OBJECT-ORIENTED PROGRAMMING
LAB 6: INHERITANCE

I. Objective

After completing this tutorial, you can:

- Understand *inheritance* in OOP.

II. Definition

Inheritance is the process in which one class acquires the properties (methods and fields) of another. With the use of inheritance, the information is made manageable in a hierarchical order.

The class which inherits the properties of another class is known as a *subclass* (derived class, child class) and the class whose properties are inherited is known as a *superclass* (base class, parent class).

1. extends keyword

The *extends* keyword is used to inherit the variables and methods of a class (except the constructors, private variables, and private methods).

```
public class Super {
    //...
}

public class Sub extends Super {
    //...
}
```

2. super keyword

The *super* keyword in Java is a reference variable that refers to its parent class object. The usage of the *super* keyword:

- To refer to parent class instance variable.
- To invoke the parent class method.
- The `super()` can be used to invoke the parent class constructor.

If a class is inheriting the properties of another class. And if the members of the subclass have the names same as the superclass, to differentiate these variables we use the **super** keyword as follows:

- For variable: `super.variableName`
- For method: `super.methodName()`

3. Override

The subclass containing the method has the same signature as the method declared in the superclass that is method overriding. If a class wants to override the method in the other, it must be in the "is-a" relationship (Inheritance).

Employee.java

```
public class Employee {
    protected String name = "";
    public Employee(String name) {
        this.name = name;
    }

    public String title() {
        return "Employee";
    }

    @Override
    public String toString() {
        return this.name + ": " + title();
    }
}
```

Developer.java

```
public class Developer extends Employee {
    public Developer(String name) {
        super(name);
    }

    @Override
    public String title() {
        return "Developer";
    }
}
```

TestOverride.java

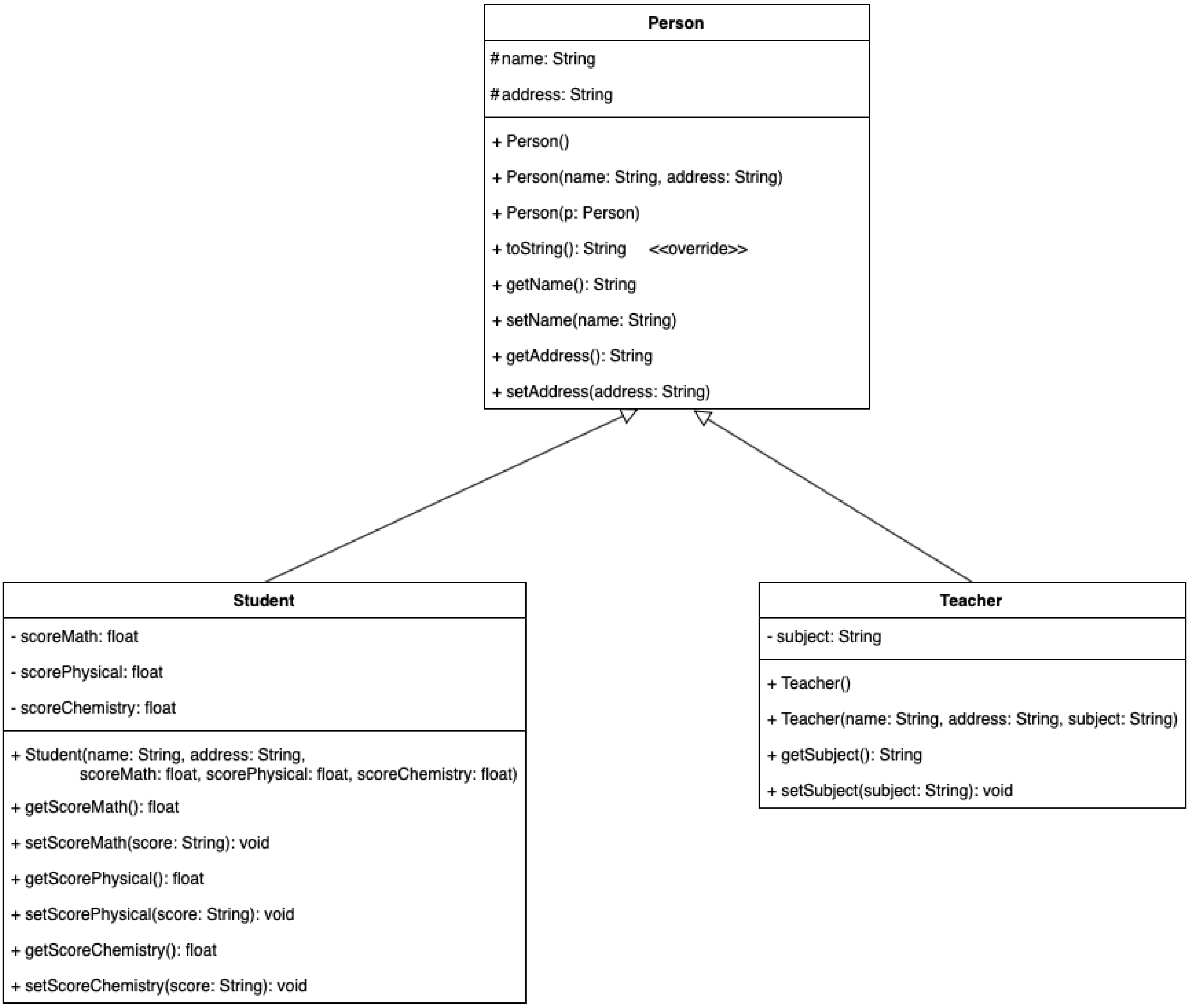
```
public class TestOverride {
    public static void main(String[] args) {
        Employee emp = new Employee("Bob");
        Developer dev = new Developer("Alice");
        Employee emp1 = new Developer("Trudy"); // We will discuss this later.

        System.out.println(emp);
        System.out.println(dev);
        System.out.println(emp1);
    }
}
```

Result:

```
Bob: Employee
Alice: Developer
Trudy: Developer
```

III. Sample program

To demonstrate how to implement inheritance in a Java program, we take an example as shown below diagram:


Person
#name: String
#address: String
+ Person()
+ Person(name: String, address: String)
+ Person(p: Person)
+ toString(): String <<override>>
+ getName(): String
+ setName(name: String)
+ getAddress(): String
+ setAddress(address: String)
Student
- scoreMath: float
- scorePhysical: float
- scoreChemistry: float
+ Student(name: String, address: String, scoreMath: float, scorePhysical: float, scoreChemistry: float)
+ getScoreMath(): float
+ setScoreMath(score: String): void
+ getScorePhysical(): float
+ setScorePhysical(score: String): void
+ getScoreChemistry(): float
+ setScoreChemistry(score: String): void
Teacher
- subject: String
+ Teacher()
+ Teacher(name: String, address: String, subject: String)
+ getSubject(): String
+ setSubject(subject: String): void

Person.java

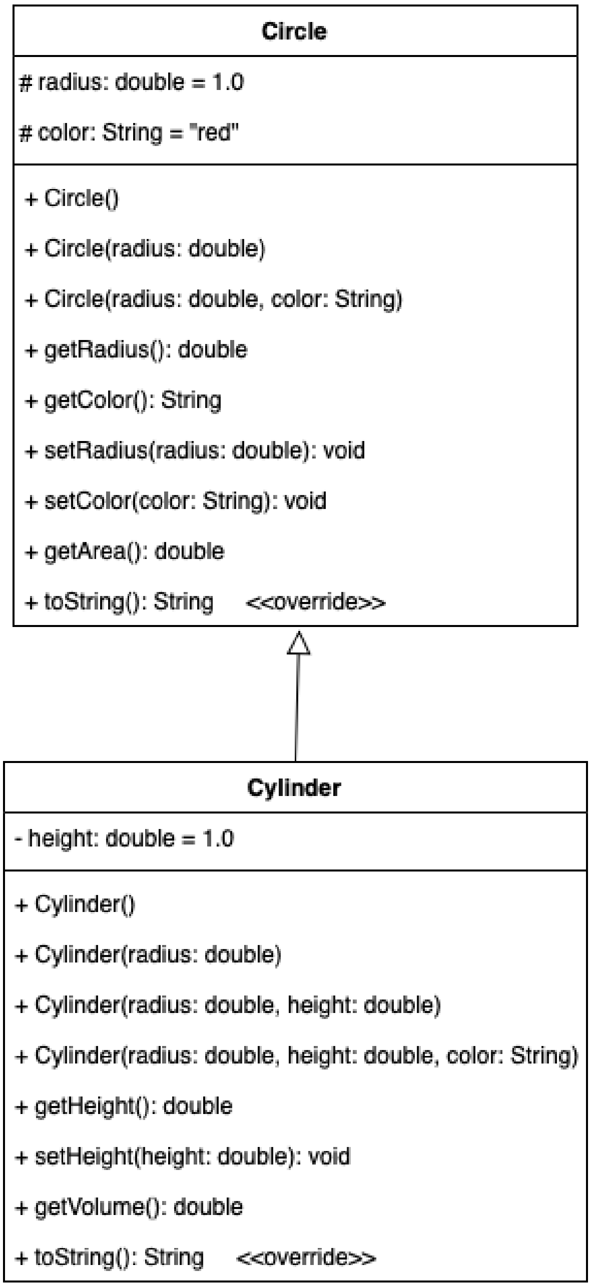
```
public class Person {
    protected String name;
    protected String address;

    public Person() {
        this.name = "";
        this.address = "";
    }

    public Person(String name, String address) {
        this.name = name;
        this.address = address;
    }

    public Person(Person person) {
        this.name = person.name;
        this.address = person.address;
    }

    @Override
    public String toString() {
        return "Person{" + "name='" + name + "\'" + ", address='" + address + "\'" + "}";
    }

    public String getName() {
        return this.name;
    }

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

    public String getAddress() {
        return this.address;
    }

    public void setAddress(String address) {
        this.address = address;
    }
}
```

Teacher.java

```java
public class Teacher extends Person {
    private String subject;

    public Teacher() {
        super();
        this.subject = "";
    }

    public Teacher(String name, String address, String subject) {
        super(name, address);
        this.subject = subject;
    }

    public String getSubject() {
        return this.subject;
    }

    public void setSubject(String subject) {
        this.subject = subject;
    }
}
```

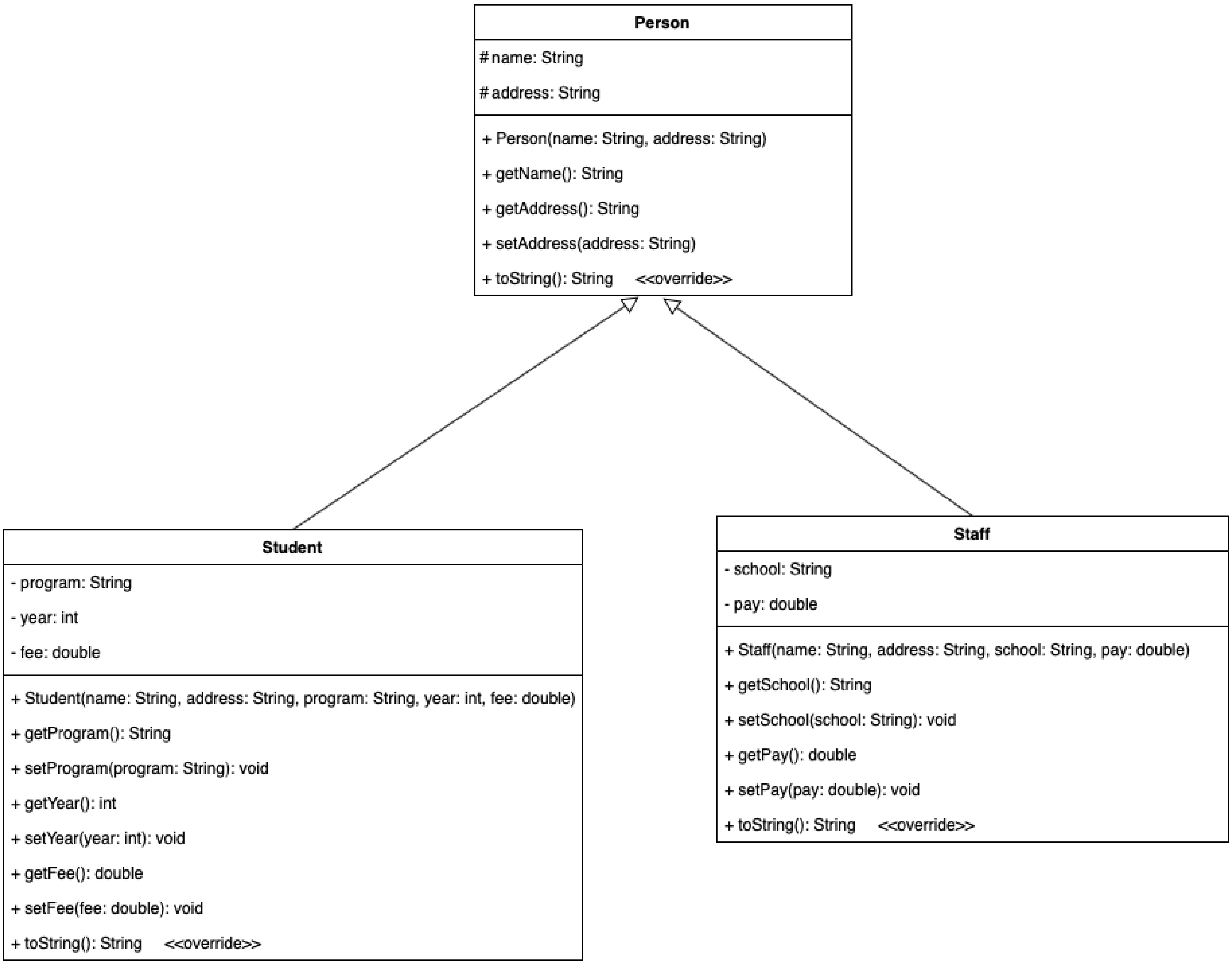
IV. Exercise

1. Giving the Circle class and the Cylinder class.


Circle
# radius: double = 1.0
# color: String = "red"
+ Circle()
+ Circle(radius: double)
+ Circle(radius: double, color: String)
+ getRadius(): double
+ getColor(): String
+ setRadius(radius: double): void
+ setColor(color: String): void
+ getArea(): double
+ toString(): String <<override>>
Cylinder
- height: double = 1.0
+ Cylinder()
+ Cylinder(radius: double)
+ Cylinder(radius: double, height: double)
+ Cylinder(radius: double, height: double, color: String)
+ getHeight(): double
+ setHeight(height: double): void
+ getVolume(): double
+ toString(): String <<override>>

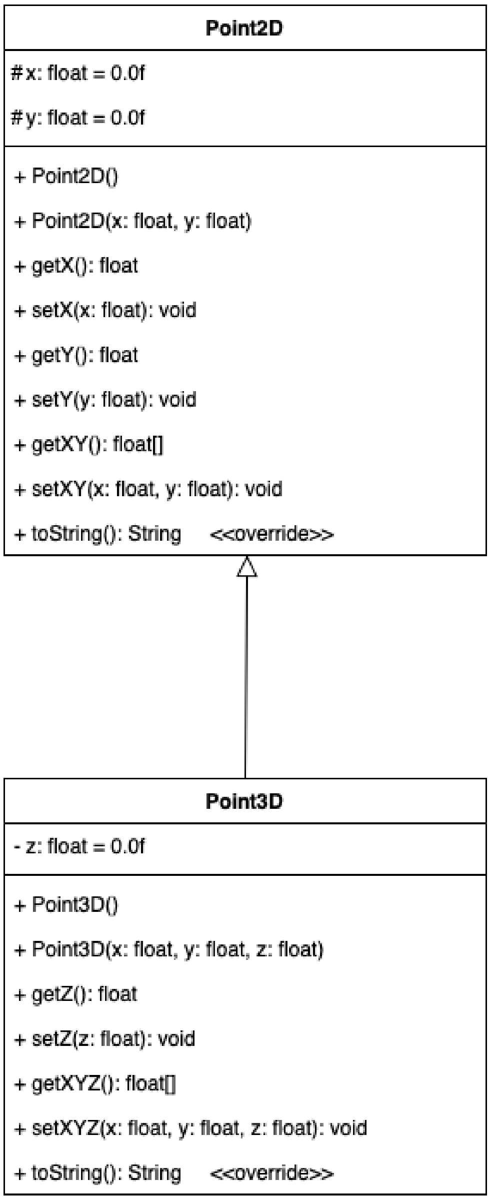
Implement the Java program based on the above diagram.

2. Giving superclass **Person** and subclasses.


Person
# name: String
# address: String
+ Person(name: String, address: String)
+ getName(): String
+ getAddress(): String
+ setAddress(address: String)
+ toString(): String <<override>>
Student
- program: String
- year: int
- fee: double
+ Student(name: String, address: String, program: String, year: int, fee: double)
+ getProgram(): String
+ setProgram(program: String): void
+ getYear(): int
+ setYear(year: int): void
+ getFee(): double
+ setFee(fee: double): void
+ toString(): String <<override>>
Staff
- school: String
- pay: double
+ Staff(name: String, address: String, school: String, pay: double)
+ getSchool(): String
+ setSchool(school: String): void
+ getPay(): double
+ setPay(pay: double): void
+ toString(): String <<override>>

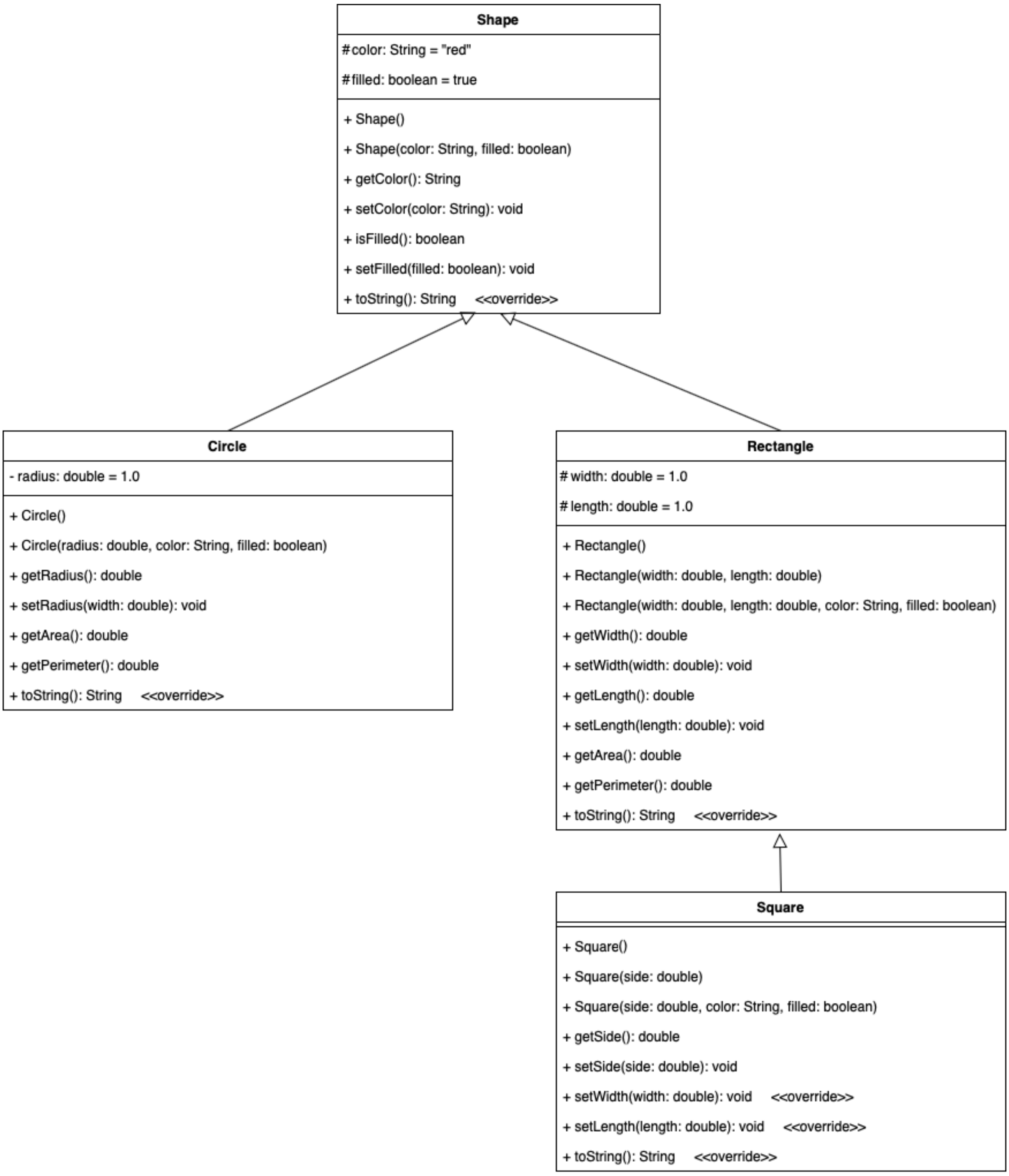
Implement the Java program based on the above diagram.

3. Giving the Point2D class and the Pointed3D class.



Implement the Java program based on the above diagram.

4. Giving superclass Shape and its subclasses.


Shape
#color: String = "red"
#filled: boolean = true
+ Shape()
+ Shape(color: String, filled: boolean)
+ getColor(): String
+ setColor(color: String): void
+ isFilled(): boolean
+ setFilled(filled: boolean): void
+ toString(): String <<override>>
Circle
- radius: double = 1.0
+ Circle()
+ Circle(radius: double, color: String, filled: boolean)
+ getRadius(): double
+ setRadius(width: double): void
+ getArea(): double
+ getPerimeter(): double
+ toString(): String <<override>>
Rectangle
# width: double = 1.0
# length: double = 1.0
+ Rectangle()
+ Rectangle(width: double, length: double)
+ Rectangle(width: double, length: double, color: String, filled: boolean)
+ getWidth(): double
+ setWidth(width: double): void
+ getLength(): double
+ setLength(length: double): void
+ getArea(): double
+ getPerimeter(): double
+ toString(): String <<override>>
Square
+ Square()
+ Square(side: double)
+ Square(side: double, color: String, filled: boolean)
+ getSide(): double
+ setSide(side: double): void
+ setWidth(width: double): void <<override>>
+ setLength(length: double): void <<override>>
+ toString(): String <<override>>

Implement the Java program based on the above diagram.

5. Implement the Employee class to store the information of employees in the manufacturing company ABC.

   Attributes:

   - **ID**: String

   - **fullName**: String

   - **yearJoined**: int

   - **coefficientsSalary**: double

   - **numDaysOff**: int (number of days off in the month)

   Constructors:

   - Constructor with no parameter **Employee()** (ID = 0, fullName = ””, yearJoined = 2020, coefficientsSalary = 1.0, numDaysOff = 0)

   - Constructor with parameter **Employee(ID: String, fullName: String, coefficientsSalary: double)** (yearJoined = 2020, numDaysOff = 0)

   - Constructor with full parameters.

   Methods:

   - **public double getSenioritySalary():** calculating seniority salary of employees: Know that if an employee works for 5 years or more, the seniority salary is calculated according to the following formula:

   seniority salary = years of work * basic salary / 100

   - **public String considerEmulation():** write a method to evaluate employee emulation.

   If the number of *holidays* <= 1 is graded A.

   If 2 <= the number of holidays <= 3 is graded B.

   If the number of holidays > 3 is graded C.

   - **public double getSalary():** write a method for calculating salaries for employees. Know that *salary* is calculated using the following formula with *basic salary = 1150*:

   *salary = basic salary + basic salary * (salary coefficient + emulation coefficient) + seniority salary*

   • If rated A: emulation coefficient = 1.0

   • If rated B: emulation coefficient = 0.75

   • If rated C: emulation coefficient = 0.5

6. In addition to the type of employees described in Exercise 5. ABC Company also has a management team called Managers to manage all the company's activities. Let's build a Manager

class to let ABC know that managers are also employees of the company. However, due to the role and function, each manager will have a corresponding position, department, and salary coefficient by position. The manager is also an employee, we will let the Manager class inherit from the Employee class and add some necessary attributes.

Attributes:

- The additional attributes include *position*, *department*, and *salary coefficient* by position.

Constructors:

- Constructor with no parameter **Manager()**: write a default constructor that creates a manager like an employee but has the position of head of the administrative office and a coefficient salary of 5.0.

- Constructor with parameter **Manager(ID: String, fullName: String, coefficientsSalary: double, position: String, salaryCoefficientPosition: double)** (yearJoined = 2020, numDaysOff = 0).

- Constructor with full parameters.

Methods:

- **public String considerEmulation()**: override the method to evaluate employee emulation and know that employees are *always rated A*.

- **public double bonusByPosition():** calculating bonus using the following formula:

*position bonus = basic salary * salary coefficient by position*

- **public double getSalary()**: override the method for calculating salaries for employees. Know that the manager's salary is calculated using the following formula:

*salary = basic salary + basic salary * (salary coefficient + emulation coefficient) + seniority salary + position bonus*