

DESIGN PRINCIPLES AND DESIGN PATTERNS EXERCISES

Exercise 1: Implementing the Singleton Pattern

```
class Logger {  
  
    private static Logger singleInstance = new Logger();  
  
    private Logger() {  
        System.out.println("Logger instance created.");  
    }  
  
    public static Logger getInstance() {  
        return singleInstance;  
    }  
  
    public void log(String message) {  
        System.out.println("Log message: " + message);  
    }  
}  
  
public class SingletonPrinciple {  
  
    public static void main(String[] args) {  
        Logger logger1 = Logger.getInstance();  
        Logger logger2 = Logger.getInstance();  
  
        logger1.log("This is the first log message.");  
        logger2.log("This is the second log message.");  
  
        if (logger1 == logger2) {  
            System.out.println("Both logger instances are the same (Singleton works!).");  
        } else {  
            System.out.println("Logger instances are different (Singleton failed!).");  
        }  
    }  
}
```

```

}

}

}

```

OUTPUT:

The screenshot shows the Eclipse IDE with the SingletonPattern.java file open. The code defines a Logger class with a private static instance and a public static getInstance() method. The terminal output shows the execution of the program, which prints "Logger instance created." and "Log message: This is the first log message." and "Log message: This is the second log message." and "Both logger instances are the same (Singleton works!)."

```

J SingletonPrinciple.java > Logger
1 class Logger {
2     private static Logger singleInstance = new Logger();
3
4     private Logger() {
5         System.out.println(x:"Logger instance created.");
6     }
7
8     public static Logger getInstance() {
9         return singleInstance;
10    }
11 }

```

```

PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15.6-hotspot\bin\java.exe' '-XX:+ShowCodeDetail'
sInExceptionMessages' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cfc4c37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task
_c6d82496\bin' 'SingletonPrinciple'
Logger instance created.
Log message: This is the first log message.
Log message: This is the second log message.
Both logger instances are the same (Singleton works!).
PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task>

```

Exercise 2: Implementing the Factory Method Pattern

```

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

class PdfDocumentFactory extends DocumentFactory {
    public Document createDocument() {
        return new PdfDocument();
    }
}

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

public class FactoryMethod {
    public static void main(String[] args) {
        DocumentFactory wordFactory = new WordDocumentFactory();
        Document word = wordFactory.createDocument();
        word.open();

        DocumentFactory pdfFactory = new PdfDocumentFactory();
        Document pdf = pdfFactory.createDocument();
        pdf.open();

        DocumentFactory excelFactory = new ExcelDocumentFactory();
        Document excel = excelFactory.createDocument();
        excel.open();
    }
}

```

OUTPUT:

The screenshot shows the Eclipse IDE interface. The top toolbar includes icons for File, Edit, Selection, View, Go, Run, and other standard IDE functions. The project explorer on the left shows a package named 'CTS task' containing several Java files: SingletonPrinciple.java, FactoryMethod.java, BuilderPattern.java, AdapterPattern.java, DecoratorPatternExample.java, and ProxyPattern.java. The 'FactoryMethod.java' file is currently open in the editor. The code in the editor matches the code provided in the first block. The 'Run' button (a green play icon) is visible above the code editor. The bottom of the IDE features a multi-tabbed console area. The 'TERMINAL' tab is active, displaying the command prompt output. The command executed is: `PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15.6-hotspot\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessages' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cf4c37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task_c6d82496\bin' 'FactoryMethod'`. The output shows the program running successfully, with messages: 'Opening Word Document...', 'Opening PDF Document...', and 'Opening Excel Document...'. The prompt returns to the command line. On the right side of the terminal, there are three tabs: 'powershell', 'powershell', and 'Run: Singlet...', with a fourth tab 'Run: Factory...' partially visible.

Exercise 3: Implementing the Builder Pattern

```
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 void showConfig() {
        System.out.println("CPU: " + cpu);
        System.out.println("RAM: " + ram);
        System.out.println("Storage: " + 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;
        }

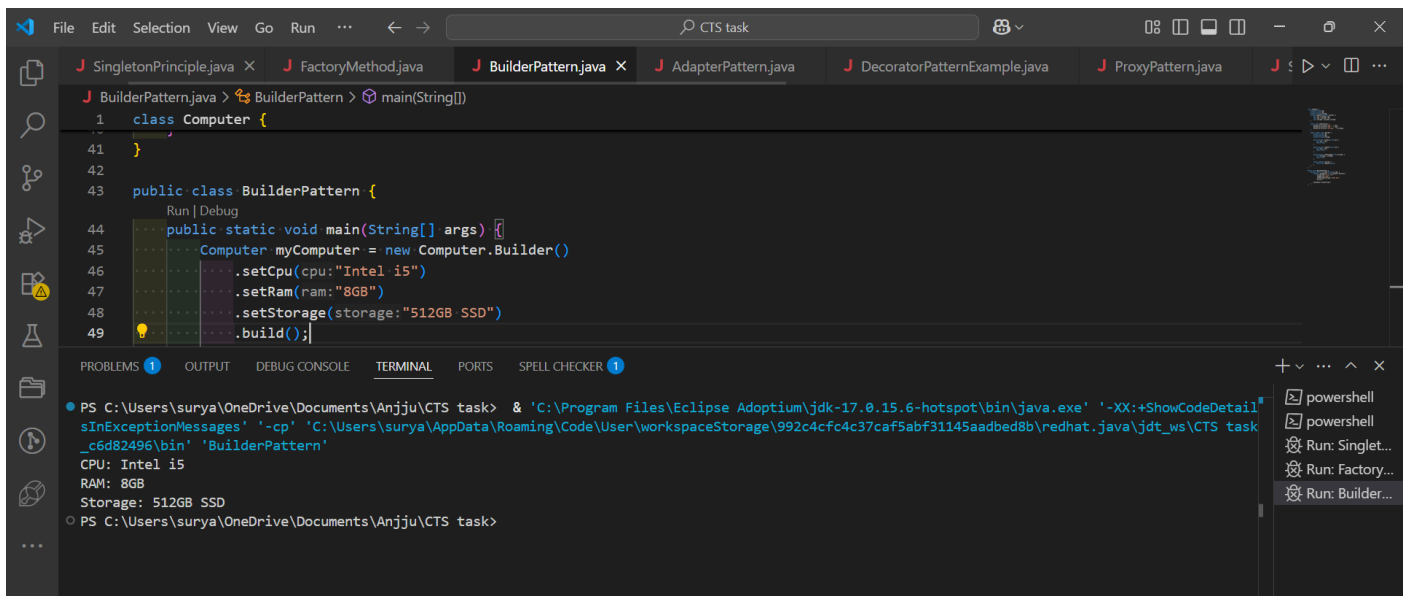
        public Builder setStorage(String storage) {
            this.storage = storage;
            return this;
        }

        public Computer build() {
            return new Computer(this);
        }
    }
}

public class BuilderPattern {
    public static void main(String[] args) {
        Computer myComputer = new Computer.Builder()
            .setCpu("Intel i5")
            .setRam("8GB")
            .setStorage("512GB SSD")
            .build();

        myComputer.showConfig();
    }
}
```

OUTPUT:



The screenshot shows an IDE with several Java files open. The active file is `BuilderPattern.java`, which contains the following code:

```
1 class Computer {  
41 }  
42  
43 public class BuilderPattern {  
44     public static void main(String[] args) {  
45         Computer myComputer = new Computer.Builder()  
46             .setCpu(cpu:"Intel i5")  
47             .setRam(ram:"8GB")  
48             .setStorage(storage:"512GB SSD")  
49             .build();  
    }
```

The terminal output shows the command executed and the resulting output:

```
PS C:\Users\surya\OneDrive\Documents\Anju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15.6-hotspot\bin\java.exe' '-XX:+ShowCodeDetails'  
sInExceptionMessages' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cf4c37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task'  
_c6d82496\bin' 'BuilderPattern'  
CPU: Intel i5  
RAM: 8GB  
Storage: 512GB SSD  
PS C:\Users\surya\OneDrive\Documents\Anju\CTS task>
```

Exercise 4: Implementing the Adapter Pattern

```
interface PaymentProcessor {  
    void processPayment(double amount);  
}  
  
class PhonePeGateway {  
    public void sendPayment(double amount) {  
        System.out.println("Processing payment of ₹" + amount + " through PhonePe.");  
    }  
}  
  
class PaytmGateway {  
    public void makePayment(double amount) {  
        System.out.println("Processing payment of ₹" + amount + " through Paytm.");  
    }  
}  
  
class GPayGateway {  
    public void performTransaction(double amount) {  
        System.out.println("Processing payment of ₹" + amount + " through GPay.");  
    }  
}  
  
class PhonePeAdapter implements PaymentProcessor {  
    private PhonePeGateway phonePe;  
  
    public PhonePeAdapter(PhonePeGateway phonePe) {  
        this.phonePe = phonePe;  
    }  
  
    public void processPayment(double amount) {  
        phonePe.sendPayment(amount);  
    }  
}  
  
class PaytmAdapter implements PaymentProcessor {  
    private PaytmGateway paytm;
```

```

public PaytmAdapter(PaytmGateway paytm) {
    this.paytm = paytm;
}

public void processPayment(double amount) {
    paytm.makePayment(amount);
}
}

class GPayAdapter implements PaymentProcessor {
    private GPayGateway gpay;

    public GPayAdapter(GPayGateway gpay) {
        this.gpay = gpay;
    }

    public void processPayment(double amount) {
        gpay.performTransaction(amount);
    }
}

public class AdapterPattern {
    public static void main(String[] args) {
        PaymentProcessor phonePeProcessor = new PhonePeAdapter(new PhonePeGateway());
        phonePeProcessor.processPayment(100.00);

        PaymentProcessor paytmProcessor = new PaytmAdapter(new PaytmGateway());
        paytmProcessor.processPayment(250.50);

        PaymentProcessor gpayProcessor = new GPayAdapter(new GPayGateway());
        gpayProcessor.processPayment(75.25);
    }
}

```

OUTPUT:

The screenshot shows an IDE with several Java files open. The active file is AdapterPattern.java, which contains the code for the Adapter Pattern. The terminal output shows the execution of the program, demonstrating how the Adapter Pattern is used to process payments through different gateways (PhonePe, Paytm, GPay).

```

PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15.6-hotspot\bin\java.exe' '-XX:+ShowCodeDetails' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cfc4c37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task\_c6d82496\bin' 'AdapterPattern'
Processing payment of ?100.0 through PhonePe.
Processing payment of ?250.5 through Paytm.
Processing payment of ?75.25 through GPay.
PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task>

```

Exercise 5: Implementing the Decorator Pattern

```

interface Notifier {
    void send();
}

class EmailNotifier implements Notifier {
    public void send() {
        System.out.println("Sending Email Notification");
    }
}

abstract class NotifierDecorator implements Notifier {
    protected Notifier notifier;

    public NotifierDecorator(Notifier notifier) {
        this.notifier = notifier;
    }
    public void send() {
        notifier.send();
    }
}

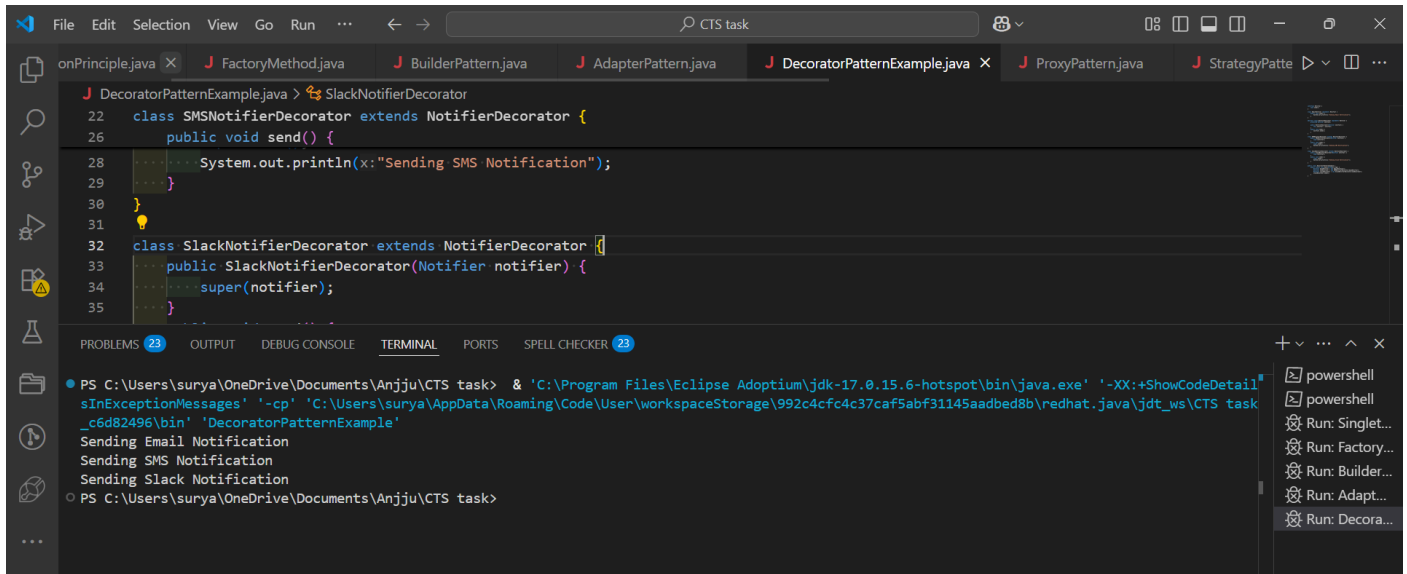
class SMSNotifierDecorator extends NotifierDecorator {
    public SMSNotifierDecorator(Notifier notifier) {
        super(notifier);
    }
    public void send() {
        super.send();
        System.out.println("Sending SMS Notification");
    }
}

class SlackNotifierDecorator extends NotifierDecorator {
    public SlackNotifierDecorator(Notifier notifier) {
        super(notifier);
    }
    public void send() {
        super.send();
        System.out.println("Sending Slack Notification");
    }
}

public class DecoratorPatternExample {
    public static void main(String[] args) {
        Notifier baseNotifier = new EmailNotifier();
        Notifier smsDecorator = new SMSNotifierDecorator(baseNotifier);
        Notifier slackDecorator = new SlackNotifierDecorator(smsDecorator);
        slackDecorator.send();
    }
}

```

OUTPUT:



Exercise 6: Implementing the Proxy Pattern

```

interface Image {
    void display();
}

class ReallImage implements Image {
    private String filename;
    public ReallImage(String filename) {
        this.filename = filename;
        loadFromRemoteServer();
    }

    private void loadFromRemoteServer() {
        System.out.println("Loading image from remote server: " + filename);
    }

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

class ProxyImage implements Image {
    private String filename;
    private ReallImage reallImage;

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

    public void display() {
        if (reallImage == null) {
            reallImage = new ReallImage(filename);
        }
        reallImage.display();
    }
}

public class ProxyPattern {
    public static void main(String[] args) {
        Image image1 = new ProxyImage("photo1.jpg");
    }
}

```



```

Image image2 = new ProxyImage("photo2.jpg");

image1.display();
image1.display();
image2.display();
image2.display();
}
}

```

OUTPUT:

The screenshot shows the Eclipse IDE with the ProxyPattern.java file open. The code defines a ProxyImage class that implements the Image interface. It has a constructor that takes a filename and a display() method that checks if a realImage is null. If it is, it creates a RealImage object and then displays it. The terminal output shows the execution of the program, which displays two images: photo1.jpg and photo2.jpg. The output is as follows:

```

PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15.6-hotspot\bin\java.exe' '-XX:+ShowCodeDetails' 'sInExceptionMessages' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cfc37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task\_c6d82496\bin' 'ProxyPattern'
Loading image from remote server: photo1.jpg
Displaying image: photo1.jpg
Displaying image: photo1.jpg
Loading image from remote server: photo2.jpg
Displaying image: photo2.jpg
Displaying image: photo2.jpg
PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task>

```

Exercise 7: Implementing the Observer Pattern

```

import java.util.*;

interface Stock {
    void registerObserver(Observer observer);
    void deregisterObserver(Observer observer);
    void notifyObservers();
}

interface Observer {
    void update(String stockName, double stockPrice);
}

class StockMarket implements Stock {
    private List<Observer> observers = new ArrayList<>();
    private String stockName;
    private double stockPrice;

    public void setStockPrice(String stockName, double stockPrice) {
        this.stockName = stockName;
        this.stockPrice = stockPrice;
        notifyObservers();
    }

    public void registerObserver(Observer observer) {
        observers.add(observer);
    }
}

```

```

public void deregisterObserver(Observer observer) {
    observers.remove(observer);
}

public void notifyObservers() {
    for (Observer observer : observers) {
        observer.update(stockName, stockPrice);
    }
}
}

class MobileApp implements Observer {
    public void update(String stockName, double stockPrice) {
        System.out.println("MobileApp - " + stockName + ": ₹" + stockPrice);
    }
}

class WebApp implements Observer {
    public void update(String stockName, double stockPrice) {
        System.out.println("WebApp - " + stockName + ": ₹" + stockPrice);
    }
}

public class ObserverPattern {
    public static void main(String[] args) {
        StockMarket stockMarket = new StockMarket();
        Observer mobileApp = new MobileApp();
        Observer webApp = new WebApp();
        stockMarket.registerObserver(mobileApp);
        stockMarket.registerObserver(webApp);
        stockMarket.setStockPrice("TCS", 3750.50);
        stockMarket.setStockPrice("Infosys", 1520.10);
        stockMarket.deregisterObserver(mobileApp);
        stockMarket.setStockPrice("Wipro", 420.75);
    }
}

```

OUTPUT:

The screenshot shows the Eclipse IDE with the file `ObserverPattern.java` open. The code in the editor matches the code block above. The bottom panel shows the `OUTPUT` tab with the following text:

```

PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15-hotspot\bin\java.exe' '-XX:+ShowCodeDetails'
sInExceptionMessages' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cfc4c37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task
_c6d82496\bin' 'ObserverPattern'
MobileApp - TCS: ₹3750.5
WebApp - TCS: ₹3750.5
MobileApp - Infosys: ₹1520.1
WebApp - Infosys: ₹1520.1
WebApp - Wipro: ₹420.75
PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task>

```

On the right side of the IDE, there is a list of run configurations including `powershell`, `Run: Singlet...`, `Run: Factory...`, `Run: Builder...`, `Run: Adapt...`, `Run: Decora...`, `Run: ProxyP...`, and `Run: Observ...`.

Exercise 8: Implementing the Strategy Pattern

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

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

class PaytmPayment implements PaymentStrategy {
    public void pay(double amount) {
        System.out.println("Paid ₹" + amount + " using Paytm.");
    }
}

class PaymentContext {
    private PaymentStrategy strategy;

    public void setPaymentStrategy(PaymentStrategy strategy) {
        this.strategy = strategy;
    }

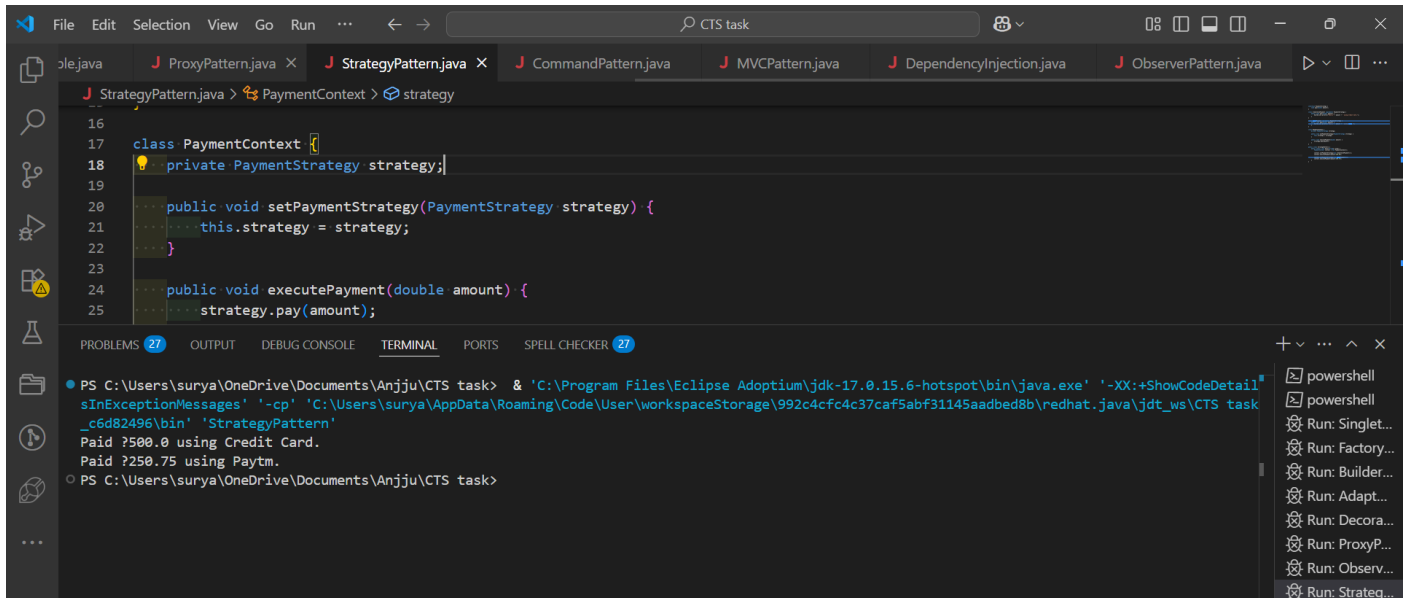
    public void executePayment(double amount) {
        strategy.pay(amount);
    }
}

public class StrategyPattern {
    public static void main(String[] args) {
        PaymentContext context = new PaymentContext();

        context.setPaymentStrategy(new CreditCardPayment());
        context.executePayment(500.00);

        context.setPaymentStrategy(new PaytmPayment());
        context.executePayment(250.75);
    }
}
```

OUTPUT:



Exercise 9: Implementing the Command Pattern

```
interface Command {
    void execute();
}

class Light {
    public void turnOn() {
        System.out.println("The light is ON");
    }

    public void turnOff() {
        System.out.println("The 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 CommandPattern {
    public static void main(String[] args) {
        Light livingRoomLight = new Light();
        Command lightOn = new LightOnCommand(livingRoomLight);
        Command lightOff = new LightOffCommand(livingRoomLight);
        RemoteControl remote = new RemoteControl();
        remote.setCommand(lightOn);
        remote.pressButton();
        remote.setCommand(lightOff);
        remote.pressButton();
    }
}

```

OUTPUT:

The screenshot shows an IDE with the following components:

- Editor:** Displays the `CommandPattern.java` file. The code is as follows:


```

class RemoteControl {
    private Command command;

    public void setCommand(Command command) {
        this.command = command;
    }

    public void pressButton() {
        command.execute();
    }
}

public class CommandPattern {
    public static void main(String[] args) {
        Light livingRoomLight = new Light();
        Command lightOn = new LightOnCommand(livingRoomLight);
        Command lightOff = new LightOffCommand(livingRoomLight);
        RemoteControl remote = new RemoteControl();
        remote.setCommand(lightOn);
        remote.pressButton();
        remote.setCommand(lightOff);
        remote.pressButton();
    }
}

```
- Terminal:** Shows the output of the program:


```

PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15.6-hotspot\bin\java.exe' '-XX:+ShowCodeDetails' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cf4c37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cf4c37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task' 'CommandPattern'
The light is ON
The light is OFF
PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task>

```
- Run Menu:** A dropdown menu is open, showing various run configurations like 'Run: Singleton...', 'Run: Factory...', 'Run: Builder...', etc.

Exercise 10: Implementing the MVC Pattern

```

class Student {
    String name;
    String id;
    String grade;
}

class StudentView {
    void displayStudentDetails(Student student) {
        System.out.println("Student Details:");
    }
}

```

```

        System.out.println("Name: " + student.name);
        System.out.println("ID: " + student.id);
        System.out.println("Grade: " + student.grade);
    }
}

class StudentController {
    Student student;
    StudentView view;

    StudentController(Student student, StudentView view) {
        this.student = student;
        this.view = view;
    }

    void updateView() {
        view.displayStudentDetails(student);
    }
}

public class MVCPattern {
    public static void main(String[] args) {
        Student student = new Student();
        student.name = "Anu";
        student.id = "S101";
        student.grade = "A";

        StudentView view = new StudentView();
        StudentController controller = new StudentController(student, view);
        controller.updateView();
        student.name = "";
        student.grade = "A+";
        controller.updateView();
    }
}

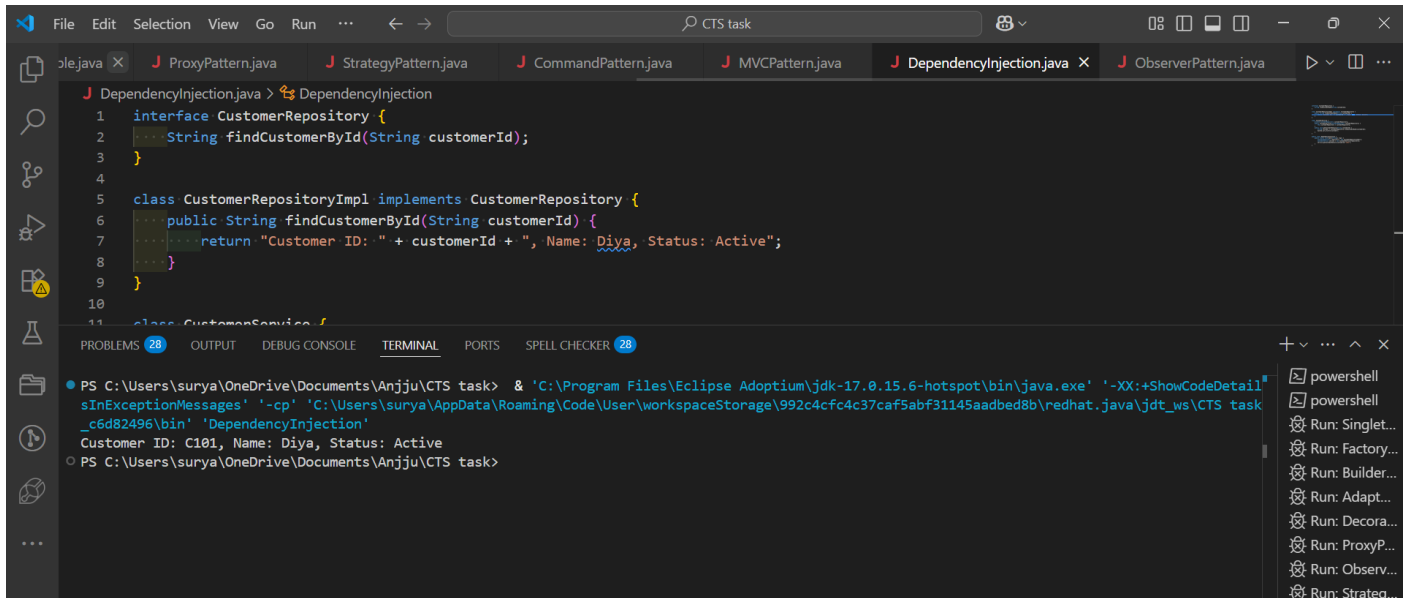
```

OUTPUT:

The screenshot shows the Eclipse IDE with the MVCPattern.java file open. The code defines a StudentController class that takes a Student and a StudentView as parameters. The terminal output shows the execution of the program, displaying student details for a student named Anu with ID S101 and grade A+.

```
File Edit Selection View Go Run ... CTS task
J MVCPattern.java X J ProxyPattern.java X J StrategyPattern.java J CommandPattern.java J MVCPattern.java X J DependencyInjection.java J ObserverPattern.java
J MVCPattern.java > MVCPattern > main(String[])
14 }
15
16 class StudentController {
17     Student student;
18     StudentView view;
19
20     StudentController(Student student, StudentView view) {
21         this.student = student;
22         this.view = view;
23     }
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```

OUTPUT:



The screenshot displays the Eclipse IDE interface. The top toolbar includes icons for File, Edit, Selection, View, Go, Run, and a search icon. The menu bar lists File, Edit, Selection, View, Go, Run, and a search icon. The toolbar also contains icons for running, debugging, and other IDE functions. The editor shows the file 'DependencyInjection.java' with the following code:

```
1 interface CustomerRepository {  
2     ... String findCustomerById(String customerId);  
3 }  
4  
5 class CustomerRepositoryImpl implements CustomerRepository {  
6     ... public String findCustomerById(String customerId) {  
7         ... return "Customer ID: " + customerId + ", Name: Diya, Status: Active";  
8     }  
9 }  
10  
11 class CustomerService {
```

The bottom panel shows the 'TERMINAL' tab with the following output:

```
PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task> & 'C:\Program Files\Eclipse Adoptium\jdk-17.0.15.6-hotspot\bin\java.exe' '-XX:+ShowCodeDetails' 'sInExceptionMessages' '-cp' 'C:\Users\surya\AppData\Roaming\Code\User\workspaceStorage\992c4cfc37caf5abf31145aadbed8b\redhat.java\jdt_ws\CTS task_c6d82496\bin' 'DependencyInjection'  
Customer ID: C101, Name: Diya, Status: Active  
PS C:\Users\surya\OneDrive\Documents\Anjju\CTS task>
```

The right sidebar shows a list of run configurations for 'DependencyInjection', including 'Run: Singlet...', 'Run: Factory...', 'Run: Builder...', 'Run: Adapt...', 'Run: Decora...', 'Run: ProxyP...', 'Run: Observ...', and 'Run: Strateg...'.