



Institute of Geographical Information Systems

CS-212 - Object Oriented Programming LAB

Semester: Fall 2025

Class: SCEE-IGIS - 2024

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LAB 06: Compositions

CLO Alignment

| CLO | Description | Domain | Taxonomy Level | PLO |
|------|--|-----------|-----------------|------|
| CLO3 | Develop programs using OOP concepts such as encapsulation, composition, and abstraction. | Cognitive | 3 (Application) | PLO3 |

Task # 1: Department → Faculty → University

Objective: To demonstrate multi-level composition and object interaction.

Requirements:

1. Create class Faculty with attributes:
 - string facultyName, string designation, int publications

Function: void showFaculty()

2. Create class Department with attributes:
 - string deptName
 - An array of Faculty objects (size 3)

Functions:

- void inputFaculty() to input details for all faculty
- void showDepartment() to display all faculty in the department

3. Create class University with:

- string uniName, string location
- One Department object

Functions:

- `void showUniversity()` to display full info (University → Department → Faculty)

Challenge:

Implement hierarchical display using indentation:

University: NUST

Location: Islamabad

Department: IGIS

Faculty 1: Dr. Ayesha (Professor) - Publications: 25

Faculty 2: Mr. Bilal (Lecturer) - Publications: 10

Faculty 3: Ms. Sara (Assistant Professor) - Publications: 18

Screenshot:

The screenshot shows the VS Code interface. The left pane displays the code for `Problem1.cpp`. The right pane shows the Explorer sidebar with a tree view of the project structure, including files like `Assignment-01`, `Week-01` through `Week-08`, and specific files like `Problem1.cpp`. The bottom pane shows the terminal output.

```
1 #include <iostream>
2 using namespace std;
3
4 class Faculty
5 {
6 public:
7     string facultyName, designation;
8     int publications;
9     void showFaculty()
10    {
11        cout << facultyName << " (" << designation << ") - Publications: " << publications << endl;
12    }
13 }
14
15 class Department
16 {
17 public:
18     string deptName;
19     Faculty faculty[3];
20     void inputFaculty()
21    {
22         for (int i = 0; i < 3; i++)
23        {
24            cout << "Enter Faculty " << i + 1 << " Name: ";
25            getline(cin, faculty[i].facultyName);
26            cout << "Enter Designation: ";
27            getline(cin, faculty[i].designation);
28            cout << "Enter Publications: ";
29            cin >> faculty[i].publications;
30            cin.ignore();
31        }
32    }
33    void showDepartment()
34 }
```

TERMINAL OUTPUT:

```
source /Users/alinawaz/Developer/Development/.venv/bin/activate
● alinawaz@Alis-MacBook-Air Development % cd "/Users/alinawaz/Developer/Development/OOP/Week-06/" && g++ Problem1.cpp -o Problem1 && ./Problem1
University: NUST
Location: Islamabad
Department: IGIS
    Faculty 1: Dr. Ayesha (Professor) - Publications: 25
    Faculty 2: Mr. Bilal (Lecturer) - Publications: 10
    Faculty 3: Ms. Sara (Assistant Professor) - Publications: 18
● alinawaz@Alis-MacBook-Air Week-06 % source /Users/alinawaz/Developer/Development/.venv/bin/activate
● (.venv) alinawaz@Alis-MacBook-Air Week-06 %
```

Output:

The screenshot shows the VS Code interface with the terminal tab selected. The terminal output shows the execution of `Problem1.cpp`, displaying the university information and faculty details.

```
PROBLEMS 3 OUTPUT DEBUG CONSOLE TERMINAL PORTS SPELL CHECKER 3

source /Users/alinawaz/Developer/Development/.venv/bin/activate
● alinawaz@Alis-MacBook-Air Development % cd "/Users/alinawaz/Developer/Development/OOP/Week-06/" && g++
University: NUST
Location: Islamabad
Department: IGIS
    Faculty 1: Dr. Ayesha (Professor) - Publications: 25
    Faculty 2: Mr. Bilal (Lecturer) - Publications: 10
    Faculty 3: Ms. Sara (Assistant Professor) - Publications: 18
● alinawaz@Alis-MacBook-Air Week-06 % source /Users/alinawaz/Developer/Development/.venv/bin/activate
● (.venv) alinawaz@Alis-MacBook-Air Week-06 %
```

Task # 2:

Objective:

To simulate object behavior and data dependency using composition.

Requirements:

1. Create class Engine with attributes:

- int horsepower, string type
- Function: void startEngine()

2. Create class FuelTank with attributes:

- float capacity, float fuelLevel

Functions:

- void refuel(float liters)
- bool consumeFuel(float amount) → returns false if insufficient fuel

3. Create class Car with:

- string model
- One Engine and one FuelTank

Functions:

- void startCar() → check if enough fuel, then start engine
- void drive(float distance) → consumes 0.1L/km
- void showStatus()

Sample Output:

Car: Civic 2023

Fuel Level: 20L

Engine started!

Driving 50 km...

Fuel left: 15L

Challenge:

Add fuel efficiency calculation and warning when fuel < 10%.

Screenshot:

The screenshot shows a VS Code interface with the following details:

- Code Editor:** Two files are open: `Problem1.cpp` and `Problem2.cpp`. `Problem2.cpp` contains the following code:

```
1 #include <iostream>
2 using namespace std;
3
4 class Engine
5 {
6 public:
7     int horsepower;
8     string type;
9     void startEngine()
10    {
11        cout << "Engine started!" << endl;
12    }
13 }
14
15 class FuelTank
16 {
17 public:
18     float capacity, fuelLevel;
19     void refuel(float liters)
20    {
21         if (fuelLevel + liters <= capacity)
22             fuelLevel += liters;
23         else
24             fuelLevel = capacity;
25     }
26     bool consumeFuel(float amount)
27    {
28         if (fuelLevel >= amount)
29         {
30             fuelLevel -= amount;
31             return true;
32         }
33     }
34     return false;
35 }
```

- Terminal:** The terminal shows the execution of the code and its output:

```
alina@Alis-MacBook-Air Week-06 % source /Users/alina/Developer/Development/.venv/bin/activate
(.venv) alina@Alis-MacBook-Air Week-06 % cd "/Users/alina/Developer/Development/OOP/Week-06/" && g++ Problem2.cpp -o Problem2 && "/Users/alina/Developer/Development/OOP/Week-06/">| ./Problem2
Car: Civic 2023
Fuel Level: 20L
Engine started!
Driving 50 km...
Fuel left: 15L
Fuel Efficiency: 10 km/L
```

- Explorer:** The sidebar shows a project structure with folders like `OOP`, `Assignment-01`, and `Week-01` through `Week-06`.

Output:

The screenshot shows the VS Code terminal window with the following details:

- Terminal:** The terminal shows the execution of the code and its output:

```
alina@Alis-MacBook-Air Week-06 % source /Users/alina/Developer/Development/.venv/bin/activate
(.venv) alina@Alis-MacBook-Air Week-06 % cd "/Users/alina/Developer/Development/OOP/Week-06/"& em2
Car: Civic 2023
Fuel Level: 20L
Engine started!
Driving 50 km...
Fuel left: 15L
Fuel Efficiency: 10 km/L
```

Task # 3: GIS Mapping System (Nested Composition with Arrays)

Objective: To design a real-world composite GIS model using nested class composition.

Requirements:

1. Class Coordinate:

- Attributes: float latitude, float longitude
- Function: void showCoordinate()

2. Class Location:

- Attributes: string name, one Coordinate
- Function: void showLocation()

3. Class MapFeature:

- Attributes: string featureType
- Array of Location objects (size 3)
- Function: void showFeature()

4. Class Map:

- Attribute: string mapName
- Array of MapFeature objects (size 2)
- Function: void displayMap()

Expected Output:

Map: Islamabad City Map

Feature: Educational Institutes

Location: NUST (33.643, 72.991)

Location: COMSATS (33.736, 73.093)

Location: Air University (33.718, 73.049)

Feature: Hospitals

Location: PIMS (33.716, 73.066)

Location: Shifa (33.694, 73.035)

Location: CDA Hospital (33.684, 73.048)

Challenge:

Allow user input for coordinates and dynamically count total locations on the map.

Submission Instructions

- Submit .cpp files for each task.
- Include a header comment block:

// Name: _____

// Reg. No: _____

// Section: _____

// Lab 09: Composition

Screenshot:

The screenshot shows the Visual Studio Code interface. The code editor has three tabs open: Problem1.cpp, Problem2.cpp, and Problem3.cpp. The Problem3.cpp tab is active, displaying C++ code for a class MapFeature. The terminal below shows a command-line session in a venv environment, printing a map of Islamabad City with features like Educational Institutes and Hospitals. The file explorer on the right shows a project structure for 'Development' with folders like 'Week-06', 'OOP', and 'Assignment-01'. The status bar at the bottom indicates the current file is 'Code - Week-06'.

```
1 #include <iostream>
2 using namespace std;
3
4 class Coordinate
5 {
6 public:
7     float latitude, longitude;
8     void showCoordinate()
9     {
10         cout << "(" << latitude << ", " << longitude << ")";
11     }
12 };
13
14 class Location
15 {
16 public:
17     string name;
18     Coordinate coord;
19     void showLocation()
20     {
21         cout << " Location: " << name << " ";
22         coord.showCoordinate();
23         cout << endl;
24     }
25 };
26
27 class MapFeature
28 {
29 public:
30     string featureType;
31     Location loc[3];
32 }
```

```
(.venv) alinawaz@Alis-MacBook-Air Week-06 % cd "/Users/alinawaz/Developer/Development/OOP/Week-06" && g++ Problem3.cpp -o Problem3 && "/Users/alinawaz/Developer/Development/OOP/Week-06/Problem3"
Map: Islamabad City Map
Feature: Educational Institutes
    Location: NUST (33.643, 72.991)
    Location: COMSATS (33.736, 73.093)
    Location: Air University (33.718, 73.049)
Feature: Hospitals
    Location: PIMS (33.716, 73.066)
    Location: Shifa (33.694, 73.035)
    Location: CDA Hospital (33.684, 73.048)
```

Output:

The screenshot shows the VS Code terminal window. It displays the same output as the previous screenshot, listing educational institutions and hospitals in Islamabad with their coordinates. The terminal interface includes tabs for PROBLEMS, OUTPUT, DEBUG CONSOLE, TERMINAL (which is selected), PORTS, and SPELL CHECKER. The status bar at the bottom shows the current file is 'Code - Week-06'.

```
(.venv) alinawaz@Alis-MacBook-Air Week-06 %
Map: Islamabad City Map
Feature: Educational Institutes
    Location: NUST (33.643, 72.991)
    Location: COMSATS (33.736, 73.093)
    Location: Air University (33.718, 73.049)
Feature: Hospitals
    Location: PIMS (33.716, 73.066)
    Location: Shifa (33.694, 73.035)
    Location: CDA Hospital (33.684, 73.048)
```