At this lab section, we will learn fundamentals of Object-Oriented Programming: Classes, interfaces, and inheritance.

Fundamentals of Object Oriented Programming

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PART 1 –Inheritance

Exercise 1. At this section, we will examine inheritance concept. Our first class is the main class *Test.java,* the second class is the super class *Point.java* and the third class is *Circle.java* that is inherited from *Point.java.*

Step – 1

Create a new Java Project. Add the java files *Test.java, Point.java* and *Circle.java.*

Test. java

```
public class Test {

	public static void main(String[] args) {

		System.out.println("----------------------------------------");
		Point p = new Point(0, 0);
		System.out.println("----------------------------------------");
		Circle c = new Circle(2, 4);
		System.out.println("----------------------------------------");
		Circle c1 = new Circle();
		System.out.println("----------------------------------------");
		p.Display();
		System.out.println();
		System.out.println("----------------------------------------");
		c.Display();
		System.out.println("----------------------------------------");
		c1.Display();
		System.out.println("----------------------------------------");
		System.out.println(c.Calculate(new Circle(9, 5)));}

}
```

Point. java

```
public class Point {

	private int x;
	public int y;

	public Point(int _x, int _y)
	{
		x = _x;
		this.y = _y;
		System.out.println("Point constructor with parameter.");
	}

	protected int GetX()
	{
		return this.x;
	}

	public void SetX(int x)
	{
		this.x = x;
	}

	public void Display()
	{
		System.out.print("X = " + x + " Y = " + y);
	}
}
```

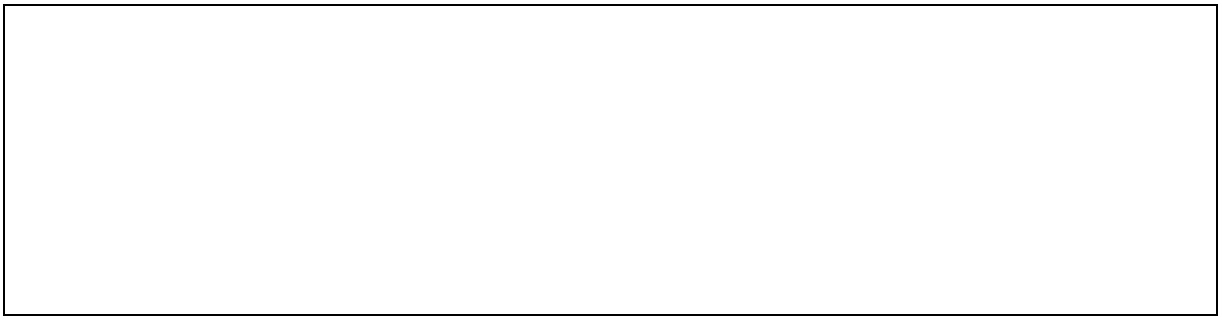
Circle. java

```
public class Circle extends Point
{

	private int r;
	public Circle()
	{
		super(0, 0);
		r = 0;
		System.out.println("Circle constructor.");
	}

	public Circle(int r, int x)
	{
		super(x, 0);
		this.r = r;
		System.out.println("Circle constructor with parameter.");
	}

	public double Calculate(Circle c)
	{
		return GetX() + c.GetX() + super.y + c.y;
	}

	public void Display()
	{
		System.out.println("\nCircle: ");
		super.Display();
		System.out.println(" Z = " + r);
	}

}
```

Step – 2

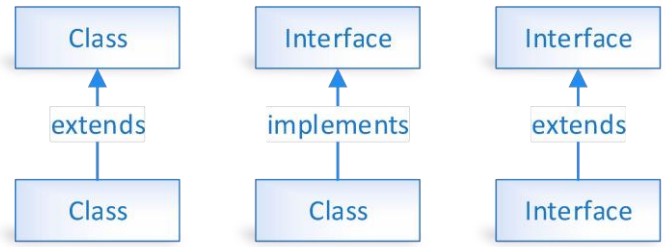
Paste the output of the Test.java.

```
---------------------------------------
Point constructor with parameter.
---------------------------------------
Point constructor with parameter.
Circle constructor with parameter.
---------------------------------------
Point constructor with parameter.
Circle constructor.
---------------------------------------
X = 0 Y = 0
---------------------------------------

Circle:
X = 4 Y = 0 Z = 2
---------------------------------------

Circle:
X = 0 Y = 0 Z = 0
---------------------------------------
Point constructor with parameter.
Circle constructor with parameter.
9.0
```



PART 2 –Interfaces

- An interface, sometimes also called an abstract data type, defines the set of operations supported by a data structure. It tells nothing about how the data structure implements these operations.
- A data structure implementation, on the other hand, includes the internal representation of the data structure.
- There can be many implementations of a single interface. At the same time, a class can implement more than one interface.



An interface is different from a class in several ways:

- You cannot instantiate an interface.
- An interface does not contain any constructors.
- All the methods in an interface are abstract.
- An interface cannot contain instance fields. The only fields that can appear in an interface must be declared both static and final.
- An interface is not extended by a class; it is implemented by a class.
- An interface can extend multiple interfaces.

Why do we use interfaces?

- It is used to achieve total abstraction.
- Since java does not support multiple inheritance in case of class, but by using interface it can achieve multiple inheritance.
- It is also used to achieve loose coupling.
- Interfaces are used to implement abstraction. So, the question arises why use interfaces when we have abstract classes?
- The reason is, abstract classes may contain non-final variables, whereas variables in interface are final, public, and static.

Exercise 2. At this section, we will implement Shape interface. Circle, Rectangle, and Triangle are the three different implementations of the same interface.

Step – 1

Create a new Java Project. Add the java files *Shape.java, Circle.java*, *Rectangle.java*, and *Triangle.java.*

```
public interface Shape {

        public String type();

        public double area();

        public double perimeter();

}
```

```
public class Circle implements Shape {
        private double radius;
        public Circle(double radius) {
                this.radius = radius;
        }
        public double area() {
                return Math.PI * radius * radius;
        }
        public double perimeter() {
                return 2.0 * Math.PI * radius;
        }
        @Override
        public String type() {
                return "Circle";
        }
}

  public class Rectangle implements Shape {
          private double width;
          private double height;
          public Rectangle(double width, double height) {
                  this.width = width;
                  this.height = height;
          }
          public double area() {
                  return width * height;
          }
          public double perimeter() {
                  return 2.0 * (width + height);
          }
          @Override
          public String type() {
                  return "Rectangle";
          }
  }

  public class Triangle implements Shape {
          private double a;
          private double b;
          private double c;
          public Triangle(double a, double b, double c) {
```

```
                this.a = a;
                this.b = b;
                this.c = c;
        }
        public double area() {
                double s = (a + b + c) / 2.0;
                return Math.sqrt(s * (s - a) * (s - b) * (s - c));
        }
        public double perimeter() {
                return a + b + c;
        }
        @Override
        public String type() {
                return "Triangle";
       }
}
```

Step – 2

Add *Test.java* into your project. You are expected to create instances of all 3 subclasses, store these objects in a common array with the type of base interface, and print objects' information by iterating the array. Change the highlighted lines with your own.

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

                        Circle circle = new Circle(5);
                        Rectangle reg   = new Rectangle(3,6);
                        Triangle tri = new Triangle(5,12,13);
                        //-------------------------------------------
                        Shape[] shapes = {circle, reg, tri};
                        //-------------------------------------------
                        for (int i =0;i<shapes.length;i++){
                            System.out.print(shapes[i].type()+"  ");
                            System.out.print("Area : "+shapes[i].area()+"  ");
                            System.out.print("Perimeter : "+shapes[i].perimeter()+"  \n");
                        }
        }
}
```

Step – 3

Paste the output of the Test.java.

Your Code
Circle Area : 78.53981633974483 Perimeter : 31.41592653589793 Rectangle Area : 18.0 Perimeter : 18.0 Triangle Area : 30.0 Perimeter : 30.0

PART 3 –Abstract Classes

There are two ways to achieve abstraction in Java,

1. Interface (100%)
2. Abstract class (0 to 100%)

An abstract class,

- must be declared with an abstract keyword.
- It can have abstract and non-abstract methods.
- It cannot be instantiated.
- It can have constructors and static methods also.
- It can have final methods which will force the subclass not to change the body of the method.

Abstract Class vs Interface

- A class can inherit from only one abstract class, but it can implement multiple interfaces. This is because an abstract class represents a type of object, while an interface represents a set of behaviors.
- Abstract classes can have access modifiers such as public, protected, and private for their methods and properties, while interfaces can only have public access.
- An abstract class can have member variables, while an interface cannot.

Exercise 3. You are given an abstract class named Course.

Course.java

```
public abstract class Course {

	public String code;

	public Course(String courseCode) {
		code = courseCode;
		System.out.println("Opening the course " + courseCode);
	}

	public abstract void Syllabus();

	public void Learn(){
		System.out.println("Preparing the content of " + this.code);
```

```
        }
}
```

Step – 1

Derive two different classes with names *DataStructures.java* (CME2201) and *OperatingSystems.java* (CME3205) from the class *Course*.

Step – 2

In Test.java create instances of classes *DataStructures* and *OperatingSystems*. Call the methods `Syllabus()` and `Learn()`.

Your Code (*DataStructures.java, OperatingSystems.java, and* Test.java)

```
public class Test {
   public static void main(String[] args) {
   DataStructures ds = new DataStructures("CME2201");
   OperatingSystems op = new OperatingSystems("CME3205");

   ds.Syllabus();
   ds.Learn();
   op.Syllabus();
   op.Learn();

   }
}

public class DataStructures extends Course{
   public DataStructures(String courseCode) {
      super(courseCode);
   }

   @Override
   public void Syllabus(){
      System.out.println("This course in we learn  the common data structures that are used in various
computational problems.");
   }
}
public class OperatingSystems extends Course{
   public OperatingSystems(String courseCode) {
      super(courseCode);
   }

   @Override
   public void Syllabus() {
      System.out.println("Operating Systems course help learners understand the different types of operating
systems, from Windows XP to the latest versions of Apple macOS.");
   }
}
```

Your Output

```
Opening the course CME2201
Opening the course CME3205
This course in we learn  the common data structures that are used in various computational problems.
Preparing the content of CME2201
Operating Systems course help learners understand the different types of operating systems, from Windows
```

XP to the latest versions of Apple macOS.
Preparing the content of CME3205

Submission

- Upload your answer sheets in PDF format by naming it as studentID_Name_FamilyName.pdf.
- DO NOT USE any Turkish character or blank in naming the file.