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ASSIGNMENT

Subject: System Design

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ASSIGNMENT – 1 (SET-1)

Q1 Explain the role of interfaces and enums in software design with proper examples.

⇨ Roles of Interfaces:

1. Achieving Abstraction
Interfaces hide implementation details and expose only essential behavior.

Design Benefit: Reduces complexity and increases maintainability.

Eg:
```
interface Payment {
   void pay(double amount);
}
```

2. Supporting Multiple Inheritance
A class can implement multiple interfaces, avoiding ambiguity problems of multiple inheritance.

Eg:
```
interface Printable {
   void print();
}

interface Scannable {
   void scan();
}

class Printer implements Printable, Scannable {
   public void print() {
      System.out.println("Printing document");
   }

   public void scan() {
      System.out.println("Scanning document");
   }
}
```

3. Loose Coupling
Interfaces allow the system to depend on abstractions, not concrete implementations.

Design Benefit: Easier testing, flexibility, and replacement of components.

Eg:
```
class ShoppingCart {
    Payment paymentMethod;

    ShoppingCart(Payment paymentMethod) {
        this.paymentMethod = paymentMethod;
    }

    void checkout(double amount) {
        paymentMethod.pay(amount);
    }
}
```

4. Enabling Polymorphism
Different classes can implement the same interface differently.

Eg:
```
class CreditCardPayment implements Payment {
    public void pay(double amount) {
        System.out.println("Paid " + amount + " using Credit Card");
    }
}

class UpiPayment implements Payment {
    public void pay(double amount) {
        System.out.println("Paid " + amount + " using UPI");
    }
}
```

⇨ Roles of Enums:

1. Representing Fixed Sets of Values
Enums prevent invalid values and make code safer.

Eg:
```
enum OrderStatus {
   PLACED,
   SHIPPED,
   DELIVERED,
   CANCELLED
}
```

2. Improving Readability and Maintainability
Enums replace magic numbers or strings with meaningful names.

Eg:
Bad Design:

```
if(status == 3) { ... }
```

Good Design:

```
if(status == OrderStatus.DELIVERED) { ... }
```

3. Type Safety
The compiler prevents invalid assignments.

Eg:
```
OrderStatus status = OrderStatus.PLACED;
// status = "SHIPPED"; ✕ Compile-time error
```

4. Adding Behavior to Constants
Enums can have methods and fields.

Eg:
```
enum TrafficLight {
   RED(60),
   YELLOW(5),
   GREEN(45);
```

```
    int time;

    TrafficLight(int time) {
        this.time = time;
    }

    int getTime() {
        return time;
    }
}
```

Q2 Discuss how interfaces enable loose coupling with example.

Loose coupling means that different parts of a software system depend on abstractions rather than concrete implementations**.** When components are loosely coupled, changes in one part of the system have minimal or no impact on other parts.

Role of Interfaces in Loose Coupling

An interface defines a contract (what to do) without revealing how it is done. Classes interact through the interface instead of directly depending on specific classes.

Tightly Coupled Design (Problem)

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

class ShoppingCart {
    CreditCardPayment payment = new CreditCardPayment();

    void checkout(double amount) {
        payment.pay(amount);
    }
}
```

Issues:

- ShoppingCart is directly dependent on CreditCardPayment
- Changing payment method requires modifying ShoppingCart
- Hard to test and extend

This is tight coupling.

Loosely Coupled Design Using Interface (Solution)

Step 1: Create an Interface

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

Step 2: Implement the Interface

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

class UpiPayment implements Payment {
   public void pay(double amount) {
      System.out.println("Paid " + amount + " using UPI");
   }
}
```

Step 3: Use the Interface in Client Class

```
class ShoppingCart {
   Payment paymentMethod;

   ShoppingCart(Payment paymentMethod) {
      this.paymentMethod = paymentMethod;

  }
```

```
    void checkout(double amount) {
    paymentMethod.pay(amount);
  }
}
```

How This Achieves Loose Coupling

- ShoppingCart depends only on the Payment interface, not on concrete classes
- Any new payment method can be added without changing ShoppingCart
- Objects can be easily swapped at runtime

```
Payment p1 = new CreditCardPayment();
Payment p2 = new UpiPayment();

ShoppingCart cart1 = new ShoppingCart(p1);
ShoppingCart cart2 = new ShoppingCart(p2);
```