Exercise 1: Implementing the Singleton Pattern

Scenario:

You need to ensure that a logging utility class in your application has only one instance throughout the application lifecycle to ensure consistent logging.

Steps:

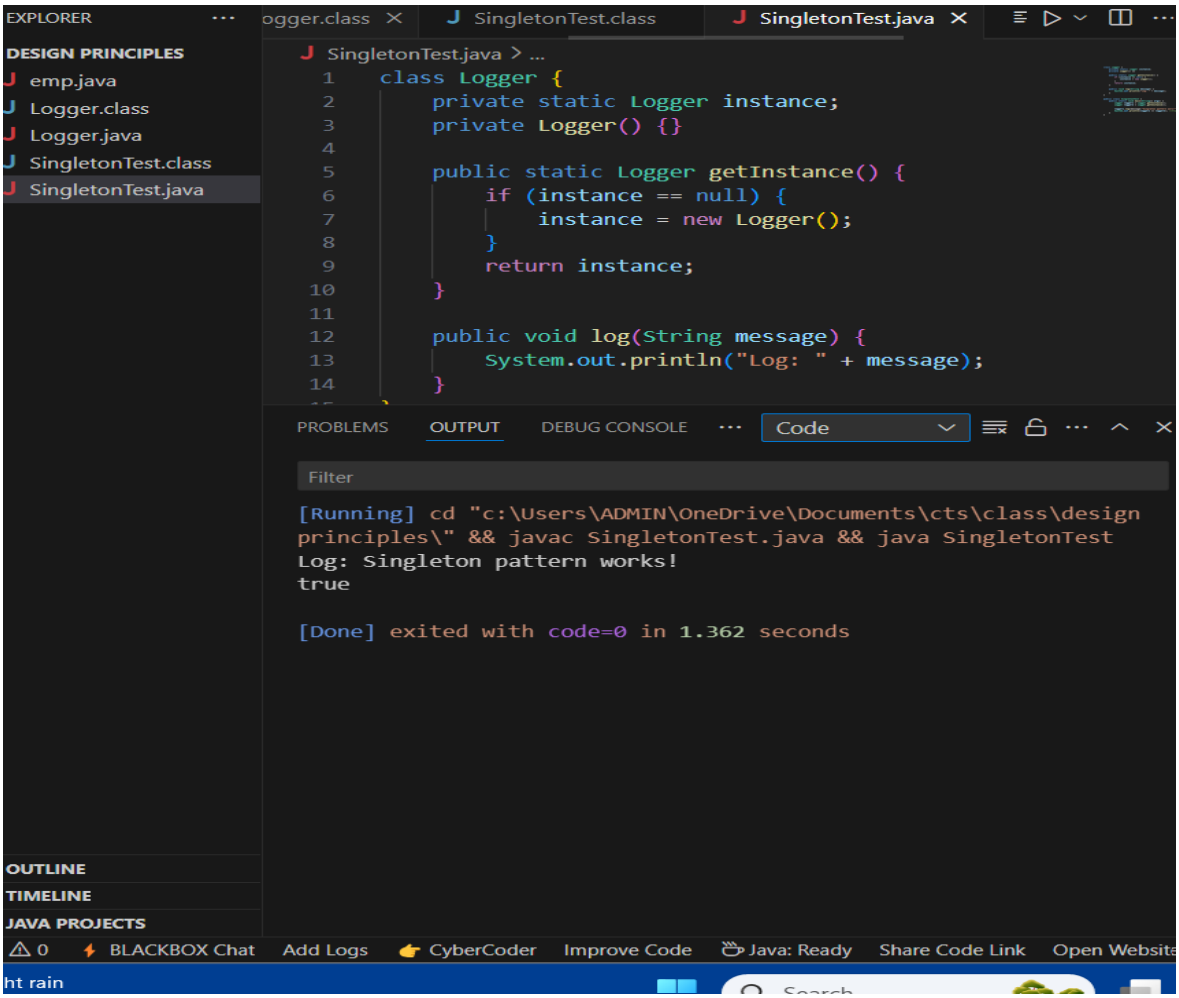
1. **Create a New Java Project:**
    - Create a new Java project named **SingletonPatternExample**.
2. **Define a Singleton Class:**
    - Create a class named Logger that has a private static instance of itself.
    - Ensure the constructor of Logger is private.
    - Provide a public static method to get the instance of the Logger class.
3. **Implement the Singleton Pattern:**
    - Write code to ensure that the Logger class follows the Singleton design pattern.
4. **Test the Singleton Implementation:**
    - Create a test class to verify that only one instance of Logger is created and used across the application.

CODE:

```
 class Logger {
private static Logger instance;
private Logger() {}
public static Logger getInstance() {
   if (instance == null) {
      instance = new Logger();
   }
   return instance;
}
public void log(String message) {
   System.out.println("Log: " + message);
}
```

```
}


class SingletonTest {
    public static void main(String[] args) {
        Logger logger1 = Logger.getInstance();
        Logger logger2 = Logger.getInstance();
        logger1.log("Singleton pattern works!");
        System.out.println(logger1 == logger2); // true
    }
}
```

OUTPUT:



Exercise 2: Implementing the Factory Method Pattern

Scenario:

You are developing a document management system that needs to create different types of documents (e.g., Word, PDF, Excel). Use the Factory Method Pattern to achieve this.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **FactoryMethodPatternExample**.
2. **Define Document Classes:**
    - Create interfaces or abstract classes for different document types such as **WordDocument**, **PdfDocument**, and **ExcelDocument**.
3. **Create Concrete Document Classes:**
    - Implement concrete classes for each document type that implements or extends the above interfaces or abstract classes.
4. **Implement the Factory Method:**
    - Create an abstract class **DocumentFactory** with a method **createDocument()**.
    - Create concrete factory classes for each document type that extends DocumentFactory and implements the **createDocument()** method.
5. **Test the Factory Method Implementation:**
    - Create a test class to demonstrate the creation of different document types using the factory method.

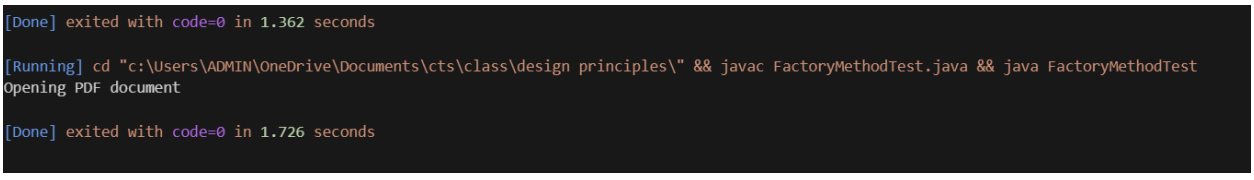
CODE:

```
interface Document {
void open();
}

class WordDocument implements Document {
  public void open() {
    System.out.println("Opening Word document");
```

```
    }
}

class PdfDocument implements Document {
    public void open() {
        System.out.println("Opening PDF document");
    }
}

class ExcelDocument implements Document {
    public void open() {
        System.out.println("Opening Excel document");
    }
}

abstract class DocumentFactory {
    public abstract Document createDocument();
}

class WordFactory extends DocumentFactory {
    public Document createDocument() {
        return new WordDocument();
    }
}

class PdfFactory extends DocumentFactory {
```

```
    public Document createDocument() {
        return new PdfDocument();
    }
}

class ExcelFactory extends DocumentFactory {
    public Document createDocument() {
        return new ExcelDocument();
    }
}

public class FactoryMethodTest {
    public static void main(String[] args) {
        DocumentFactory factory = new PdfFactory();
        Document doc = factory.createDocument();
        doc.open();
    }
}
```

OUTPUT:



Exercise 3: Implementing the Builder Pattern

Scenario:

You are developing a system to create complex objects such as a Computer with multiple optional parts. Use the Builder Pattern to manage the construction process.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **BuilderPatternExample**.
2. **Define a Product Class:**
    - Create a class **Computer** with attributes like **CPU**, **RAM**, **Storage**, etc.
3. **Implement the Builder Class:**
    - Create a static nested Builder class inside Computer with methods to set each attribute.
    - Provide a **build()** method in the Builder class that returns an instance of Computer.
4. **Implement the Builder Pattern:**
    - Ensure that the **Computer** class has a private constructor that takes the **Builder** as a parameter.
5. **Test the Builder Implementation:**
    - Create a test class to demonstrate the creation of different configurations of Computer using the Builder pattern.

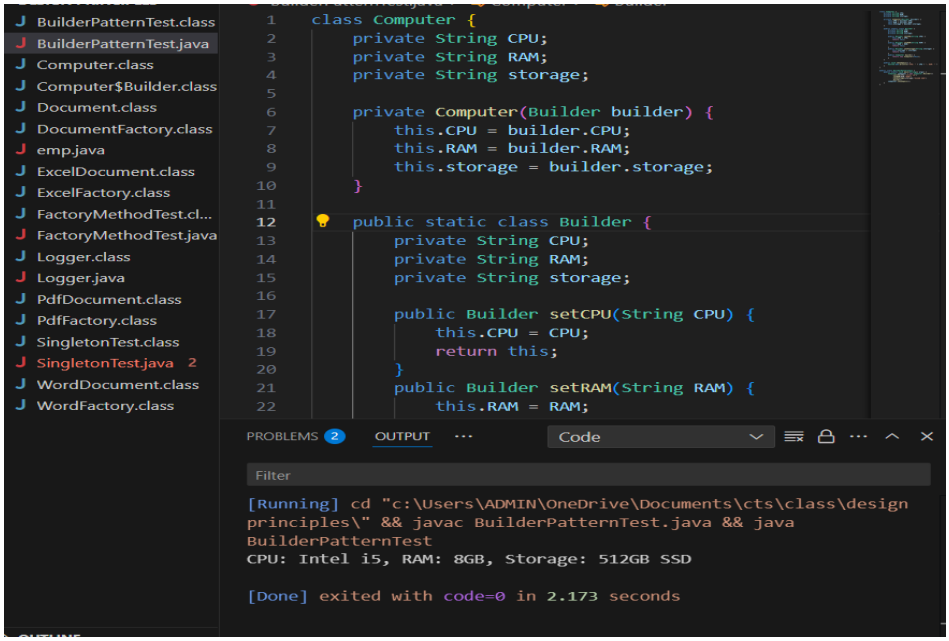
CODE:

```
class Computer {
private String CPU;
private String RAM;
private String storage;

private Computer(Builder builder) {
   this.CPU = builder.CPU;
   this.RAM = builder.RAM;
   this.storage = builder.storage;
}

public static class Builder {
   private String CPU;
```

```
        private String RAM;
        private String storage;

        public Builder setCPU(String CPU) {
            this.CPU = CPU;
            return this;
        }
        public Builder setRAM(String RAM) {
            this.RAM = RAM;
            return this;
        }
        public Builder setStorage(String storage) {
            this.storage = storage;
            return this;
        }
        public Computer build() {
            return new Computer(this);
        }
    }

    public void showSpecs() {
        System.out.println("CPU: " + CPU + ", RAM: " + RAM + ", Storage: " + storage);
    }
}

public class BuilderPatternTest {
    public static void main(String[] args) {
        Computer computer = new Computer.Builder()
            .setCPU("Intel i5")
```

```
        .setRAM("8GB")
        .setStorage("512GB SSD")
        .build();
    computer.showSpecs();
  }
}
```

OUTPUT:



Exercise 4: Implementing the Adapter Pattern

Scenario:

You are developing a payment processing system that needs to integrate with multiple third-party payment gateways with different interfaces. Use the Adapter Pattern to achieve this.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **AdapterPatternExample**.
2. **Define Target Interface:**
    - Create an interface **PaymentProcessor** with methods like **processPayment()**.
3. **Implement Adaptee Classes:**

- Create classes for different payment gateways with their own methods.

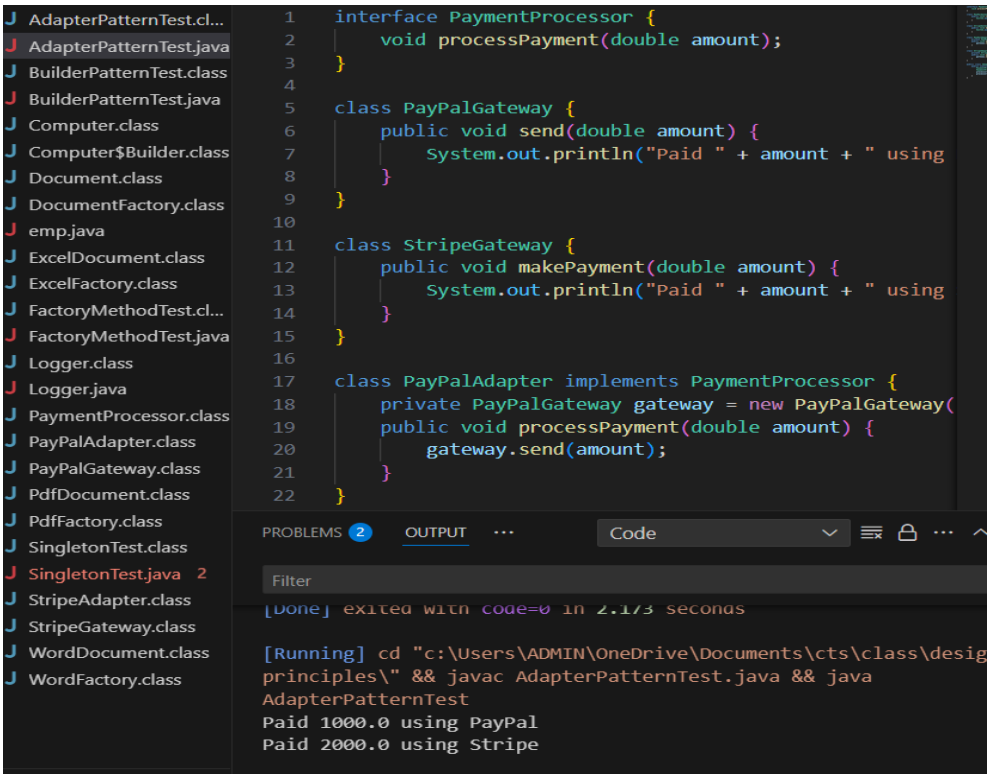
4. **Implement the Adapter Class:**
   - Create an adapter class for each payment gateway that implements PaymentProcessor and translates the calls to the gateway-specific methods.
5. **Test the Adapter Implementation:**
   - Create a test class to demonstrate the use of different payment gateways through the adapter.

CODE:

```
interface PaymentProcessor {
   void processPayment(double amount);
}


class PayPalGateway {
   public void send(double amount) {
      System.out.println("Paid " + amount + " using PayPal");
   }
}


class StripeGateway {
   public void makePayment(double amount) {
      System.out.println("Paid " + amount + " using Stripe");
   }
}
class PayPalAdapter implements PaymentProcessor {
   private PayPalGateway gateway = new PayPalGateway();
   public void processPayment(double amount) {
```

```
        gateway.send(amount);
    }
}
class StripeAdapter implements PaymentProcessor {
    private StripeGateway gateway = new StripeGateway();
    public void processPayment(double amount) {
        gateway.makePayment(amount);
    }
}
public class AdapterPatternTest {
    public static void main(String[] args) {
        PaymentProcessor processor1 = new PayPalAdapter();
        PaymentProcessor processor2 = new StripeAdapter();
        processor1.processPayment(1000);
        processor2.processPayment(2000);
    }
}
```

OUTPUT:



Exercise 5: Implementing the Decorator Pattern

Scenario:

You are developing a notification system where notifications can be sent via multiple channels (e.g., Email, SMS). Use the Decorator Pattern to add functionalities dynamically.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **DecoratorPatternExample**.
2. **Define Component Interface:**
    - Create an interface **Notifier** with a method **send()**.
3. **Implement Concrete Component:**
    - Create a class **EmailNotifier** that implements Notifier.
4. **Implement Decorator Classes:**
    - Create abstract decorator class **NotifierDecorator** that implements **Notifier** and holds a reference to a **Notifier** object.

- Create concrete decorator classes like **SMSNotifierDecorator**, **SlackNotifierDecorator** that extend **NotifierDecorator**.

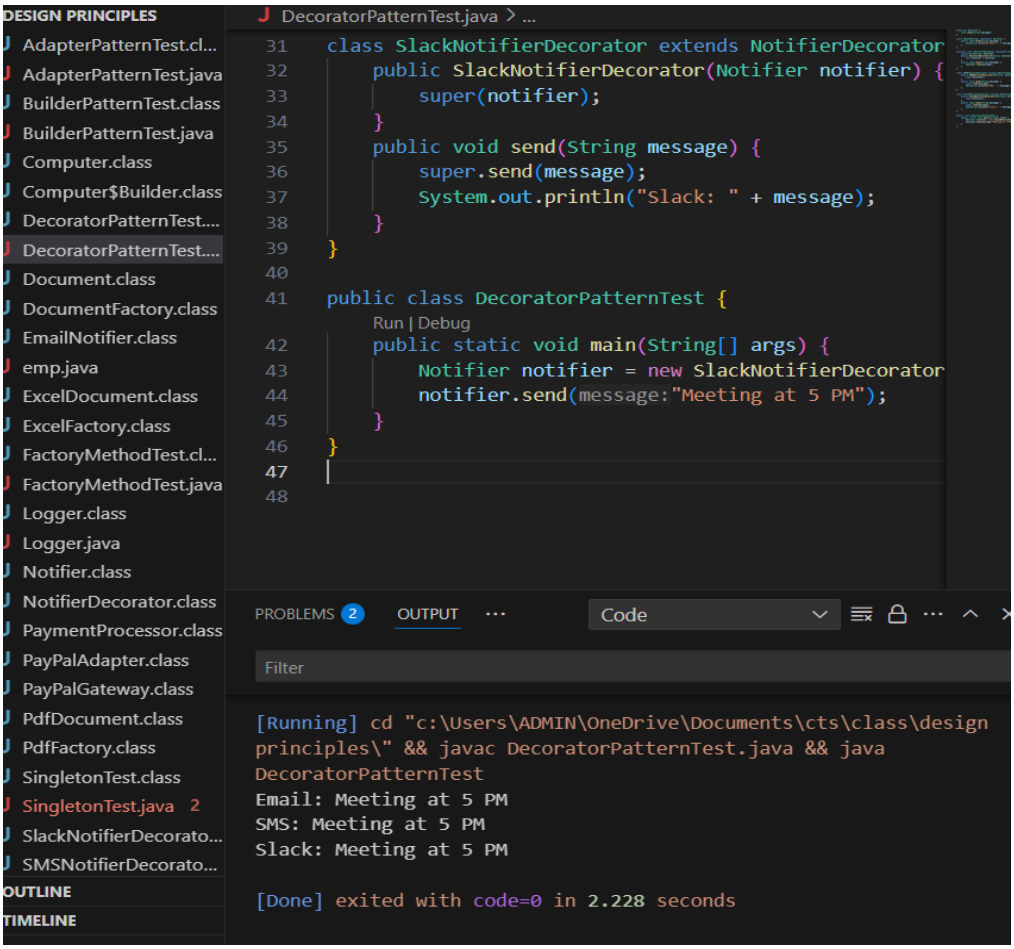
5. **Test the Decorator Implementation:**
   - Create a test class to demonstrate sending notifications via multiple channels using decorators.

CODE:

```
interface Notifier {
  void send(String message);
}

class EmailNotifier implements Notifier {
  public void send(String message) {
    System.out.println("Email: " + message);
  }
}

abstract class NotifierDecorator implements Notifier {
  protected Notifier notifier;
  public NotifierDecorator(Notifier notifier) {
    this.notifier = notifier;
  }
  public void send(String message) {
    notifier.send(message);
  }
}

class SMSNotifierDecorator extends NotifierDecorator {
  public SMSNotifierDecorator(Notifier notifier) {
    super(notifier);
```

```
    }
    public void send(String message) {
        super.send(message);
        System.out.println("SMS: " + message);
    }
}

class SlackNotifierDecorator extends NotifierDecorator {
    public SlackNotifierDecorator(Notifier notifier) {
        super(notifier);
    }
    public void send(String message) {
        super.send(message);
        System.out.println("Slack: " + message);
    }
}

public class DecoratorPatternTest {
    public static void main(String[] args) {
        Notifier notifier = new SlackNotifierDecorator(new SMSNotifierDecorator(new EmailNotifier()));
        notifier.send("Meeting at 5 PM");
    }
}
```

OUTPUT:



Exercise 6: Implementing the Proxy Pattern

Scenario:

You are developing an image viewer application that loads images from a remote server. Use the Proxy Pattern to add lazy initialization and caching.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **ProxyPatternExample**.
2. **Define Subject Interface:**
    - Create an interface Image with a method **display()**.
3. **Implement Real Subject Class:**
    - Create a class **RealImage** that implements Image and loads an image from a remote server.

4. **Implement Proxy Class:**
    - Create a class **ProxyImage** that implements Image and holds a reference to RealImage.
    - Implement lazy initialization and caching in **ProxyImage**.
5. **Test the Proxy Implementation:**
    - Create a test class to demonstrate the use of **ProxyImage** to load and display images.

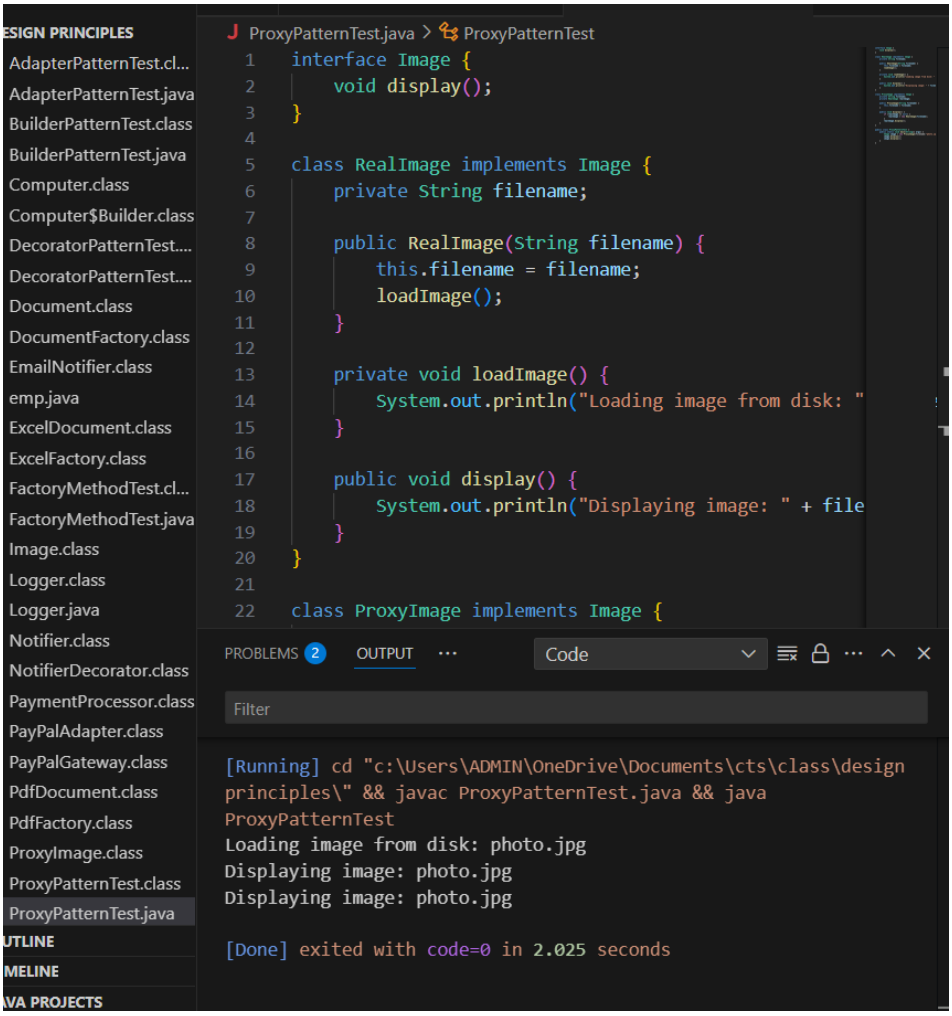
CODE:

```
interface Image {
   void display();
}

class RealImage implements Image {
   private String filename;

   public RealImage(String filename) {
      this.filename = filename;
      loadImage();
   }

   private void loadImage() {
      System.out.println("Loading image from disk: " + filename);
   }

   public void display() {
      System.out.println("Displaying image: " + filename);
```

```
    }
}

class ProxyImage implements Image {
    private String filename;
    private RealImage realImage;

    public ProxyImage(String filename) {
        this.filename = filename;
    }

    public void display() {
        if (realImage == null) {
            realImage = new RealImage(filename);
        }
        realImage.display();
    }
}

public class ProxyPatternTest {
    public static void main(String[] args) {
        Image image = new ProxyImage("photo.jpg");
        image.display();
        image.display();
```

```
    }
}
```

OUTPUT:



Exercise 7: Implementing the Observer Pattern

Scenario:

You are developing a stock market monitoring application where multiple clients need to be notified whenever stock prices change. Use the Observer Pattern to achieve this.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **ObserverPatternExample**.
2. **Define Subject Interface:**

- Create an interface **Stock** with methods to **register**, **deregister**, and **notify** observers.

3. **Implement Concrete Subject:**
   - Create a class **StockMarket** that implements **Stock** and maintains a list of observers.
4. **Define Observer Interface:**
   - Create an interface Observer with a method **update().**
5. **Implement Concrete Observers:**
   - Create classes **MobileApp**, **WebApp** that implement Observer.
6. **Test the Observer Implementation:**
   - Create a test class to demonstrate the registration and notification of observers.

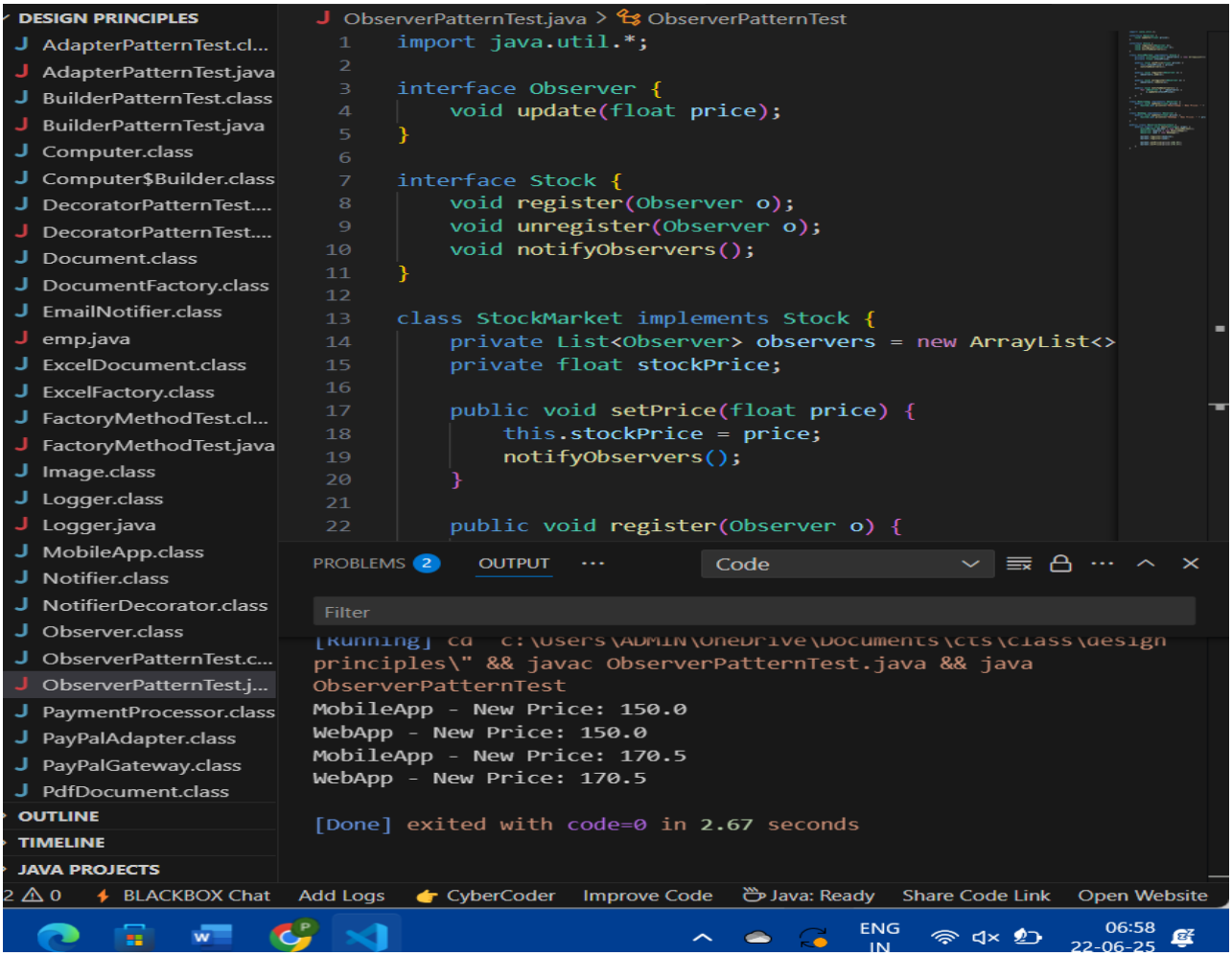
CODE:

```
import java.util.*;
interface Observer {
   void update(float price);
}
interface Stock {
   void register(Observer o);
   void unregister(Observer o);
   void notifyObservers();
}
class StockMarket implements Stock {
   private List<Observer> observers = new ArrayList<>();
   private float stockPrice;
   public void setPrice(float price) {
      this.stockPrice = price;
      notifyObservers();
   }
   public void register(Observer o) {
      observers.add(o);
   }
```

```
    public void unregister(Observer o) {
        observers.remove(o);
    }
    public void notifyObservers() {
        for (Observer o : observers) {
            o.update(stockPrice);
        }
    }
}
class MobileApp implements Observer {
    public void update(float price) {
        System.out.println("MobileApp - New Price: " + price);
    }
}

class WebApp implements Observer {
    public void update(float price) {
        System.out.println("WebApp - New Price: " + price);
    }
}
public class ObserverPatternTest {
    public static void main(String[] args) {
        StockMarket market = new StockMarket();
        Observer mobile = new MobileApp();
        Observer web = new WebApp();
        market.register(mobile);
        market.register(web);
```

```
        market.setPrice(150.0f);
        market.setPrice(170.5f);
    }
}
```

OUTPUT:



Exercise 8: Implementing the Strategy Pattern

Scenario:

You are developing a payment system where different payment methods (e.g., Credit Card, PayPal) can be selected at runtime. Use the Strategy Pattern to achieve this.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **StrategyPatternExample**.

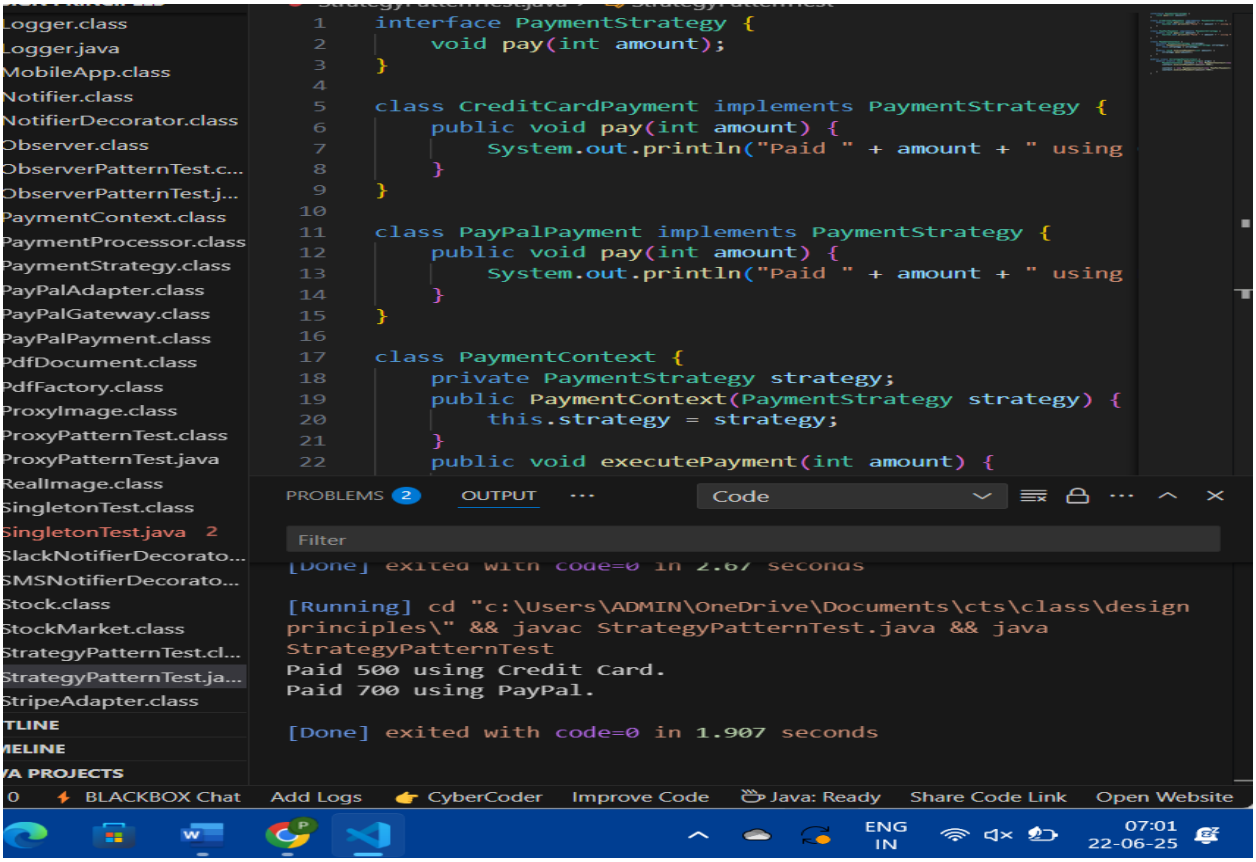
2. **Define Strategy Interface:**
    - Create an interface PaymentStrategy with a method **pay()**.
3. **Implement Concrete Strategies:**
    - Create classes **CreditCardPayment**, **PayPalPayment** that implement **PaymentStrategy**.
4. **Implement Context Class:**
    - Create a class **PaymentContext** that holds a reference to **PaymentStrategy** and a method to execute the strategy.
5. **Test the Strategy Implementation:**
    - Create a test class to demonstrate selecting and using different payment strategies.

CODE:

```
interface PaymentStrategy {
   void pay(int amount);
}

class CreditCardPayment implements PaymentStrategy {
   public void pay(int amount) {
      System.out.println("Paid " + amount + " using Credit Card.");
   }
}

class PayPalPayment implements PaymentStrategy {
   public void pay(int amount) {
      System.out.println("Paid " + amount + " using PayPal.");
   }
}

class PaymentContext {
   private PaymentStrategy strategy;
```

```
    public PaymentContext(PaymentStrategy strategy) {
        this.strategy = strategy;
    }
    public void executePayment(int amount) {
        strategy.pay(amount);
    }
}

public class StrategyPatternTest {
    public static void main(String[] args) {
        PaymentContext context = new PaymentContext(new CreditCardPayment());
        context.executePayment(500);

        context = new PaymentContext(new PayPalPayment());
        context.executePayment(700);
    }
}
```

OUTPUT:



Exercise 9: Implementing the Command Pattern

Scenario: You are developing a home automation system where commands can be issued to turn devices on or off. Use the Command Pattern to achieve this.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **CommandPatternExample**.
2. **Define Command Interface:**
    - Create an interface Command with a method **execute()**.
3. **Implement Concrete Commands:**
    - Create classes **LightOnCommand**, **LightOffCommand** that implement Command.
4. **Implement Invoker Class:**
    - Create a class **RemoteControl** that holds a reference to a Command and a method to execute the command.
5. **Implement Receiver Class:**

- Create a class **Light** with methods to turn on and off.

6. **Test the Command Implementation:**
   - Create a test class to demonstrate issuing commands using the **RemoteControl**.

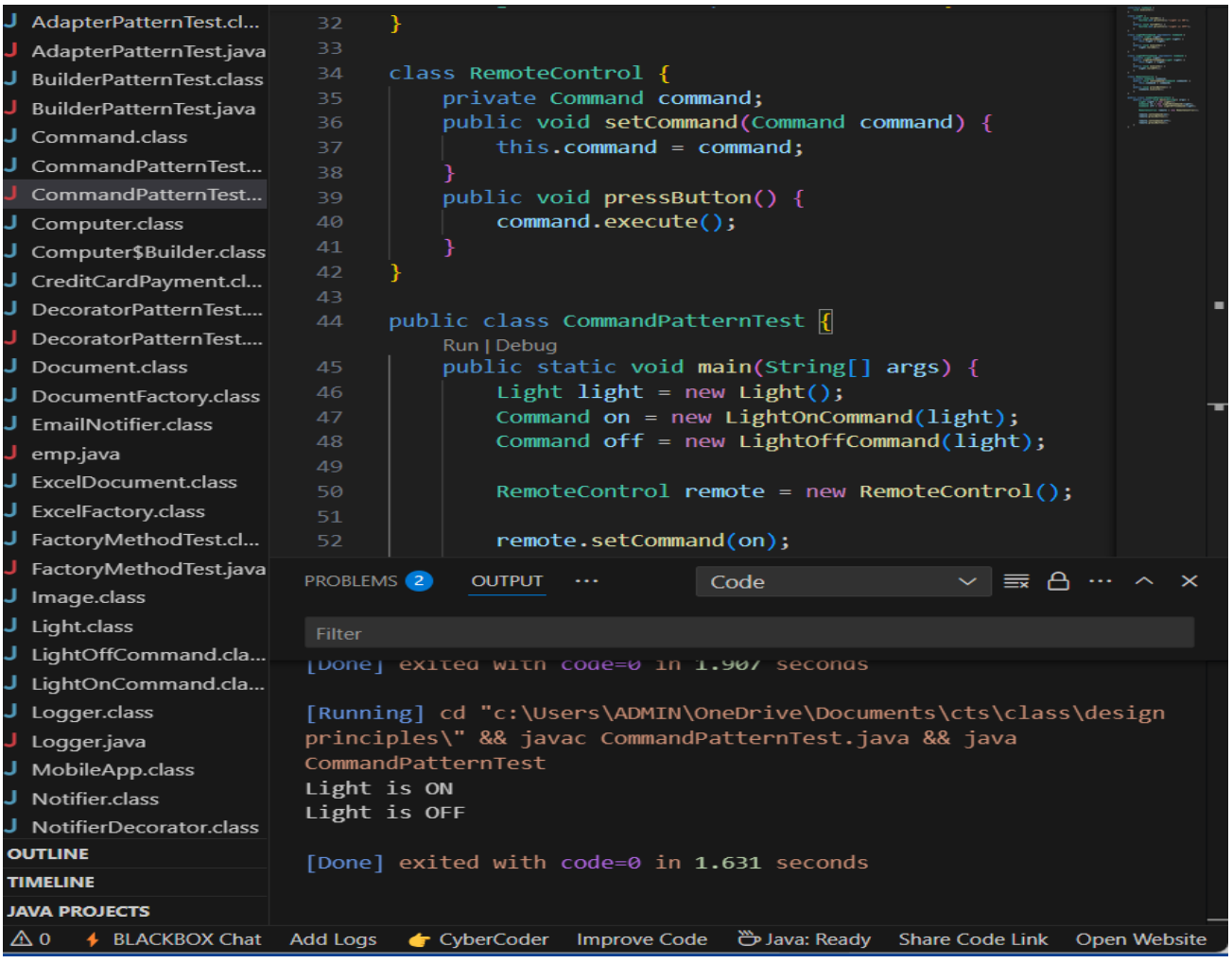
CODE:

```
interface Command {
   void execute();
}
class Light {
   public void turnOn() {
      System.out.println("Light is ON");
   }
public void turnOff() {
      System.out.println("Light is OFF");
   }
}
class LightOnCommand implements Command {
   private Light light;
   public LightOnCommand(Light light) {
      this.light = light;
   }
   public void execute() {
      light.turnOn();
   }
}
```

```
class LightOffCommand implements Command {
    private Light light;
    public LightOffCommand(Light light) {
        this.light = light;
    }
    public void execute() {
        light.turnOff();
    }
}
class RemoteControl {
    private Command command;
    public void setCommand(Command command) {
        this.command = command;
    }
    public void pressButton() {
        command.execute();
    }
}
public class CommandPatternTest {
    public static void main(String[] args) {
        Light light = new Light();
        Command on = new LightOnCommand(light);
        Command off = new LightOffCommand(light);
```

```
        RemoteControl remote = new RemoteControl();
        remote.setCommand(on);
        remote.pressButton();
        remote.setCommand(off);
        remote.pressButton();
    }
}
```

OUTPUT:



Exercise 10: Implementing the MVC Pattern

Scenario:

You are developing a simple web application for managing student records using the MVC pattern.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **MVCPatternExample**.
2. **Define Model Class:**
    - Create a class **Student** with attributes like **name, id, and grade**.
3. **Define View Class:**
    - Create a class **StudentView** with a method **displayStudentDetails()**.
4. **Define Controller Class:**
    - Create a class **StudentController** that handles the communication between the model and the view.
5. **Test the MVC Implementation:**
    - Create a main class to demonstrate creating a **Student**, updating its details using **StudentController**, and displaying them using **StudentView**.

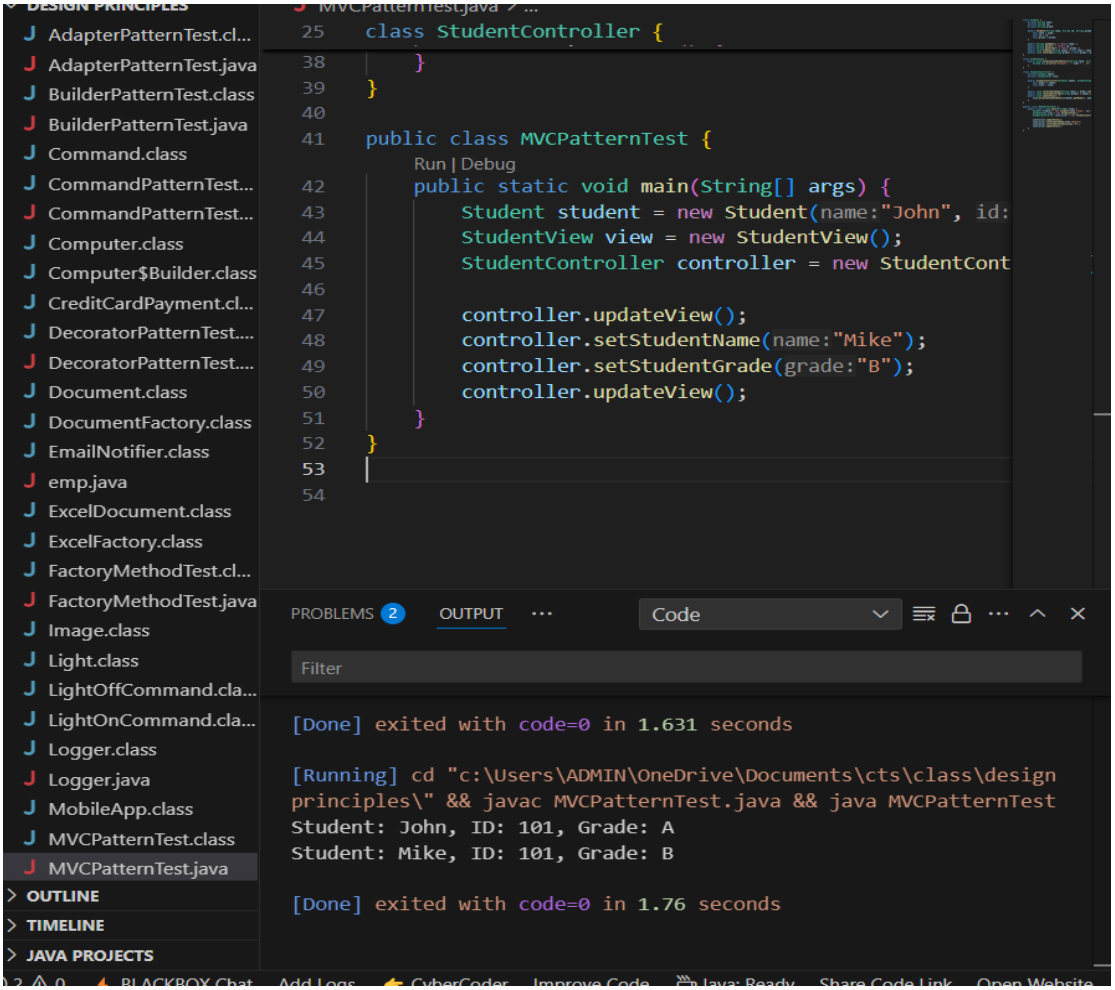
CODE:

```
class Student {
   private String name;
   private String id;
   private String grade;
   public Student(String name, String id, String grade) {
      this.name = name;
      this.id = id;
      this.grade = grade;
   }
   public String getName() { return name; }
   public String getId() { return id; }
```

```
    public String getGrade() { return grade; }
    public void setName(String name) { this.name = name; }
    public void setGrade(String grade) { this.grade = grade; }
}
class StudentView {
    public void displayStudentDetails(String name, String id, String grade) {
        System.out.println("Student: " + name + ", ID: " + id + ", Grade: " + grade);
    }
}
class StudentController {
    private Student model;
    private StudentView view;
    public StudentController(Student model, StudentView view) {
        this.model = model;
        this.view = view;
    }
    public void setStudentName(String name) { model.setName(name); }
    public void setStudentGrade(String grade) { model.setGrade(grade); }
    public void updateView() {
        view.displayStudentDetails(model.getName(), model.getId(),
model.getGrade());
    }
}
public class MVCPatternTest {
    public static void main(String[] args) {
```

```
        Student student = new Student("John", "101", "A");
        StudentView view = new StudentView();
        StudentController controller = new StudentController(student, view);

        controller.updateView();
        controller.setStudentName("Mike");
        controller.setStudentGrade("B");
        controller.updateView();
    }
}
```

OUTPUT:



Exercise 11: Implementing Dependency Injection

Scenario:

You are developing a customer management application where the service class depends on a repository class. Use Dependency Injection to manage these dependencies.

Steps:

1. **Create a New Java Project:**
    - Create a new Java project named **DependencyInjectionExample**.
2. **Define Repository Interface:**
    - Create an interface **CustomerRepository** with methods like **findCustomerById()**.
3. **Implement Concrete Repository:**
    - Create a class **CustomerRepositoryImpl** that implements **CustomerRepository**.
4. **Define Service Class:**

- Create a class **CustomerService** that depends on **CustomerRepository**.

5. **Implement Dependency Injection:**
   - Use constructor injection to inject **CustomerRepository** into **CustomerService**.
6. **Test the Dependency Injection Implementation:**
   - Create a main class to demonstrate creating a **CustomerService** with **CustomerRepositoryImpl** and using it to find a customer.

CODE:

```
interface CustomerRepository {
   String findCustomerById(String id);
}

class CustomerRepositoryImpl implements CustomerRepository {
   public String findCustomerById(String id) {
      return "Customer " + id;
   }
}

class CustomerService {
   private CustomerRepository repository;
   public CustomerService(CustomerRepository repository) {
      this.repository = repository;
   }
   public void displayCustomer(String id) {
      System.out.println(repository.findCustomerById(id));
   }
}

public class DependencyInjectionTest {
```

```
    public static void main(String[] args) {
        CustomerRepository repo = new CustomerRepositoryImpl();
        CustomerService service = new CustomerService(repo);
        service.displayCustomer("C001");
    }
}
```

OUTPUT: