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ASSIGNMENT

Subject: System Design

Subject Code: 23CSH-314

Date: 3/02/2026

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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);
```