.out.println("Temperature in Celsius: " + celsius);
        } else {
            System.out.println("Invalid choice. Please enter 1 or
2.");
        }
        sc.close();
    }
}
```

Output:

Choose conversion type:
1. Celsius to Fahrenheit
2. Fahrenheit to Celsius
Enter your choice (1 or 2): 1
Enter temperature in Celsius: 25
Temperature in Fahrenheit: 77.0

Inheritance

a. **Single Inheritance Program**

First program

```
// Superclass (Parent class)
class Animal {
    // Property of the superclass
    String name;

    // Constructor
    public Animal(String name) {
        this.name = name;
    }

    // Method of the superclass
    public void makeSound() {
        System.out.println("The
animal makes a sound.");
    }
}

// Subclass (Child class) inherits
from Animal
class Dog extends Animal {
    // Constructor of subclass
    public Dog(String name) {
        super(name); // Calling the
superclass constructor
```

```
    }

    // Overriding the makeSound
method
    @Override
    public void makeSound() {
        System.out.println("The dog
barks.");
    }
}

// Main class to run the code
public class Main {
    public static void main(String[]
args) {
        Animal myAnimal = new
Animal("Generic Animal");
        myAnimal.makeSound();

        Dog myDog = new Dog("Buddy");
        myDog.makeSound(); // This
will use the overridden method
    }
}
```

Output:

```
The animal makes a sound.
The dog barks.
```

Second

```
// Superclass (Parent class)
class Vehicle {
    // Property of superclass
    String brand;

    // Constructor of superclass
    public Vehicle(String brand) {
        this.brand = brand;
    }

    // Method of superclass
    public void start() {
        System.out.println(brand + "
is starting.");
    }
}

// Subclass (Child class) inherits
from Vehicle
class Car extends Vehicle {
    // Property specific to Car
```

```
    int doors;

    // Constructor of subclass
    public Car(String brand, int
doors) {
        super(brand); // Calling the
superclass constructor
        this.doors = doors;
    }

    // Overriding the start method
    @Override
    public void start() {
        System.out.println(brand + "
car with " + doors + " doors is
starting.");
    }
}

// Main class to run the code
public class Main {
    public static void main(String[]
args) {
        Vehicle myVehicle = new
Vehicle("Toyota");
        myVehicle.start();
```

```
        Car myCar = new Car("Honda",
4);
        myCar.start(); // This will
use the overridden method
    }
}
```

Output:

```
Toyota is starting.
Honda car with 4 doors is starting.
```

b. MultiLevel Inheritance

First

```
// Base class - Person
class Person {
    String name;
    int age;

    // Constructor
    public Person(String name, int
age) {
        this.name = name;
        this.age = age;
    }
```

```
    // Method to display person
details
    public void
displayPersonDetails() {
        System.out.println("Name: " +
name);
        System.out.println("Age: " +
age);
    }
}

// Derived class 1 - Student
(inherits from Person)
class Student extends Person {
    String course;

    // Constructor
    public Student(String name, int
age, String course) {
        super(name, age);  // Call
the constructor of Person
        this.course = course;
    }

    // Method to display student
details
```

```
    public void
displayStudentDetails() {
        displayPersonDetails();  //
Call method from Person class
        System.out.println("Course: "
+ course);
    }
}

// Derived class 2 - GraduateStudent
(inherits from Student)
class GraduateStudent extends Student
{
    String thesisTitle;

    // Constructor
    public GraduateStudent(String
name, int age, String course, String
thesisTitle) {
        super(name, age, course);  //
Call the constructor of Student
        this.thesisTitle =
thesisTitle;
    }
```

```
    // Method to display graduate
student details
    public void
displayGraduateStudentDetails() {
        displayStudentDetails();  //
Call method from Student class
        System.out.println("Thesis
Title: " + thesisTitle);
    }
}

// Main class to run the program
public class Main {
    public static void main(String[]
args) {
        // Create an object of
GraduateStudent (three-level
inheritance)
        GraduateStudent gradStudent =
new GraduateStudent("Alice", 25,
"Computer Science", "AI in
Healthcare");

        // Call method to display
details from all classes
```

```
        gradStudent.displayGraduateStudentDetails();  // Displays all details
    }
}
```

Output:

```
Name: Alice
Age: 25
Course: Computer Science
Thesis Title: AI in Healthcare
```

Second

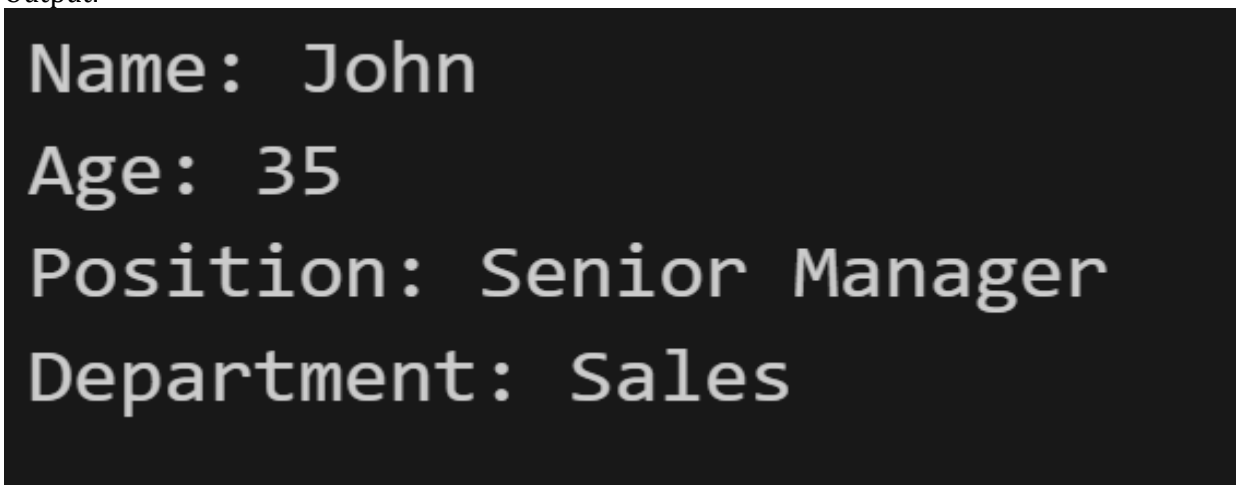
```
// Base class - Person
class Person {
    String name;
    int age;

    // Constructor
    public Person(String name, int age) {
        this.name = name;
        this.age = age;
    }
```

```
    // Method to display person
details
    public void
displayPersonDetails() {
        System.out.println("Name: " +
name);
        System.out.println("Age: " +
age);
    }
}

// Derived class 1 - Employee
(inherits from Person)
class Employee extends Person {
    String position;

    // Constructor
    public Employee(String name, int
age, String position) {
        super(name, age);  // Call
the constructor of Person
        this.position = position;
    }

    // Method to display employee
details
```

```
    public void
displayEmployeeDetails() {
        displayPersonDetails();  //
Call method from Person class
        System.out.println("Position:
" + position);
    }
}

// Derived class 2 - Manager
(inherits from Employee)
class Manager extends Employee {
    String department;

    // Constructor
    public Manager(String name, int
age, String position, String
department) {
        super(name, age,
position);  // Call the constructor
of Employee
        this.department = department;
    }

    // Method to display manager
details
```

```
    public void
displayManagerDetails() {
        displayEmployeeDetails();  //
Call method from Employee class
        System.out.println("Departmen
t: " + department);
    }
}

// Main class to run the program
public class Main {
    public static void main(String[]
args) {
        // Create an object of
Manager (three-level inheritance)
        Manager manager = new
Manager("John", 35, "Senior Manager",
"Sales");

        // Call method to display
details from all classes
        manager.displayManagerDetails
();  // Displays all details
    }
}
```

Output:



c. **Hierarchical Inheritance**

First

```
// Base class - Animal
class Animal {
    String name;
    int age;

    // Constructor
    public Animal(String name, int
age) {
        this.name = name;
        this.age = age;
    }

    // Method to display animal
details
    public void displayDetails() {
        System.out.println("Name: " +
name);
        System.out.println("Age: " +
age);
    }
}

// Derived class 1 - Dog (inherits
from Animal)
class Dog extends Animal {
```

```
    String breed;

    // Constructor
    public Dog(String name, int age,
String breed) {
        super(name, age);  // Call
the constructor of Animal
        this.breed = breed;
    }

    // Method to display dog details
    public void displayDogDetails() {
        displayDetails();  // Call
method from Animal class
        System.out.println("Breed: "
+ breed);
    }
}

// Derived class 2 - Cat (inherits
from Animal)
class Cat extends Animal {
    String color;

    // Constructor
```

```
    public Cat(String name, int age,
String color) {
        super(name, age);  // Call
the constructor of Animal
        this.color = color;
    }

    // Method to display cat details
    public void displayCatDetails() {
        displayDetails();  // Call
method from Animal class
        System.out.println("Color: "
+ color);
    }
}

// Main class to run the program
public class Main {
    public static void main(String[]
args) {
        // Create an object of Dog
        Dog dog = new Dog("Buddy", 3,
"Golden Retriever");
        // Create an object of Cat
        Cat cat = new Cat("Whiskers",
2, "Black");
```

```
        // Call methods to display
details
        System.out.println("Dog
Details:");
        dog.displayDogDetails();  //
Displays dog details

        System.out.println("\nCat
Details:");
        cat.displayCatDetails();  //
Displays cat details
    }
}
```

Output:

```
Cat Details:
Name: Whiskers
Age: 2
Color: Black
```

Second

```
// Base class - Vehicle
class Vehicle {
    String brand;
    int year;
```

```
    // Constructor
    public Vehicle(String brand, int
year) {
        this.brand = brand;
        this.year = year;
    }

    // Method to display vehicle
details
    public void displayDetails() {
        System.out.println("Brand: "
+ brand);
        System.out.println("Year: " +
year);
    }
}

// Derived class 1 - Car (inherits
from Vehicle)
class Car extends Vehicle {
    int numberOfDoors;

    // Constructor
    public Car(String brand, int
year, int numberOfDoors) {
```

```
        super(brand, year);  // Call
the constructor of Vehicle
        this.numberOfDoors =
numberOfDoors;
    }

    // Method to display car details
    public void displayCarDetails() {
        displayDetails();  // Call
method from Vehicle class
        System.out.println("Number of
Doors: " + numberOfDoors);
    }
}

// Derived class 2 - Truck (inherits
from Vehicle)
class Truck extends Vehicle {
    int loadCapacity;

    // Constructor
    public Truck(String brand, int
year, int loadCapacity) {
        super(brand, year);  // Call
the constructor of Vehicle
```

```
        this.loadCapacity =
loadCapacity;
    }

    // Method to display truck
details
    public void displayTruckDetails()
{
        displayDetails();  // Call
method from Vehicle class
        System.out.println("Load
Capacity: " + loadCapacity + "
tons");
    }
}

// Main class to run the program
public class Main {
    public static void main(String[]
args) {
        // Create an object of Car
        Car car = new Car("Toyota",
2021, 4);
        // Create an object of Truck
        Truck truck = new
Truck("Ford", 2018, 10);
```

```
        // Call methods to display
details
        System.out.println("Car
Details:");
        car.displayCarDetails();  //
Displays car details

        System.out.println("\nTruck
Details:");
        truck.displayTruckDetails();
 // Displays truck details
    }
}
```

Output:

```
Car Details:
Brand: Toyota
Year: 2021
Number of Doors: 4

Truck Details:
Brand: Ford
Year: 2018
Load Capacity: 10 tons
```

d. Hybrid Inheritance

First

```
// Base class - Person
class Person {
    String name;
    int age;

    // Constructor
    public Person(String name, int
age) {
        this.name = name;
        this.age = age;
    }
```

```
    // Method to display person
details
    public void
displayPersonDetails() {
        System.out.println("Name: " +
name);
        System.out.println("Age: " +
age);
    }
}

// Interface 1 - Employee (related to
employee duties)
interface Employee {
    void work();  // Abstract method
}

// Interface 2 - Manager (related to
managerial duties)
interface Manager {
    void manage();  // Abstract
method
}
```

```
// Derived class - ManagerEmployee
(inherits from Person, implements
Employee and Manager interfaces)
class ManagerEmployee extends Person
implements Employee, Manager {
    String department;

    // Constructor
    public ManagerEmployee(String
name, int age, String department) {
        super(name, age);  // Call
the constructor of Person
        this.department = department;
    }

    // Implement method from Employee
interface
    public void work() {
        System.out.println(name + "
is working in the department: " +
department);
    }

    // Implement method from Manager
interface
    public void manage() {
```

```
        System.out.println(name + "
is managing the team in the " +
department + " department.");
    }

    // Method to display manager-
employee details
    public void
displayManagerEmployeeDetails() {
        displayPersonDetails();  //
Call method from Person class
        System.out.println("Departmen
t: " + department);
        work();  // Call work method
from Employee interface
        manage();  // Call manage
method from Manager interface
    }
}

// Main class to run the program
public class Main {
    public static void main(String[]
args) {
        // Create an object of
ManagerEmployee (hybrid inheritance)
```

```
        ManagerEmployee manager = new
ManagerEmployee("John", 35, "Sales");

        // Call method to display
details
        manager.displayManagerEmploye
eDetails();  // Displays all details
    }
}
```

Output:

```
Name: John
Age: 35
Department: Sales
John is working in the department: Sales
John is managing the team in the Sales department.
```

Second

```
// Base class
class A {
    void displayA() {
        System.out.println("Class A:
Base Class");
    }
}

// Derived class B inheriting from A
(Single Inheritance)
```

```
class B extends A {
    void displayB() {
        System.out.println("Class B:
Derived from A");
    }
}

// Interface C
interface C {
    void displayC();
}

// Class D inheriting from B and
implementing interface C (Hybrid
Inheritance)
class D extends B implements C {
    public void displayC() {
        System.out.println("Class C:
Implemented in D");
    }

    void displayD() {
        System.out.println("Class D:
Derived from B and implements C");
    }
}
```

```
// Main class
public class Main {
    public static void main(String[]
args) {
        D obj = new D();
        obj.displayA(); // From Class
A
        obj.displayB(); // From Class
B
        obj.displayC(); // From
Interface C (Implemented in D)
        obj.displayD(); // From Class
D
    }
}
```

Output:

```
Class A: Base Class
Class B: Derived from A
Class C: Implemented in D
Class D: Derived from B and implements C
```

Polymorphism

a. **Constructor Programs**

First

```
// Class with Constructors
class Student {
```

```
    String name;
    int age;

    // Default Constructor (No
parameters)
    Student() {
        System.out.println("Default
Constructor called.");
        name = "Unknown";
        age = 0;
    }

    // Parameterized Constructor
    Student(String n, int a) {
        System.out.println("Parameter
ized Constructor called.");
        name = n;
        age = a;
    }

    // Copy Constructor
    Student(Student s) {
        System.out.println("Copy
Constructor called.");
        name = s.name;
        age = s.age;
```

```
    }

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

// Main Class
public class Main {
    public static void main(String[]
args) {
        // Using Default Constructor
        Student s1 = new Student();
        s1.display();

        // Using Parameterized
Constructor
        Student s2 = new
Student("Alice", 20);
        s2.display();

        // Using Copy Constructor
        Student s3 = new Student(s2);
        s3.display();
```

```
    }
}
```

Output:

```
Default Constructor called.
Name: Unknown, Age: 0
Parameterized Constructor called.
Name: Alice, Age: 20
Copy Constructor called.
Name: Alice, Age: 20
```

b. **Constructor Overloading Programs**

First

```
// Class with Constructor Overloading
class Person {
    String name;
    int age;
    String city;

    // Constructor 1: No parameters
(Default Constructor)
    Person() {
        System.out.println("Default
Constructor called.");
        name = "Unknown";
        age = 0;
        city = "Not Specified";
    }
```

```
    // Constructor 2: Parameterized
Constructor (name & age)
    Person(String n, int a) {
        System.out.println("Construct
or with Name & Age called.");
        name = n;
        age = a;
        city = "Not Specified";
    }

    // Constructor 3: Parameterized
Constructor (name, age & city)
    Person(String n, int a, String c)
{
        System.out.println("Construct
or with Name, Age & City called.");
        name = n;
        age = a;
        city = c;
    }

    // Display Method
    void display() {
        System.out.println("Name: " +
name + ", Age: " + age + ", City: " +
city);
```

```
    }
}

// Main Class
public class
ConstructorOverloadingExample {
    public static void main(String[]
args) {
        // Using Default Constructor
        Person p1 = new Person();
        p1.display();

        // Using Constructor with
Name & Age
        Person p2 = new
Person("Alice", 25);
        p2.display();

        // Using Constructor with
Name, Age & City
        Person p3 = new Person("Bob",
30, "New York");
        p3.display();
    }
}
```

Output:

```
Default Constructor called.
Name: Unknown, Age: 0, City: Not Specified
Constructor with Name & Age called.
Name: Alice, Age: 25, City: Not Specified
Constructor with Name, Age & City called.
Name: Bob, Age: 30, City: New York
```

c. **Method Overloading Programs**

First

```
// Calculator class demonstrating method overloading
class Calculator {

    // Method 1: Addition of two integers
    int add(int a, int b) {
        System.out.println("Adding two integers:");
        return a + b;
    }

    // Method 2: Addition of three integers
    int add(int a, int b, int c) {
        System.out.println("Adding three integers:");
        return a + b + c;
    }
```

```
    // Method 3: Addition of two
double values
    double add(double a, double b) {
        System.out.println("Adding
two double values:");
        return a + b;
    }

    // Method 4: Concatenation of two
strings
    String add(String a, String b) {
        System.out.println("Concatena
ting two strings:");
        return a + b;
    }
}

// Main class
public class MethodOverloadingDemo {
    public static void main(String[]
args) {
        Calculator calc = new
Calculator();
```

```
        // Calling different
overloaded methods
        System.out.println(calc.add(5
, 10));          // Two integers
        System.out.println(calc.add(3
, 7, 2));        // Three integers
        System.out.println(calc.add(4
.5, 2.3));       // Two doubles
        System.out.println(calc.add("
Hello, ", "World!")); // Two Strings
    }
}
```

Output:

```
Adding two integers:
15
Adding three integers:
12
Adding two double values:
6.8
Concatenating two strings:
Hello, World!
```

Second

```
// Shape class demonstrating method
overloading
class Shape {

    // Method 1: Area of a square
    int area(int side) {
        System.out.println("Calculati
ng area of square:");
        return side * side;
    }

    // Method 2: Area of a rectangle
    int area(int length, int width) {
        System.out.println("Calculati
ng area of rectangle:");
        return length * width;
    }

    // Method 3: Area of a circle
(double parameter)
    double area(double radius) {
        System.out.println("Calculati
ng area of circle:");
        return Math.PI * radius *
radius;
    }
```

```
    // Method 4: Area of a triangle
    double area(double base, double
height) {
        System.out.println("Calculati
ng area of triangle:");
        return 0.5 * base * height;
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Shape shape = new Shape();

        // Calling different
overloaded methods
        System.out.println("Area: " +
shape.area(5)); // Square
        System.out.println("Area: " +
shape.area(4, 6)); // Rectangle
        System.out.println("Area: " +
shape.area(3.5)); // Circle
        System.out.println("Area: " +
shape.area(5.0, 8.0)); // Triangle
```

```
    }
}
```

Output:

```
Area: 25
Calculating area of rectangle:
Area: 24
Calculating area of circle:
Area: 38.484510006474 96
Calculating area of triangle:
Area: 20.0
```

d. **Method Overriding**

First

```
// Parent class
class Animal {
    void makeSound() {
        System.out.println("Animals
make sounds");
    }
}

// Child class overriding makeSound()
method
class Dog extends Animal {
    @Override
    void makeSound() {
```

```
        System.out.println("Dog
barks");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Animal myAnimal = new
Animal(); // Parent class object
        myAnimal.makeSound();

        Dog myDog = new Dog(); //
Child class object
        myDog.makeSound();
    }
}
```

Output:

```
Animals make sounds
Dog barks
```

Second

```
// Parent class: Bank
class Bank {
```

```
    double getInterestRate() {
        return 5.0; // Default
interest rate
    }
}

// Child class 1: SBI overriding
getInterestRate()
class SBI extends Bank {
    @Override
    double getInterestRate() {
        return 6.5; // SBI specific
interest rate
    }
}

// Child class 2: HDFC overriding
getInterestRate()
class HDFC extends Bank {
    @Override
    double getInterestRate() {
        return 7.2; // HDFC specific
interest rate
    }
}
```

```
// Main class
public class Main {
    public static void main(String[]
args) {
        Bank b1 = new Bank();
        System.out.println("Bank
Interest Rate: " +
b1.getInterestRate() + "%");

        Bank b2 = new SBI(); //
Dynamic Method Dispatch
        System.out.println("SBI
Interest Rate: " +
b2.getInterestRate() + "%");

        Bank b3 = new HDFC(); //
Dynamic Method Dispatch
        System.out.println("HDFC
Interest Rate: " +
b3.getInterestRate() + "%");
    }
}
```

Output:

```
Bank Interest Rate: 5.0%
SBI Interest Rate: 6.5%
HDFC Interest Rate: 7.2%
```

Abstraction

a. **Abstract Class Programs**

First

```
// Abstract class
abstract class Animal {
    // Abstract method (without
implementation)
    abstract void makeSound();

    // Concrete method (with
implementation)
    void sleep() {
        System.out.println("Animal is
sleeping...");
    }
}

// Subclass implementing the abstract
method
class Dog extends Animal {
    @Override
```

```
    void makeSound() {
        System.out.println("Dog
barks: Woof! Woof!");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Dog d = new Dog();
        d.makeSound(); // Calls the
implemented method
        d.sleep(); // Calls the
inherited concrete method
    }
}
```

Output:

```
Dog barks: Woof! Woof!
Animal is sleeping...
```

Second

```
// Abstract class
abstract class Shape {
    // Abstract method
```

```
    abstract void draw();
}

// Subclass 1
class Circle extends Shape {
    @Override
    void draw() {
        System.out.println("Drawing a
Circle");
    }
}

// Subclass 2
class Rectangle extends Shape {
    @Override
    void draw() {
        System.out.println("Drawing a
Rectangle");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Shape s1 = new Circle();
```

```
        s1.draw(); // Calls the
Circle's implementation

        Shape s2 = new Rectangle();
        s2.draw(); // Calls the
Rectangle's implementation
    }
}
```

Output:

```
Drawing a Circle
Drawing a Rectangle
```

Third

```
// Abstract class
abstract class Vehicle {
    String brand;

    // Constructor
    Vehicle(String brand) {
        this.brand = brand;
        System.out.println("Vehicle
brand: " + brand);
    }

    // Abstract method
    abstract void start();
```

```
}

// Subclass implementing the abstract
method
class Car extends Vehicle {
    Car(String brand) {
        super(brand); // Calling the
parent class constructor
    }

    @Override
    void start() {
        System.out.println("Car is
starting...");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Car c = new Car("Toyota");
        c.start();
    }
}
```

Output:

```
Vehicle brand: Toyota
Car is starting...
```

Fourth

```
// Interface
interface Drivable {
    void drive();
}

// Abstract class implementing the
interface
abstract class Bike implements
Drivable {
    abstract void fuelType();
}

// Subclass providing implementations
class ElectricBike extends Bike {
    @Override
    void fuelType() {
        System.out.println("Electric
Bike runs on battery.");
    }

    @Override
    public void drive() {
```

```
        System.out.println("Electric
Bike is being driven.");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Bike myBike = new
ElectricBike();
        myBike.fuelType();
        myBike.drive();
    }
}
```

Output:

```
Electric Bike runs on battery.
Electric Bike is being driven.
```

b. Interface

First

```
// Define an interface
interface Animal {
    void makeSound(); // Abstract
method
}

// Implementing class
class Dog implements Animal {
    @Override
    public void makeSound() {
        System.out.println("Dog
barks: Woof! Woof!");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Dog d = new Dog();
        d.makeSound();
    }
}
```

Output:

```
Dog barks: Woof! Woof!
```

Second

```
// First interface
interface Flyable {
    void fly();
}

// Second interface
interface Swimable {
    void swim();
}

// Class implementing both interfaces
class Bird implements Flyable,
Swimable {
    @Override
    public void fly() {
        System.out.println("Bird is
flying.");
    }

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

```
// Main class
public class Main {
    public static void main(String[]
args) {
        Bird b = new Bird();
        b.fly();
        b.swim();
    }
}
```

Output:

```
Bird is flying.
Bird is swimming.
```

Third

```
// Define an interface
interface Vehicle {
    void start();

    // Default method
    default void honk() {
        System.out.println("Vehicle
is honking.");
    }
```

```
    // Static method
    static void show() {
        System.out.println("This is a
Vehicle interface.");
    }
}

// Implementing class
class Car implements Vehicle {
    @Override
    public void start() {
        System.out.println("Car is
starting.");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Car c = new Car();
        c.start();
        c.honk(); // Calling default
method
```

```
        Vehicle.show(); // Calling
static method
    }
}
```

Output:

```
Car is starting.
Vehicle is honking.
This is a Vehicle interface.
```

Fourth

```
// Define an interface
interface Payment {
    void processPayment(int amount);
}

// Implementing class 1
class CreditCardPayment implements
Payment {
    @Override
    public void processPayment(int
amount) {
        System.out.println("Credit
Card Payment of $" + amount + "
processed.");
    }
}
```

```
// Implementing class 2
class PayPalPayment implements
Payment {
    @Override
    public void processPayment(int
amount) {
        System.out.println("PayPal
Payment of $" + amount + "
processed.");
    }
}

// Main class
public class Main {
    public static void main(String[]
args) {
        Payment p1 = new
CreditCardPayment();
        p1.processPayment(100);

        Payment p2 = new
PayPalPayment();
        p2.processPayment(200);
    }
}
```

Output:

```
Credit Card Payment of $100 processed.
PayPal Payment of $200 processed.
```

Encapsulation

a. **Encapsulation Programs**

First

```
// Encapsulated class
class Person {
    private String name; // Private
variable

    // Setter method
    public void setName(String name)
{
        this.name = name;
    }

    // Getter method
    public String getName() {
        return name;
    }
}

// Main class
public class EncapsulationExample1 {
    public static void main(String[]
args) {
        Person p = new Person();
        p.setName("John Doe");
        System.out.println("Person's
Name: " + p.getName());
```

```
    }
}
```

Output:

```
Person's Name: John Doe
```

Second

```
// Encapsulated class
class Student {
    private int age; // Private
variable

    // Setter method with validation
    public void setAge(int age) {
        if (age > 0) {
            this.age = age;
        } else {
            System.out.println("Inval
id Age. Age must be positive.");
        }
    }

    // Getter method
    public int getAge() {
        return age;
    }
```

```
}

// Main class
public class EncapsulationExample2 {
    public static void main(String[]
args) {
        Student s = new Student();
        s.setAge(20);
        System.out.println("Student's
Age: " + s.getAge());

        s.setAge(-5); // Invalid age
input
    }
}
```

Output:

```
Student's Age: 20
Invalid Age. Age must be positive.
```

Third

```
// Encapsulated class
class BankAccount {
    private double balance; //
Private variable
```

```
    // Constructor to initialize
balance
    public BankAccount(double
initialBalance) {
        if (initialBalance > 0) {
            this.balance =
initialBalance;
        }
    }

    // Getter method
    public double getBalance() {
        return balance;
    }

    // Deposit method
    public void deposit(double
amount) {
        if (amount > 0) {
            balance += amount;
            System.out.println("Depos
ited: $" + amount);
        } else {
            System.out.println("Inval
id deposit amount.");
        }
```

```
    }

    // Withdraw method with
validation
    public void withdraw(double
amount) {
        if (amount > 0 && amount <=
balance) {
            balance -= amount;
            System.out.println("Withd
rawn: $" + amount);
        } else {
            System.out.println("Insuf
ficient balance or invalid amount.");
        }
    }
}

// Main class
public class EncapsulationExample3 {
    public static void main(String[]
args) {
        BankAccount account = new
BankAccount(500);
        System.out.println("Initial
Balance: $" + account.getBalance());
```

```
        account.deposit(200);
        account.withdraw(100);
        System.out.println("Final
Balance: $" + account.getBalance());
    }
}
```

Output:

```
Initial Balance: $500.0
Deposited: $200.0
Withdrawn: $100.0
Final Balance: $600.0
```

Fourth

```
// Encapsulated class
class Employee {
    private String name;
    private int empID;
    private double salary;

    // Constructor
    public Employee(String name, int
empID, double salary) {
        this.name = name;
        this.empID = empID;
```

```
        this.salary = salary;
    }

    // Getter methods
    public String getName() {
        return name;
    }

    public int getEmpID() {
        return empID;
    }

    public double getSalary() {
        return salary;
    }

    // Setter method for salary with
validation
    public void setSalary(double
salary) {
        if (salary > 0) {
            this.salary = salary;
        } else {
            System.out.println("Inval
id salary amount.");
        }
```

```
    }
}

// Main class
public class EncapsulationExample4 {
    public static void main(String[]
args) {
        Employee emp = new
Employee("Alice", 101, 55000);

        // Accessing details via
getter methods
        System.out.println("Employee
Name: " + emp.getName());
        System.out.println("Employee
ID: " + emp.getEmpID());
        System.out.println("Employee
Salary: $" + emp.getSalary());

        // Updating salary using
setter
        emp.setSalary(60000);
        System.out.println("Updated
Salary: $" + emp.getSalary());
    }
}
```

Output:

```
Employee Name: Alice
Employee ID: 101
Employee Salary: $55000.0
Updated Salary: $60000.0
```

b. **Exception Handling**

First

```
public class
ExceptionHandlingExample1 {
    public static void main(String[]
args) {
        try {
            int a = 10, b = 0;
            int result = a / b;  //
This will throw ArithmeticException
            System.out.println("Resul
t: " + result);
        } catch (ArithmeticException
e) {
            System.out.println("Error
: Division by zero is not allowed.");
        }
    }
```

```
}
```

Output:

```
Error: Division by zero is not allowed.
```

Second

```
public class
ExceptionHandlingExample2 {
    public static void main(String[]
args) {
        try {
            int[] numbers = {1, 2,
3};
            System.out.println(number
s[5]);  // Invalid index
        } catch
(ArrayIndexOutOfBoundsException e) {
            System.out.println("Error
: Array index is out of bounds.");
        }
    }
}
```

Output:

```
Error: Array index is out of bounds.
```

Third

```
public class
ExceptionHandlingExample3 {
```

```
    public static void main(String[]
args) {
        try {
            System.out.println("Tryin
g to divide...");
            int result = 10 / 2;
            System.out.println("Resul
t: " + result);
        } catch (ArithmeticException
e) {
            System.out.println("Error
: Cannot divide by zero.");
        } finally {
            System.out.println("Execu
tion completed. Cleaning up
resources...");
        }
    }
}
```

Output:

```
Trying to divide...
Result: 5
Execution completed. Cleaning up resources...
```

Fourth

```
// Custom exception class
```

```
class InvalidAgeException extends
Exception {
    public InvalidAgeException(String
message) {
        super(message);
    }
}

// Main class
public class
ExceptionHandlingExample4 {
    // Method that throws an
exception
    static void checkAge(int age)
throws InvalidAgeException {
        if (age < 18) {
            throw new
InvalidAgeException("Age must be 18
or above.");
        } else {
            System.out.println("Acces
s granted.");
        }
    }
```

```
    public static void main(String[]
args) {
        try {
            checkAge(16); // Invalid
age
        } catch (InvalidAgeException
e) {
            System.out.println("Excep
tion: " + e.getMessage());
        }
    }
}
```

Output:

```
Exception: Age must be 18 or above.
```

c. **File Handling**

First

```
import java.io.File;
import java.io.FileWriter;
import java.io.IOException;

public class FileHandlingExample1 {
    public static void main(String[]
args) {
        try {
            File file = new
File("example1.txt"); // File object
```

```
            if (file.createNewFile())
{
                System.out.println("F
ile created: " + file.getName());
            } else {
                System.out.println("F
ile already exists.");
            }

            // Writing to the file
            FileWriter writer = new
FileWriter("example1.txt");
            writer.write("Hello, this
is a file handling example in
Java.");
            writer.close();
            System.out.println("Succe
ssfully wrote to the file.");
        } catch (IOException e) {
            System.out.println("An
error occurred.");
            e.printStackTrace();
        }
    }
}
```

Output:

```
File created: example1.txt
Successfully wrote to the file.
```

example1.txt ×

Encapsulation > File Handling > example1.txt

```
1  Hello, this is a file handling example in Java.
```

Second

```
import java.io.File;
import java.io.FileNotFoundException;
import java.util.Scanner;

public class FileHandlingExample2 {
    public static void main(String[]
args) {
        try {
            File file = new
File("example1.txt"); // Read the
same file from Program 1
            Scanner reader = new
Scanner(file);

            while
(reader.hasNextLine()) {
                String data =
reader.nextLine();
```

```
                System.out.println(da
ta);
            }
            reader.close();
        } catch
(FileNotFoundException e) {
            System.out.println("An
error occurred. File not found.");
            e.printStackTrace();
        }
    }
}
```

Output:

```
Hello, this is a file handling example in Java.
```

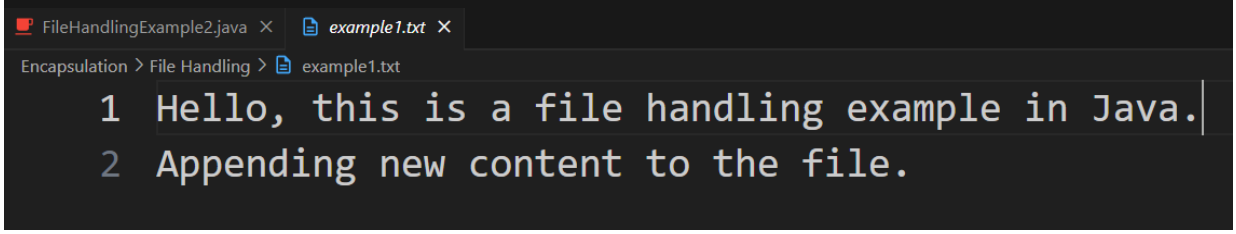
Third

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

public class FileHandlingExample3 {
    public static void main(String[]
args) {
        try {
            FileWriter writer = new
FileWriter("example1.txt", true); //
Append mode
```

```
            writer.write("\nAppending
new content to the file.");
            writer.close();
            System.out.println("Succe
ssfully appended to the file.");
        } catch (IOException e) {
            System.out.println("An
error occurred.");
            e.printStackTrace();
        }
    }
}
```

Output:

```
Successfully appended to the file.
```



Fourth

```
import java.io.File;

public class FileHandlingExample4 {
    public static void main(String[]
args) {
```

```
        File file = new
File("example1.txt"); // File to be
deleted
        if (file.delete()) {
            System.out.println("Delet
ed the file: " + file.getName());
        } else {
            System.out.println("Faile
d to delete the file.");
        }
    }
}
```

Output:

```
Deleted the file: example1.txt
```

Packages Problem
User Defined Packages

First

Folder Structure

```
ProjectFolder/
├── mathutils/
│   └── Calculator.java
└── MainApp.java
```

Calculator.java

```
package mathutils;

public class Calculator {
```

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

    public int subtract(int a, int b)
{
        return a - b;
    }

    public int multiply(int a, int b)
{
        return a * b;
    }

    public double divide(int a, int
b) {
        if (b == 0) {
            System.out.println("Error
: Cannot divide by zero.");
            return 0;
        }
        return (double) a / b;
    }
```

```
}
```

MainApp.java

```
import mathutils.Calculator;

public class MainApp {
    public static void main(String[]
args) {
        Calculator calc = new
Calculator();

        System.out.println("Addition:
" + calc.add(10, 5));
        System.out.println("Subtracti
on: " + calc.subtract(10, 5));
        System.out.println("Multiplic
ation: " + calc.multiply(10, 5));
        System.out.println("Division:
" + calc.divide(10, 5));
    }
}
```

Output:

Addition: 15
Subtraction: 5
Multiplication: 50
Division: 2.0

Second

Folder Structure

ProjectFolder/
├── geometry/
│ └── AreaCalculator.java
└── GeometryApp.java

GeometryApp.java

```
import geometry.AreaCalculator;

public class GeometryApp {
    public static void main(String[]
args) {
        AreaCalculator ac = new
AreaCalculator();

        double circle =
ac.circleArea(7.5);
        double rectangle =
ac.rectangleArea(10, 5);
```

```
        System.out.println("Area of
Circle: " + circle);
        System.out.println("Area of
Rectangle: " + rectangle);
    }
}
```

AreaCalculator.java

```
package geometry;

public class AreaCalculator {
    public double circleArea(double
radius) {
        return Math.PI * radius *
radius;
    }

    public double
rectangleArea(double length, double
width) {
        return length * width;
    }
}
```

Output:

Area of Circle: 176.71458676442586
Area of Rectangle: 50.0

Basic Built In code

FileExample.java

```
import java.io.FileWriter;

import java.io.FileReader;

import java.io.IOException;



public class FileExample {

    public static void main(String[] args) {

        try {

            // Writing to file

            FileWriter writer = new FileWriter("sample.txt");

            writer.write("Hello, Agneay!");

            writer.close();



            // Reading from file

            FileReader reader = new FileReader("sample.txt");

            int ch;

            while ((ch = reader.read()) != -1) {

                System.out.print((char) ch);

            }

            reader.close();
```

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

MathExample.java

```
public class MathExample {
    public static void main(String[] args) {
        double result = Math.pow(2, 5);  // 2 to the power 5
        System.out.println("2^5 = " + result);
    }
}
```

Input Example

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

public class FileExample {
    public static void main(String[] args) {
        try {
            // Writing to file
            FileWriter writer = new FileWriter("sample.txt");
```

```
            writer.write("Hello, Agneay!");
            writer.close();


            // Reading from file
            FileReader reader = new FileReader("sample.txt");
            int ch;
            while ((ch = reader.read()) != -1) {
                System.out.print((char) ch);
            }
            reader.close();
        } catch (IOException e) {
            System.out.println("An error occurred.");
            e.printStackTrace();
        }
    }
}
```

Advanced Built In Packages

DatabaseExample.java

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.Statement;
import java.sql.ResultSet;
import java.sql.SQLException;
```

```
public class DatabaseExample {
    public static void main(String[]
args) {
        String url =
"jdbc:sqlite:sample.db"; // Path to
SQLite database file
        try (Connection conn =
DriverManager.getConnection(url)) {
            if (conn != null) {
                System.out.println("C
onnected to the database!");
                String query =
"SELECT id, name FROM users";
                Statement stmt =
conn.createStatement();
                ResultSet rs =
stmt.executeQuery(query);

                while (rs.next()) {
                    int id =
rs.getInt("id");
```

```
                String name =
rs.getString("name");
                System.out.printl
n("User ID: " + id + ", Name: " +
name);
            }
        }
    } catch (SQLException e) {
        System.out.println(e.getM
essage());
    }
}
}
```

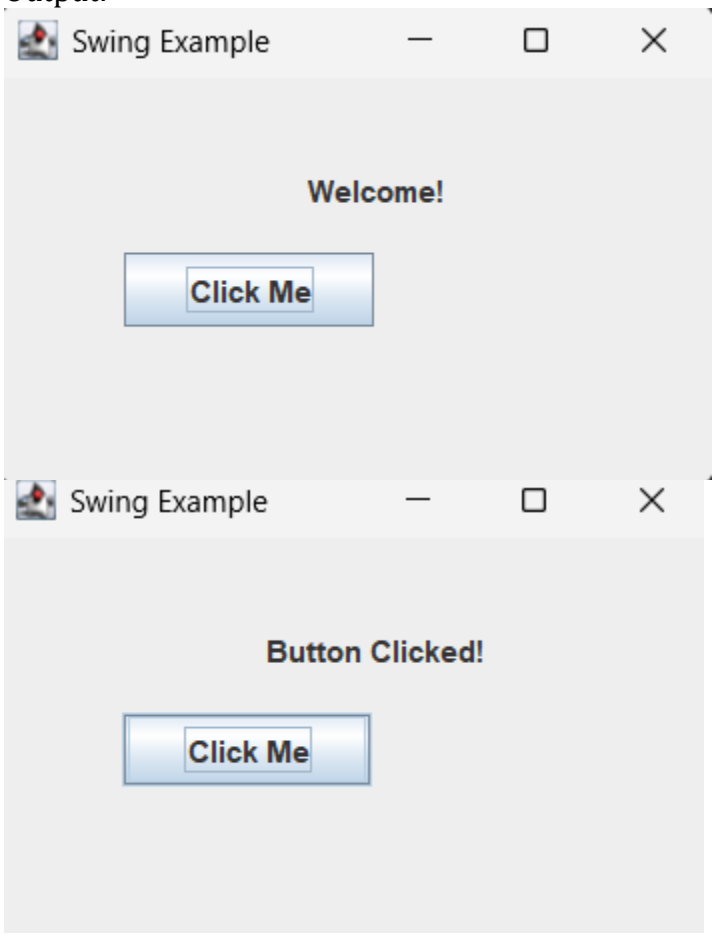
SwingExample.java

```
import javax.swing.*;
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;

public class SwingExample {
    public static void main(String[]
args) {
```

```
        JFrame frame = new
JFrame("Swing Example");
        JButton button = new
JButton("Click Me");
        JLabel label = new
JLabel("Welcome!", JLabel.CENTER);

        button.addActionListener(new
ActionListener() {
            @Override
            public void
actionPerformed(ActionEvent e) {
                label.setText("Button
Clicked!");
            }
        });

        frame.setLayout(null);
        label.setBounds(50, 30, 200,
30);
        button.setBounds(50, 70, 100,
30);
```

```
        frame.add(label);
        frame.add(button);
        frame.setSize(300, 200);
        frame.setDefaultCloseOperatio
n(JFrame.EXIT_ON_CLOSE);
        frame.setVisible(true);
    }
}
```

Output:



TCPServer.java

```
import java.net.*;
```

```
import java.io.*;

public class TCPServer {
    public static void main(String[]
args) throws IOException {
        ServerSocket serverSocket =
new ServerSocket(12345); // Listening
on port 12345
        System.out.println("Server is
running...");

        Socket clientSocket =
serverSocket.accept(); // Accept
client connection
        System.out.println("Client
connected");

        BufferedReader input = new
BufferedReader(new
InputStreamReader(clientSocket.getInp
utStream()));
        String message =
input.readLine();
```

```
        System.out.println("Client
says: " + message);

        clientSocket.close();
        serverSocket.close();
    }
}
```