1.Write a C++ program to create a base class Person with attributes name and age. Derive a class Student that adds rollNo. Use constructors to initialize all attributes. Create objects of both classes and display their details to show how Student inherits Person members.

```
#include <iostream>
#include <string>
using namespace std;
class Person {
protected:
string name;
int age;
public:
Person(string n, int a) : name(n), age(a) {}
void display() const {
cout << "Name: " << name << ", Age: " << age << endl;
}
};
class Student : public Person {
private:
int rollNo;
public:
Student(string n, int a, int r) : Person(n, a), rollNo(r) {}
void display() const {
cout << "Student Details:" << endl;
Person::display();
cout << "Roll No: " << rollNo << endl;
}
};
int main() {
string name;
int age, rollNo;
cout << "Creating Person object:" << endl;
cout << "Enter name: ";
```

```
getline(cin, name);
cout << "Enter age: ";
cin >> age;
cin.ignore();
Person person(name, age);
cout << "\nPerson Details:" << endl;
person.display();
cout << endl;
cout << "Creating Student object:" << endl;
cout << "Enter name: ";
getline(cin, name);

cout << "Enter age: ";
cin >> age;
cout << "Enter roll number: ";
cin >> rollNo;
cin.ignore();
Student student(name, age, rollNo);
cout << "\nStudent Details:" << endl;
student.display();
return 0;
}
```

```
Creating Person object:
Enter name: pradip
Enter age: 20

Person Details:
Name: pradip, Age: 20

Creating Student object:
Enter name: pradip
Enter age: 20
Enter roll number: 001

Student Details:
Student Details:
Name: pradip, Age: 20
Roll No: 1
```

2. Implement a C++ program with a base class Account having a protected attribute balance. Derive a class SavingsAccount that adds an attribute interestRate and a function addInterest() to modify balance. Use user input to initialize attributes and show how the protected balance is accessed in the derived class but not outside.

```
#include <iostream>
using namespace std;
class Account {
protected:
double balance;
public:
Account(double b) : balance(b) {}
void display() const {
cout << "Balance: Rs" << balance << endl;
}};
class SavingsAccount : public Account {
private:
double interestRate;
public:
SavingsAccount(double b, double ir) : Account(b), interestRate(ir) {}
void addInterest() {
double interest = balance * (interestRate / 100);
balance += interest; // Accessing protected balance
cout << "Interest of Rs" << interest << " added." << endl;
}
void display() const {
cout << "Savings Account Details:" << endl;
Account::display();
cout << "Interest Rate: " << interestRate << "%" << endl;
}};
int main() {
double balance, interestRate;
```

```
cout << "Creating Account object:" << endl;
cout << "Enter balance: Rs";
cin >> balance;
Account account(balance);
cout << "\nAccount Details:" << endl;
account.display();
cout << endl;
cout << "Creating SavingsAccount object:" << endl;
cout << "Enter balance: Rs";
cin >> balance;
cout << "Enter interest rate (%): ";
cin >> interestRate;
SavingsAccount savings(balance, interestRate);
cout << "\nSavings Account Details (Before Interest):" << endl;
savings.display();
cout << endl;
savings.addInterest();
cout << "Savings Account Details (After Interest):" << endl;
savings.display();
cout << endl;
return 0;
}
```

```
Creating Account object:
Enter balance: Rs1200000

Account Details:
Balance: Rs1.2e+006

Creating SavingsAccount object:
Enter balance: Rs1200000
Enter interest rate (%): 10

Savings Account Details (Before Interest):
Savings Account Details:
Balance: Rs1.2e+006
Interest Rate: 10%

Interest of Rs120000 added.
Savings Account Details (After Interest):
Savings Account Details:
Balance: Rs1.32e+006
Interest Rate: 10%


Process returned 0 (0x0)   execution time : 25.907 s
Press any key to continue.
```

3. Write a C++ program with a base class Shape having a function draw(). Declare a derived class Circle with an attribute radius initialized via user input. Create a Circle object and call draw() to display a message including radius, demonstrating proper derived class declaration.

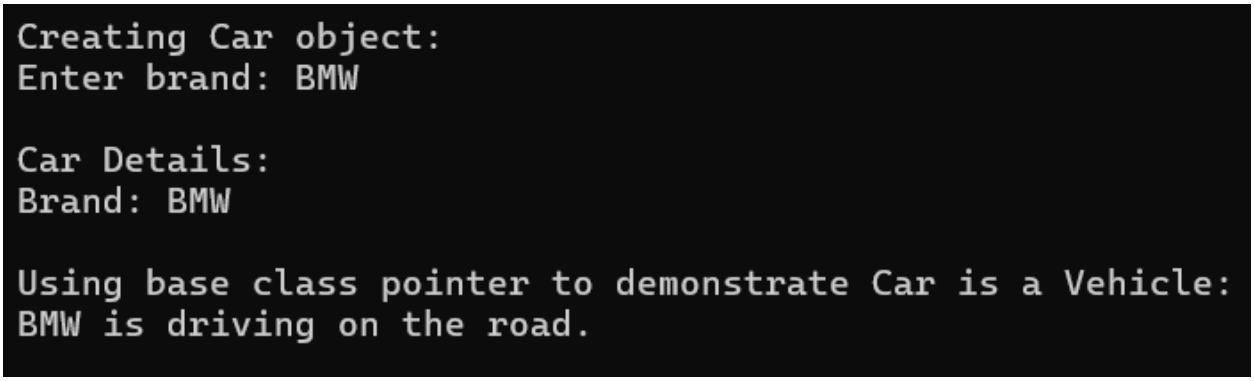
```
#include <iostream>
using namespace std;
class Shape {
public:
virtual void draw() const {
cout << "Drawing a generic shape." << endl;
}};
class Circle : public Shape {
private:
double radius;
public:
Circle(double r) : radius(r) {}
void draw() const override {
cout << "Drawing a Circle with radius: " << radius << endl;
}};
int main() {
double radius;
cout << "Creating Circle object:" << endl;
cout << "Enter radius: ";
cin >> radius;
Circle circle(radius);
cout << "\nCircle Details:" << endl;
circle.draw();
return 0;
}
```

```
Creating Circle object:
Enter radius: 10

Circle Details:
Drawing a Circle with radius: 10

Process returned 0 (0x0)   execution time : 2.649 s
Press any key to continue.
```

4. Create a C++ program with a base class Vehicle having a function move(). Derive a class Car that overrides move() to indicate driving. Use a base class pointer to call move() on a Car object initialized with user input for attributes like brand. Show that Car is a Vehicle.

```
#include <iostream>
#include <string>
using namespace std;
class Vehicle {
protected:
string brand;
public:
Vehicle(string b) : brand(b) {}
virtual void move() const {
cout << brand << " is moving." << endl;
}
void display() const {
cout << "Brand: " << brand << endl;
}};
class Car : public Vehicle {
public:
Car(string b) : Vehicle(b) {}
void move() const override {
cout << brand << " is driving on the road." << endl;
}};
int main() {
string brand;
cout << "Creating Car object:" << endl;
```

```
cout << "Enter brand: ";
getline(cin, brand);
Car car(brand);
cout << "\nCar Details:" << endl;
car.display();
cout << endl;
cout << "Using base class pointer to demonstrate Car is a Vehicle:" << endl;
Vehicle* vehiclePtr = &car;
vehiclePtr->move();
return 0;
}
```



5. Implement a C++ program with a class Engine having an attribute horsepower. Create a class Car that contains an Engine object (composition) and an attribute model. Initialize all attributes with user input and display details to show that Car has an Engine.

```
#include <iostream>
#include <string>
using namespace std;
class Engine {
private:
int horsepower;
public:
Engine(int hp) : horsepower(hp) {}
void display() const {
cout << "Engine Horsepower: " << horsepower << endl;
```

```
}};
class Car {
private:
Engine engine;
string model;
public:
Car(int hp, string m) : engine(hp), model(m) {}
void display() const {
cout << "Car Details:" << endl;
cout << "Model: " << model << endl;
engine.display();
}};
int main() {
string model;
int horsepower;
cout << "Creating Car object:" << endl;
cout << "Enter car model: ";
getline(cin, model);
cout << "Enter engine horsepower: ";
cin >> horsepower;
cin.ignore();
Car car(horsepower, model);
cout << "\n";
car.display();
return 0;
}
```

```
Creating Car object:
Enter car model: BMW 23
Enter engine horsepower: 15000

Car Details:
Model: BMW 23
Engine Horsepower: 15000
```

6. Write a C++ program with a base class Base having public, protected, and private attributes (e.g., pubVar, protVar, privVar). Derive three classes using public, protected, and private inheritance, respectively. Demonstrate with user-initialized objects how each inheritance type affects access to base class members.

```
#include <iostream>
#include <string>
using namespace std;
class Base {
public:
int pubVar;
protected:
int protVar;
private:
int privVar;
public:
Base(int pub, int prot, int priv) : pubVar(pub), protVar(prot), privVar(priv) {}
void display() const {
cout << "Base: Public Var = " << pubVar << ", Protected Var = " << protVar << ", Private Var = " <<
privVar << endl;
}};
class PublicDerived : public Base {
public:
PublicDerived(int pub, int prot, int priv) : Base(pub, prot, priv) {}
void display() const {
cout << "PublicDerived: Public Var = " << pubVar << ", Protected Var = " << protVar << endl;
}};
class ProtectedDerived : protected Base {
public:
ProtectedDerived(int pub, int prot, int priv) : Base(pub, prot, priv) {}
void display() const {
cout << "ProtectedDerived: Public Var = " << pubVar << ", Protected Var = " << protVar << endl;
};
```

```
class PrivateDerived : private Base {
public:
PrivateDerived(int pub, int prot, int priv) : Base(pub, prot, priv) {}
void display() const {
cout << "PrivateDerived: Public Var = " << pubVar << ", Protected Var = " << protVar << endl;
}};
int main() {
int pub, prot, priv;
cout << "Creating Base object:" << endl;
cout << "Enter public variable: ";
cin >> pub;
cout << "Enter protected variable: ";
cin >> prot;
cout << "Enter private variable: ";
cin >> priv;
Base base(pub, prot, priv);
cout << "\nBase Object Details:" << endl;
base.display();
cout << "Accessing pubVar directly: " << base.pubVar << endl;
cout << endl;
cout << "Creating PublicDerived object:" << endl;
cout << "Enter public variable: ";
cin >> pub;
cout << "Enter protected variable: ";
cin >> prot;
cout << "Enter private variable: ";
cin >> priv;
PublicDerived pubDerived(pub, prot, priv);
cout << "\nPublicDerived Object Details:" << endl;
pubDerived.display();
cout << "Accessing pubVar directly: " << pubDerived.pubVar << endl;
```

```
cout << endl;
cout << "Creating ProtectedDerived object:" << endl;
cout << "Enter public variable: ";
cin >> pub;
cout << "Enter protected variable: ";
cin >> prot;
cout << "Enter private variable: ";
cin >> priv;
ProtectedDerived protDerived(pub, prot, priv);
cout << "\nProtectedDerived Object Details:" << endl;
protDerived.display();
cout << endl;
cout << "Creating PrivateDerived object:" << endl;
cout << "Enter public variable: ";
cin >> pub;
cout << "Enter protected variable: ";
cin >> prot;
cout << "Enter private variable: ";
cin >> priv;
PrivateDerived privDerived(pub, prot, priv);
cout << "\nPrivateDerived Object Details:" << endl;
privDerived.display();
return 0;
}
```

```
Accessing pubVar directly: 13

Creating PublicDerived object:
Enter public variable: 13
Enter protected variable: 24
Enter private variable: 44

PublicDerived Object Details:
PublicDerived: Public Var = 13, Protected Var = 24
Accessing pubVar directly: 13

Creating ProtectedDerived object:
Enter public variable: 13
Enter protected variable: 24
Enter private variable: 44

ProtectedDerived Object Details:
ProtectedDerived: Public Var = 13, Protected Var = 24

Creating PrivateDerived object:
Enter public variable: 13
Enter protected variable: 24
Enter private variable: 44

PrivateDerived Object Details:
PrivateDerived: Public Var = 13, Protected Var = 24
```

7.Create a C++ program with a base class Animal having a virtual function sound(). Derive classes Dog and Cat that override sound() to print specific sounds. Use a base class pointer array to call sound() on Dog and Cat objects created with user input, showing runtime polymorphism.

```
#include <iostream>

#include <string>

using namespace std;

class Animal {

protected:

string name;

public:

Animal(string n) : name(n) {}

virtual void sound() const {

cout << name << " makes a generic animal sound." << endl;

}

void display() const {

cout << "Name: " << name << endl;

}
```

```
};
class Dog : public Animal {
public:
Dog(string n) : Animal(n) {}
void sound() const override {
cout << name << " says: Woof!" << endl;
}};
class Cat : public Animal {
public:
Cat(string n) : Animal(n) {}
void sound() const override {

cout << name << " says: Meow!" << endl;
}};
int main() {
string name;
Animal* animals[2];
cout << "Creating Dog object:" << endl;
cout << "Enter dog name: ";
getline(cin, name);
animals[0] = new Dog(name);
cout << "\nCreating Cat object:" << endl;
cout << "Enter cat name: ";
getline(cin, name);
animals[1] = new Cat(name);
cout << "\nAnimal Details and Sounds:" << endl;
for (int i = 0; i < 2; i++) {
animals[i]->display();
animals[i]->sound();
cout << endl;
}
```

```
for (int i = 0; i < 2; i++) {
delete animals[i];
}
return 0;
}
```

```
Creating Dog object:
Enter dog name: rocky

Creating Cat object:
Enter cat name: tom

Animal Details and Sounds:
Name: rocky
rocky says: Woof!

Name: tom
tom says: Meow!
```

8.Write a C++ program with two base classes Battery and Screen, each with a function showStatus(). Derive a class Smartphone that inherits from both. Resolve ambiguity when calling showStatus() using the scope resolution operator. Initialize attributes with user input and display details.

```
#include <iostream>
#include <string>
using namespace std;
class Battery {
protected:
int capacity;
public:
Battery(int cap) : capacity(cap) {}
void showStatus() const {
cout << "Battery Status: " << capacity << " mAh" << endl;
}};
class Screen {
protected:
```

```
double size;
public:
Screen(double s) : size(s) {}
void showStatus() const {
cout << "Screen Status: " << size << " inches" << endl;
}};
class Smartphone : public Battery, public Screen {
private:
string model;
public:
Smartphone(int cap, double s, string m) : Battery(cap), Screen(s), model(m) {}
void display() const {
cout << "Smartphone Details:" << endl;
cout << "Model: " << model << endl;
Battery::showStatus();
Screen::showStatus();
}};
int main() {
string model;
int capacity;
double size;
cout << "Creating Smartphone object:" << endl;
cout << "Enter model: ";
getline(cin, model);
cout << "Enter battery capacity (mAh): ";
cin >> capacity;
cout << "Enter screen size (inches): ";
cin >> size;
cin.ignore();
Smartphone phone(capacity, size, model);
cout << "\n";
```

```
phone.display();
return 0;
}
```

```
Creating Smartphone object:
Enter model: blackberry
Enter battery capacity (mAh): 5400
Enter screen size (inches): 9

Smartphone Details:
Model: blackberry
Battery Status: 5400 mAh
Screen Status: 9 inches
```

9.Implement a C++ program with a base class Person having a parameterized constructor for name and age. Derive a class Employee with an additional attribute employeeID. Use user input to initialize all attributes and show the order of constructor invocation when creating an Employee object.

```
#include <iostream>
#include <string>
using namespace std;
class Person {
protected:
string name;
int age;
public:
Person(string n, int a) : name(n), age(a) {
cout << "Person constructor called: Name = " << name << ", Age = " << age << endl;
}
void display() const {
cout << "Name: " << name << ", Age: " << age << endl;
}};
class Employee : public Person {
private:
```

```
string employeeID;
public:
Employee(string n, int a, string id) : Person(n, a), employeeID(id) {
cout << "Employee constructor called: EmployeeID = " << employeeID << endl;
}
void display() const {
cout << "Employee Details:" << endl;
Person::display();
cout << "Employee ID: " << employeeID << endl;
}};
int main() {
string name, employeeID;
int age;
cout << "Creating Employee object:" << endl;
cout << "Enter name: ";
getline(cin, name);
cout << "Enter age: ";
cin >> age;
cin.ignore();
cout << "Enter employee ID: ";
getline(cin, employeeID);
cout << "\nConstructor Invocation Order:" << endl;
Employee employee(name, age, employeeID);
cout << "\n";
employee.display();
return 0;
}
```

```
Creating Employee object:
Enter name: ram
Enter age: 34
Enter employee ID: 10203

Constructor Invocation Order:
Person constructor called: Name = ram, Age = 34
Employee constructor called: EmployeeID = 10203

Employee Details:
Name: ram, Age: 34
Employee ID: 10203
```

10.Write a C++ program with a base class Shape and a derived class Rectangle, both with destructors that print messages. Make the base class destructor virtual. Create a Rectangle object through a base class pointer using user input for attributes, and delete it to show proper destructor invocation. Compare with a non-virtual destructor case.

```
#include <iostream>
using namespace std;
class Shape {
protected:
double width;
public:
Shape(double w) : width(w) {
cout << "Shape constructor called: Width = " << width << endl;
}
virtual ~Shape() {
cout << "Shape destructor called" << endl;
}
void display() const {
cout << "Shape Width: " << width << endl;
}};
class Rectangle : public Shape {
private:
double height;
public:
```

```
Rectangle(double w, double h) : Shape(w), height(h) {
cout << "Rectangle constructor called: Height = " << height << endl;
}
~Rectangle() {
cout << "Rectangle destructor called" << endl;
}
void display() const {
cout << "Rectangle Details:" << endl;
Shape::display();
cout << "Height: " << height << endl;
}};
int main() {
double width, height;
cout << "Creating Rectangle object via base class pointer:" << endl;
cout << "Enter width: ";
cin >> width;
cout << "Enter height: ";
cin >> height;
Shape* shapePtr = new Rectangle(width, height);
cout << "\n";
shapePtr->display();
cout << "\nDeleting Rectangle object via base class pointer:" << endl;
delete shapePtr;
return 0;
}
```

```
Creating Rectangle object via base class pointer:
Enter width: 10
Enter height: 23
Shape constructor called: Width = 10
Rectangle constructor called: Height = 23

Shape Width: 10

Deleting Rectangle object via base class pointer:
Rectangle destructor called
Shape destructor called
```

11.Create a C++ program with a base class A having an attribute value. Derive classes B and C from A, and derive class D from both B and C. Use virtual inheritance to avoid duplication of A's members. Initialize value with user input and display it from D to show ambiguity resolution.

```
#include <iostream>
using namespace std;
class A {
protected:
int value;
public:
void setValue(int v) {
value = v;}
void showValue() {
cout << "Value from class A: " << value << endl;
}
};
class B : virtual public A {};
class C : virtual public A {};
class D : public B, public C {
public:
void display() {
showValue();
}
};
int main() {
D obj;
int input;
cout << "Enter a value: ";
cin >> input;
obj.setValue(input);
obj.display();
return 0;
```

}

```
Enter a value: 10
Value from class A: 10

Process returned 0 (0x0)   execution time : 2.955 s
Press any key to continue.
```