Tutorial and Old Question solution

Object Oriented Programming in in C++

Prepared By: Pradip Paudel
Email: pradippaudel89@gmail.com

CHAPTER-1 (THEORY SOLUTION)

1. Explain the notation "Everything is an object" in an object oriented Programming.[PU:2017 spring]

An entity that has state and behavior is known as an object .If we consider the real-world, we can find many objects around us, cars, dogs, humans, etc. All these objects have a state and a behavior .If we consider a dog, then its state is - name, breed, color, and the behavior is - barking, wagging the tail, running.
In object oriented programming problem is analyzed in terms of object and nature of communication between them. Program object should be chosen such that they match closely with real-world objects. In object oriented programming object's state is stored as data member and behavior is defined using functions (methods).
When a program is executed, the object interact by sending message to one another. For example, if "Customer" and "account" are two objects in a program then the customer object may send a message to the account object requesting for the bank balance. Each object contains data, and code (methods) to manipulate data. Objects can interact without having to know details of each other's data or code. It is sufficient to know the type of message accepted, and the type of response returned by objects.
So, from above discussion we can say that "Everything is an object" in an object oriented Programming.

2. With the help of object oriented programming, explain how can object oriented programming cope in solving complex problem. [PU:2014 spring][PU:2018 fall]

When the software sizes grows large, due to the interconnections of software components the complexity of software system increases. The interconnections of software components means the dependence of one portion of code on another portion. Due to complexity, it is difficult to understand program in isolation as well it makes difficult to divide a task between a several programs.
The abstraction mechanism is used to manage complexity. The Abstraction is mechanism displays only essential information and hiding the details.
Abstraction is often combined with a division into components. For example, we divided the automobile into the engine and the transmission. Components are carefully chosen so that they can encapsulate certain key features and interact with another component through simple and fixed interface.

The division of components means we can divide large task into smaller problems that can then be worked on more less or less independently of each other. It is a responsibility of a developer of a component to provide a implementation that satisfies the requirement of interface. So, set of procedure written by one programmer can be used by many other programmers without knowing the exact details of implementation. They needed only the necessary interface.
From above discussion we can conclude that, breaking down the system in a way such that component can be reuse in solution of different problems just by knowing only the interfaces which must utilize. The implementation details can be modified in future without affecting the program. So program can also easily maintained. In this way object oriented programming cope in solving complex problem.

3. What influence is an object oriented approach said to have on software system design? What is your own opinion? Justify through example.[PU:2009 fall]

Object oriented approach contributes greater programmer productivity, better quality of software and lesser maintenance cost.
The influence of an object oriented approach is discussed below with certain characteristic of OOP which justifies that object oriented approach leads to better software design.

- It is easy to model a real system as programming objects in OOP represents real objects. the objects are processed by their member data and functions. It is easy to analyze the user requirements.
- Complexity that arises due to interconnections of software components can be managed by abstraction. So, set of procedure written by one programmer can be used by many other programmers without knowing the exact details of implementation. They needed only the necessary interface.
- It modularize the programs. Modular programs are easy to develop and can be distributed independently among different programmers.
- Large problems can be reduced to smaller and more manageable problems. It is easy to partition the work in a project based on objects.
- It makes software easier to maintain. Since the design is modular, part of the system can be updated in case of issues without a need to make large-scale changes.
- Elimination of redundant code due to inheritance, that is, we can use the same code in a base class by deriving a new class from it. The reusability feature of OOP lowers the cost of software development.
- Reuse also enables faster development. Object-oriented programming languages come with rich libraries of objects, and code developed during projects is also reusable in future projects.

- It provides a good framework for code libraries where the supplied software components can be easily adapted and modified by the programmer. This is particularly useful for developing graphical user interfaces.
- In OOP, data can be made private to a class such that only member functions of the class can access the data. This principle of data hiding helps the programmer to build a secure program that cannot be invaded by code in other part of the program.
- With the help of polymorphism, the same function or same operator can be used for different purposes. This helps to manage software complexity easily.

4. What is the significance of forming abstractions while designing an object oriented System. Explain with a example.[PU:2015 fall]

Abstraction means displaying only essential information and hiding the details. Data abstraction refers to providing only essential information about the data to the outside world, hiding the background details or implementation.
Consider a real life example of a man driving a car. The man only knows that pressing the accelerators will increase the speed of car or applying brakes will stop the car but he does not know about how on pressing accelerator the speed is actually increasing, he does not know about the inner mechanism of the car or the implementation of accelerator, brakes etc in the car.
The significance of forming abstractions while designing an object oriented system can be listed as follows:
- It manage complexity that arises due to interconnections of software components.
- Set of procedure written by one programmer can be used by many other programmers without knowing the exact details of implementation. They needed only the necessary interface.
- Data abstraction increases the reusability of the code by avoiding any chances of redundancy.
- It increases the readability of the code as it eliminates the possibility of displaying the complex working of the code.
- With the implementation of classes and objects, comes enhanced security. Since data abstraction is a method of implementing classes and objects any denying access to other classes of accessing the data members and member functions of the base class.
- Helps the user to avoid writing the low level code.
- It separates the entire program into code and implementation making it more comprehensible.

- Can change internal implementation of class independently without affecting the user level code.
- Helps to increase security of an application or program as only important details are provided to the user.
- To increase security of an application or program as only important details are provided to the user.

5. What are the mechanism of data abstraction? What is the use of abstraction mechanism in C++?Explain with example.[PU:2019 fall]

Data abstraction refers to providing only essential information to the outside world and hiding their background details, i.e., to represent the needed information in program without presenting the details. Data abstraction is a programming (and design) technique that relies on the separation of interface and implementation

Let's take a real life example of AC, which can be turned ON or OFF, change the temperature, change the mode, and other external components such as fan, swing. But, we don't know the internal details of the AC, i.e., how it works internally. Thus, we can say that AC separates the implementation details from the external interface.

Data Abstraction can be achieved in following ways:

- Abstraction using classes
- Abstraction in header files
- Abstraction using access specifiers

Abstraction using classes: An abstraction can be achieved using classes. A class is used to group all the data members and member functions into a single unit by using the access specifiers. A class has the responsibility to determine which data member is to be visible outside and which is not.

Abstraction in header files: An another type of abstraction is header file. For example, pow() function available is used to calculate the power of a number without actually knowing which algorithm function uses to calculate the power. Thus, we can say that header files hides all the implementation details from the user.

Abstraction using Access specifiers: Access specifiers are the main pillar of implementing abstraction in C++. We can use access specifiers to enforce restrictions on class members.

For example;

- Members declared as public in a class, can be accessed from anywhere in the program.
- Members declared as private in a class, can be accessed only from within the class. They are not allowed to be accessed from any part of code outside the class.

We can easily implement abstraction using the above two features provided by access specifiers. Say, the members that defines the internal implementation can be marked as private in a class. And the important information needed to be given to the outside world can be marked as public. And these public members can access the private members as they are inside the class.

Example:

```
#include <iostream>
using namespace std;
class AbstractionExample
{
private:
int a, b;
public:
void setdata(int x, int y)
{
a = x;
b = y;
}
void display()
{
cout<<"a = " <<a << endl;
cout<<"b = " << b << endl;
}
};
int main()
{
AbstractionExample obj;
obj.setdata(10, 20);
obj.display();
return 0;
}
```

In above program ,By making data members private, we have hidden them from outside world. These data members are not accessible outside the class. The only way to set and get their values is through the public functions.

The main use of abstraction mechanism in C++ are as follows:

- To manage complexity that arises due to interconnections of software components using abstraction.
- Set of procedure written by one programmer can be used by many other programmers without knowing the exact details of implementation. They needed only the necessary interface. The program can use the function sort_name() to sort names in alphabetical order without knowing whether implementation uses bubble sort, merge sort, quick sort algorithms.
- To change the Internal implementation without affecting the user level code.
- To avoids the code duplication, i.e., programmer does not have to undergo the same tasks every time to perform the similar operation.
- To increase the readability of the code as it eliminates the possibility of displaying the complex working of the code.
- To increase security of an application or program as only important details are provided to the user.

Chapter 2(Program solution)

1. Declare a C++ structure (Program) to contain the following piece of information about cars on used car lot. **[PU:2013 spring]**

i. Manufacturer of the car
ii. Model name of the car
iii. The asking price of car
iv. The number of miles on odometer

```
#include<iostream>
using namespace std;
struct car
{
char name[50];
char model[50];
long int price;
int miles;
}
 int main()
  {
        car c;
        cout<<"Enter manufacturer of car"<<endl;
        cin.getline(c.name,50);
        cout<<"Enter the model name of car"<<endl;
        cin.getline(c.model,50);
        cout<<"Enter the price of car"<<endl;
        cin>>c.price;
        cout<<"Enter number of miles on odometer"<<endl;
        cin>>c.miles;
        cout<<"Details of car:"<<endl;
        cout<<"Manufacturer name:"<<c.name<<endl;
        cout<<"Model name:"<<c.model<<endl;
        cout<<"Price :"<<c.price<<endl;
        cout<<"Number of miles on odometer:"<<c.miles<<endl;
        return 0;
 }
```

2. Create a class called Employee with three data members (empno , name, address), a function called readdata() to take in the details of the employee from the user, and a function called displaydata() to display the details of the employee. In main, create two objects of the class Employee and for each object call the readdata() and the displaydata() functions. **[PU:2005 fall]**

```
#include<iostream>
using namespace std;
class Employee
{
private:
int empno;
char name[20];
char address[20];
public:
void readdata();
void displaydata();
};
void Employee::readdata()
{
cout<<"Enter the Employee number"<<endl;
cin>>empno;
cout<<"Enter the Employee name"<<endl;
cin>>name;
cout<<"Enter the address"<<endl;
cin>>address;
}
void Employee::displaydata()
{
cout<<"Employee number="<<empno<<endl;
cout<<"Employee name="<<name<<endl;
cout<<"Employee address="<<address<<endl;
}
int main()
{
Employee e1,e2;
cout<<"Enter the information of first employee"<<endl;
e1.readdata();
cout<<"Enter the information of second employee"<<endl;
e2.readdata();
cout<<"Information of first employee is"<<endl;
e1.displaydata();
cout<<"Information of second employee is"<<endl;
e2.displaydata();
return 0;
}
```

3. Create a class called Student with three data members(stdnt_name[20],faculty[20],roll_no), a function called readdata() to take the details of the students from the user and a function called displaydata() to display the details the of the students. In main, create two objects of the class student and for each object call both of the functions. **[PU:2010 fall]**

```
#include<iostream>
using namespace std;
class Student
{
private:
char stdnt_name[20];
char faculty[20];
int roll_no;
public:
void readdata();
void displaydata();
};
void Student::readdata()
{
cout<<"Enter student name"<<endl;
cin>>stdnt_name;
cout<<"Enter student faculty"<<endl;
cin>>faculty;
cout<<"Enter student roll number"<<endl;
cin>>roll_no;
}
void Student::displaydata()
{
cout<<"Name="<<stdnt_name<<endl;
cout<<"Roll no="<<roll_no<<endl;
cout<<"Faculty="<<faculty<<endl;
}
int main()
{
Student st1,st2;
cout<<"Enter the information of first student"<<endl;
st1.readdata();
cout<<"Enter the information of second student"<<endl;
st2.readdata();
cout<<"Informaton of first student is:"<<endl;
st1.displaydata();
cout<<"Information of second student is:"<<endl;
st2.displaydata();
return 0;}
```

4. Modify the **Que.no 3** for 20 students using array of object.

```
#include<iostream>
using namespace std;
class Student
{
private:
char stdnt_name[20];
char faculty[20];
int roll_no;
public:
void readdata();
void displaydata();
};
void Student::readdata()
{
cout<<"Enter student name"<<endl;
cin>>stdnt_name;
cout<<"Enter student faculty"<<endl;
cin>>faculty;
cout<<"Enter student roll number"<<endl;
cin>>roll_no;
}
void Student::displaydata()
{
cout<<"Name="<<stdnt_name<<endl;
cout<<"Roll no="<<roll_no<<endl;
cout<<"Faculty="<<faculty<<endl;
}
int main()
{
Student st[20];
int i;
for(i=0;i<20;i++)
{
cout<<"Enter the information of student:"<<i+1<<endl;
st[i].readdata();
}
for(i=0;i<20;i++)
{
cout<<"Information of student:"<<i+1<<endl;
st[i].displaydata();
}
return 0;}
```

5. WAP to perform the addition of time in hours, minutes and seconds by passing object as an argument.

```
#include<iostream>
using namespace std;
class Time
{
private:
int hours,minutes,seconds;
public:
void gettime(int h,int m,int s)
{
hours=h;
minutes=m;
seconds=s;
}
void display()
{
cout<<hours<<":"<<minutes<<":"<<seconds<<endl;
}
void sum(Time t1,Time t2)
{
seconds=t1.seconds+t2.seconds;
minutes=seconds/60;
seconds=seconds%60;
minutes=minutes+t1.minutes+t2.minutes;
hours=minutes/60;
minutes=minutes%60;
hours=hours+t1.hours+t2.hours;
}
};
int main()
{
Time t1,t2,t3;
t1.gettime(2,45,35);
t2.gettime(3,30,40);
t3.sum(t1,t2);
cout<<"First time=";
t1.display();
cout<<"Second time=";
t2.display();
cout<<"sum of two times=";
t3.display();
return 0;  }
```

6. WAP to perform the addition of time using the concept of returning object as argument.

```
#include<iostream>
using namespace std;

class Time
{
private:
int hours,minutes,seconds;
public:
void gettime(int h,int m,int s)
{
hours=h;
minutes=m;
seconds=s;
}
void display()
{
cout<<hours<<":"<<minutes<<":"<<seconds<<endl;
}
Time sum(Time t1,Time t2)
{
Time temp;
temp.seconds=t1.seconds+t2.seconds;
temp.minutes=temp.seconds/60;
temp.seconds=temp.seconds%60;
temp.minutes=temp.minutes+t1.minutes+t2.minutes;
temp.hours=temp.minutes/60;
temp.minutes=temp.minutes%60;
temp.hours=temp.hours+t1.hours+t2.hours;
return temp;
}
};
```

```
int main()
{
Time t1,t2,t3,result;
t1.gettime(2,45,35);
t2.gettime(3,30,40);
result=t3.sum(t1,t2);
cout<<"First time=";
t1.display();
cout<<"Second time=";
t2.display();
cout<<"Sum of two times=";
result.display();
return 0;
}
```

7. WAP to create two time objects with data members hours, minutes and seconds a function call by one object passing second object as function argument and return third object adding two objects. *Hint:t3=t1.adddistance(t2);*

```
#include<iostream>
using namespace std;
class Time
{
private:
int hours,minutes,seconds;
public:
void gettime(int h,int m,int s)
{
hours=h;
minutes=m;
seconds=s;
}
void display()
{
cout<<hours<<":"<<minutes<<":"<<seconds<<endl;
}
```

```
Time sum(Time t2)
{
Time temp;
temp.seconds=seconds+t2.seconds;
temp.minutes=temp.seconds/60;
temp.seconds=temp.seconds%60;
temp.minutes=temp.minutes+minutes+t2.minutes;
temp.hours=temp.minutes/60;
temp.minutes=temp.minutes%60;
temp.hours=temp.hours+hours+t2.hours;
return temp;
}
};
int main()
{
Time t1,t2,t3;
t1.gettime(2,45,35);
t2.gettime(3,30,40);
t3=t1.sum(t2);
cout<<"First time=";
t1.display();
cout<<"Second time=";
t2.display();
cout<<"Sum of two times=";
t3.display();
return 0;
}
```

8. WAP to create two distance objects with data members feet, inches and a function call by one object passing second object as function argument and return third object adding two objects. *Hint:d3=d1.adddistance(d2);*

```
#include<iostream>
using namespace std;
class Distance
{
private:
int feet;
int inches;
public:
void getdata();
Distance add(Distance);
void display();
};
```

```
void Distance::getdata()
{
cout<<"Enter feet:"<<endl;
cin>>feet;
cout<<"Enter inches:"<<endl;
cin>>inches;
}
void Distance::display()
{
cout<<feet<<"feet and"<<inches<<"inches"<<endl;
}
Distance Distance::add( Distance d2)
{
Distance sum;
sum.inches=inches+d2.inches;
sum.feet=sum.inches/12;
sum.inches=sum.inches%12;
sum.feet=sum.feet+feet+d2.feet;
return (sum);
}
int main()
{
Distance d1,d2,d3;
cout<<"Enter first Distance"<<endl;
d1.getdata();
cout<<"Enter second Distance"<<endl;
d2.getdata();
d3=d1.add(d2);
cout<<"The sum of  two distances=" ;
d3.display();
return 0;
}
```

*9.*Create a class called Rational having data members nume and deno and using friend function find which one is greater.

```
#include<iostream>
using namespace std;

class Rational
{
private:
int nume,deno;
```

```
public:
void getdata()
{
cout<<"Enter the value of numerator"<<endl;
cin>>nume;
cout<<"Enter the value of denominator"<<endl;
cin>>deno;
}
friend void max(Rational r);
};
void max(Rational r)
{
if(r.nume>r.deno)
{
cout<<"Maximum value="<<r.nume<<endl;
}
else
{
cout<<"Maximum value="<<r.deno<<endl;
}
}
int main()
{
Rational r;
r.getdata();
max(r);
return 0;
}
```

10. WAP to add the private data of three different classes using friend function.

```
#include<iostream>
using namespace std;
class B;
class C;
class A
{
private:
int x;
public:
void setdata(int num)
{
x=num;
}
friend void sum(A,B,C); };
```

```
class B
{
private:
int y;
public:
void setdata(int num)
{
y=num;
}
friend void sum(A,B,C);
};
class C
{
private:
int z;
public:
void setdata(int num)
{
z=num;
}
friend void sum(A,B,C);
};
void sum(A m,B n,C o)
{
cout<<"sum="<<(m.x+n.y+o.z)<<endl;
}
int main()
{
A p;
B q;
C r;
p.setdata(5);
q.setdata(10);
r.setdata(15);
sum(p,q,r);
return 0;
}
```

11. Write a program to find the largest of four integers .your program should have three classes and each classes have one integer number.[**PU:2014 spring]**

```
#include<iostream>
using namespace std;

class Y;
class Z;

class X
{
private:
int a;
public:
void getdata()
{
cout<<"Enter first number"<<endl;
cin>>a;
}
friend void max(X,Y,Z);
};
class Y
{
private:
int b;
public:
void getdata()
{
cout<<"Enter second number"<<endl;
cin>>b;
}
friend void max(X,Y,Z);
};
class Z
{
private:
int c;
```

```
public:
void getdata()
{
cout<<"Enter third number"<<endl;
cin>>c;
}
friend void max(X,Y,Z);
};
void max(X m,Y n,Z o)
{
int d;
cout<<"Enter fourth number"<<endl;
cin>>d;
if(m.a>n.b&&m.a>o.c&&m.a>d)
{
cout<<"Largest number="<<m.a<<endl;
}
else if(n.b>o.c&&n.b>d)
{
cout<<"Largest number="<<n.b<<endl;
}
else if(o.c>d)
{
cout<<"Largest number="<<o.c<<endl;
}
else
{
cout<<"Largest number="<<d<<endl;
}
}
int main()
{
X p;
Y q;
Z r;
p.getdata();
q.getdata();
r.getdata();
max(p,q,r);
return 0; }
```

12. WAP to swap the contents of two variables of 2 different classes using friend function.

```
#include <iostream>
using namespace std;
class ABC;
class XYZ
{
private:
int x;
public:
void getdata ()
{
cout<<"Enter Value of class XYZ"<<endl;
cin>>x;
}
void display()
{
cout<<"value1="<<x<<endl;
}
friend void swap (XYZ &,ABC &);
};
class ABC
{
private:
int y ;
public:
void getdata ()
{
cout<<"Enter the value of class ABC"<<endl;
cin>>y;
}
void display()
{
cout<<"value2="<<y<<endl;
}
friend void swap(XYZ &,ABC &) ;
};
```

```
void swap (XYZ &m, ABC &n)
{
int temp;
temp=m.x;
m.x=n.y;
n.y=temp;
}
int main( )
{
XYZ p;
ABC q;
p.getdata() ;
q.getdata() ;
cout<<"Value before swapping"<<endl;
p.display();
q.display();
swap(p,q);
cout<<"Value after swapping"<<endl;
p.display();
q.display();
return 0;
}
```

13. WAP to add two complex numbers of two different classes using friend function.

```
#include<iostream>
using namespace std;
class complex2;
class complex1
{
private:
int real,imag;
public:
void getdata()
{
cout<<"Enter real and imaginary part"<<endl;
cin>>real>>imag;
}
```

```
void display()
{
cout<<real<<"+"<<imag<<"i"<<endl;
}
friend void addcomplex(complex1,complex2);
};

class complex2
{
private:
int real,imag;
public:
void getdata()
{
cout<<"Enter real and imaginary part"<<endl;
cin>>real>>imag;
}
void display()
{
cout<<real<<"+"<<imag<<"i"<<endl;
}
friend void addcomplex(complex1,complex2);
};

void addcomplex(complex1 c1,complex2 c2)
{
int real,imag;
real=c1.real+c2.real;
imag=c1.imag+c2.imag;
cout<<"sum of complex number="<<real<<"+"<<imag<<"i"<<endl;
}
int main()
{
complex1 c1;
complex2 c2;
c1.getdata();
c2.getdata();
cout<<"first complex number"<<endl;
c1.display();
cout<<"second complex number"<<endl;
```

```
c2.display();
addcomplex(c1,c2);
return 0;
}
```

14. WAP to add complex numbers of two different classes using friend class.

```
#include<iostream>
using namespace std;
class complex2;
class complex1
{
private:
int real,imag;
public:
void getdata()
{
cout<<"Enter real and imaginary part"<<endl;
cin>>real>>imag;
}
void display()
{
cout<<real<<"+i"<<imag<<endl;
}
friend class complex2;
};
class complex2
{
private:
int real,imag;
public:
void getdata()
{
cout<<"Enter real and imaginary part"<<endl;
cin>>real>>imag;
}
void display()
{
cout<<real<<"+i"<<imag<<endl;
}
void addcomplex(complex1);
};
```

```
void complex2::addcomplex(complex1 c1)
{
real=c1.real+real;
imag=c1.imag+imag;
cout<<"sum of complex number="<<real<<"+i"<<imag<<endl;
}
int main()
{
complex1 c1;
complex2 c2;
c1.getdata();
c2.getdata();
cout<<"first complex number"<<endl;
c1.display();
cout<<"second complex number"<<endl;
c2.display();
cout<<"sum="<<endl;
c2.addcomplex(c1);
return 0;
}
```

15. Using class write a program that receives inputs principle amount, time and rate. Keeping rate 8% as the default argument, calculate simple interest for three customers.**[PU:2019 fall]**

```
#include<iostream>
using namespace std;
class customer
{
private:
float principle,rate,si;
int time;
public:
void setdata(float p,int t,float r=8);
void display();
};
void customer::setdata(float p,int t,float r)
{
principle=p;
time=t;
rate=r;
}
```

```
void customer::display()
{
si=(principle*time*rate)/100;
cout<<"Simple Interest="<<si<<endl;
}
int main()
{
float p;
int t,i;
customer c[3];
for(i=0;i<3;i++)
{
cout<<"Enter principle and time for customer"<<i+1<<endl;
cin>>p>>t;
c[i].setdata(p,t);
c[i].display();
}
return 0;
};
```

16. Create a new class named City that will have two member varibles CityName (char[20]), and DistFromKtm (float).Add member functions to set and retrieve the CityName and DistanceFromKtm separately. Add new member function AddDistance that takes two arguments of class City and returns the sum of DistFromKtm of two arguments. In the main function, Initialize three city objects .Set the first and second City to be pokhara and Dhangadi. Display the sum ofDistFromKtm of Pokhara and Dhangadi calling AddDistance function of third City object. **[PU: 2010 Spring]**

```
#include<iostream>
#include<string.h>
using namespace std;
class City
{
private:
char CityName[20];
float DistFromKtm;
public:
void setdata(char cname[],float d)
{
strcpy(CityName,cname);
DistFromKtm=d;
}
```

```
void display()
{
cout<<"City name="<<CityName<<endl;
cout<<"Distance from ktm="<<DistFromKtm<<endl;
}
float AddDistance(City c1,City c2)
{
return (c1.DistFromKtm+c2.DistFromKtm);
}
};
int main()
{
City c1,c2,c3;
c1.setdata("Pokhara",250);
c2.setdata("Dhangadi",150);
cout<<"Information of first city"<<endl;
c1.display();
cout<<"Information of second city"<<endl;
c2.display();
cout<<"sum of DistFromKtm of Pokhara and Dhangadi="<<c3.AddDistance(c1,c2);
return 0;
}
```

17. Create a class called Volume that uses three Variables (length, width, height) of type distance (feet and inches) to model the volume of a room. Read the three dimensions of the room and calculate the volume it represent, and print out the result .The volume should be in (feet3) form ie. you will have to convert each dimension into the feet and fraction of foot. For instance , the length 12 feet 6 inches will be 12.5 ft)
[PU: 2009 spring]

```
#include<iostream>
using namespace std;
class volume
{
private:
int lf,wf,hf,li,wi,hi;
float vol,length,width,height;
public:
void getdata();
void convertdim();
void display();
};
```

```
void volume::getdata()
{
cout<<"Enter the length of room in feet and inches"<<endl;
cin>>lf>>li;
cout<<"Enter the width of room in feet and inches"<<endl;
cin>>wf>>wi;
cout<<"Enter the Height of room in feet and inches"<<endl;
cin>>hf>>hi;
}
void volume::convertdim()
{
length=lf+(float)li/12;
width=wf+(float)wi/12;
height=hf+(float)hi/12;
cout<<"The length of room ="<<length<<endl;
cout<<"The width of room ="<<width<<endl;
cout<<"The Height of room="<<height<<endl;
}
void volume::display()
{
vol=length*width*height;
cout<<"Volume of Room ="<<vol<<endl;
}
int main()
{
volume v;
v.getdata();
v.convertdim();
v.display();
return 0;
}
```

18. WAP to read two complex numbers and a function that calls by passing references of two objects rather than values of objects and add into third object and returns that object.

```
#include<iostream>
using namespace std;
```

```
class Complex
{
private:
int real,imag;
public:
void getdata();
void display();
Complex sum( Complex &c1,Complex &c2);
};
void Complex::getdata()
{
cout<<"Enter real part and imaginary part"<<endl;
cin>>real>>imag;
}
void Complex::display()
{
cout<<real<<"+"<<imag<<"i"<<endl;
}
Complex Complex::sum( Complex &c1,Complex &c2)
{
Complex c3;
c3.real=c1.real+c2.real;
c3.imag=c1.imag+c2.imag;
return c3;
}
int main()
{
Complex c1,c2,c3,c4;
c1.getdata();
c2.getdata();
c4=c3.sum(c1,c2);
cout<<"sum=";
c4.display();
return 0;
}
```

19. WAP in C++ to calculate simple interest from given principal, time and rate. Set the rate to 15 % as default argument when rate is not provided.

```
#include<iostream>
using namespace std;
float calculate(float principle,int time,float rate=15);
int main()
{
float p,r;
int t;
char ch;
cout<<"Enter principle and time"<<endl;
cin>>p>>t;
cout<<"Do you want to enter rate?"<<endl;
cin>>ch;
if(ch=='Y'||ch=='y')
{
cout<<"Enter rate"<<endl;
cin>>r;
cout<<"Interest="<<calculate(p,t,r)<<endl;
}
else
{
cout<<"Interest="<<calculate(p,t)<<endl;
}
return 0;
}
float calculate(float principle,int time,float rate)
{
return(principle*time*rate)/100.0;
}
```

20. Create a class comparison with data members x and y and max and member function getdata() to read the value of x, y, largest() to find greater of two and print() to the greater number.

```
#include<iostream>
using namespace std;
class Comparison
{
private:
int x,y,max;
public:
void getdata()
{
cout<<"Enter two numbers"<<endl;
cin>>x>>y;
}
int largest()
{
max=(x>y)?x:y;
return max;
}
void print()
{
cout<<"Greater number="<<max<<endl;
}
};
int main()
{
Comparison c1;
c1.getdata();
c1.largest();
c1.print();
return 0;
}
```

21. Create a class student with six data members (roll no, name, marks in English,math, science and total).Write a program init() to initializes necessary data members calctotal() and display().Create a program for one student (i.e one object only necessary)

```
#include<iostream>
using namespace std;
class Student
{
private:
char name[20];
int roll;
float me,mm,ms,total;
public:
void init()
{
cout<<"Enter roll number"<<endl;
cin>>roll;
cout<<"Enter name"<<endl;
cin>>name;
cout<<"Enter Marks in English,Math and science"<<endl;
cin>>me>>mm>>ms;
}
void calctotal()
{
total=me+mm+ms;
}
void display()
{
cout<<"Name:"<<name<<endl;
cout<<"RollNo:"<<roll<<endl;
cout<<"Marks in English:"<<me<<endl;
cout<<"Marks in Math:"<<mm<<endl;
cout<<"Marks in science:"<<ms<<endl;
cout<<"Total:"<<total<<endl;
}
};
int main()
{
Student st;
st.init();
st.calctotal();
st.display();
return 0;  }
```

CHAPTER 2 (THEORY SOLUTION)

1. **What sorts of shortcomings of structure are addressed by classes? Explain giving appropriate example.[PU:2014 fall]**

   The shortcoming of structure that are addressed by classes are as follows:

   1) Class can create a subclass that will inherit parent's properties and methods, whereas Structure does not support the inheritance.
   2) Structure members can be easily accessed by the structure variables in their scope but class members doesn't due to feature of data hiding.
   3) Classes support polymorphism (late binding), whereas structure doesn't.
   4) Also we can use "this" pointers in classes due to which you don't have to explicitly pass an object to a member function.
   5) The structure data type cannot be treated like built in types while performing arithmetic operations. But it is valid in class using the concept of operator overloading.
      For example:

      ```
      struct complex
      {
      int real;
      int imag;
      }
      struct complex c1,c2,c3;
      c3=c1+c2; Is illegal .
      ```

2. **Differentiate between structure and class. Why Class is preferred over structure? Support your answer with suitable examples.*[PU:2016 fall]***

Structure	Class
1. A structure is a collection of variables of different data types under a single unit.	1. A class is a user-defined blueprint or prototype from which objects are created.
2. To define structure we will use "struct" keyword.	2. To define class we will use "class" keyword.
3. A structure has all members public by default.	3. A class has all members private by default.

4. A Structure does not support inheritance.	4. A Class can inherit from another class. Which means class supports inheritance.
5. Structures are good for small and isolated model objects.	5. Classes are suitable for larger or complex objects.
6. Structure is a value type and its object is created on the stack memory.	6. Class is a reference type and its object is created on the heap memory.
7. Function member of the struct cannot be virtual or abstract	7. Function member of the class can be virtual or abstract.

Due to the following reasons class is preferred over structure.

- Structures in C++ doesn't provide data hiding where as a class provides data hiding
- A Structure is not secure and cannot hide its implementation details from the end user while a class is secure and can hide its programming and designing details.
- Classes support polymorphism (late binding), whereas structure doesn't.
- Class support inheritance but structure doesn't.
- "this" pointer will works only with class.
- Class lets us to use constructors and destructors.

3. Explain the various access specifier used in C++ with example.

Access Modifiers or Access Specifiers in a class are used to set the accessibility of the class members. That is, it sets some restrictions on the class members not to get directly accessed by the outside functions.
There are 3 types of access modifiers available in C++.They are:

1) Public:
All the class members declared under public will be available to everyone. The data members and member functions declared public can be accessed by other classes too. The public members of a class can be accessed from anywhere in the program using the direct member access operator (.) with the object of that class.

2) Private:

The class members declared as private can be accessed only by the functions inside the class. They are not allowed to be accessed directly by any object or function outside the class. Only the member functions or the friend functions are allowed to access the private data members of a class.

```
#include<iostream>
using namespace std;
class Rectangle
{
private:
float length,breadth,area;
public:
void setdata(float l,float b)
{
length=l;
breadth=b;
}
void disp_area()
{
area=length*breadth;
cout<<"Area="<<area<<endl;
}
};
int main()
{
Rectangle r;
r.setdata(10.5,6);
r.disp_area();
return 0;
}
```

Here, member function disp_area() is public so it is accessible outside class .But data member length ,breadth and area being private they are not accessible outside class. Only member function of that class disp_area() can access it.

3) Protected

class member declared as Protected are inaccessible outside the class but they can be accessed by any subclass(derived class) of that class.

Example:

```
#include <iostream>
using namespace std;
class A
{
protected:
int a, b;
public:
void setdata(int x, int y)
{
a = x;
b = y;
}
};
class B : public A
{
public:
void display()
{
cout << "value of a=" << a << endl;
cout << "value of b=" << b << endl;
cout << "Sum of two protected variables a and b = "<< a + b << endl;
}
};
int main()
{
B obj;
obj.setdata(4, 5);
obj.display();
return 0;
}
```

In above example , protected variable a and b is accessed by the derived class B.

From above discussion we can conclude that:

Access Specifier	**Accessible from own class**	**Accessible from derived class**	**Accessible from objects outside class**
public	yes	yes	yes
private	yes	no	no
protected	yes	yes	no

4. **What is data hiding/Information hiding? How do you achieve data hiding in C++? Explain with suitable program.*[PU:2019 fall]***

Data Hiding means protecting the data members of a class from an illegal or unauthorized access from outside class. It ensures exclusive data access to class members and protects object integrity by preventing unintended or intended changes.

By declaring the data member private in a class, the data members can be hidden from outside the class. Those private data members cannot be accessed by the object directly.

```
#include<iostream>
using namespace std;
class Square
{
private:
int num;
public:
void getdata()
{
cout << "Enter the number"<<endl;;
cin>>num;
}
void display()
{
cout << "Square of a given number= "<< num*num<<endl;
}
};
int main()
{
Square obj;
obj.getdata();
obj.display();
return 0;
}
```

In the above example, the variable “num” is private. Hence this variable can be accessed only by the member function of the same class and is not accessible from anywhere else. Hence outside the classes will be unable to access this variable which is called data hiding. In this way data hiding can be achieved.

5. **What is encapsulation? How can encapsulation enforced in C++? Explain with suitable example code.** ***[PU:2017 spring]***

Encapsulation is a process of combining data members and functions in a single unit called class.
In encapsulation, the variables or data of a class is hidden from any other class and can be accessed only through any member function of own class in which they are declared. As in encapsulation, the data in a class is hidden from other classes, so it is also known as data-hiding.
Encapsulation can be enforced by declaring all the variables in the class as private and writing public methods in the class to set and get the values of variable.

Example:

```
#include<iostream>
using namespace std;
class Square
{
private:
int num;
public:
void setnum(int x)
{
num=x;
}
int getnum()
{
return (num*num);
}
};
int main()
{
Square obj;
obj.setnum(5);
cout<<"Square of a number="<<obj.getnum()<<endl;
return 0;
}
```

In the above program the Class square is encapsulated as the variables are declared as private. The get methods getnum() is set as public, this method is used to access these variables. The setter method like setnum() is also declared as public and is used to set the values of the variables.

6. **Where do you use friend function? What are the merits and di-merits of friend function?**

In some situation non-member function need to access the private data of class or one class wants to access private data of second class and second wants to access private data of first class. This can achieve by using friend functions.
The non-member function that is “friendly” to a class, has full access rights to the private members of the class.

For example when we want to compare two private data members of two different classes in that case you need a common function which can make use of both the private variables of different class. In that case we create a normal function and make friend in both the classes, as to provide access of theirs private variables.

Merits of friend function:

- It can access the private data member of class from outside the class
- Allows sharing private class information by a non-member function.
- It acts as the bridge between two classes by operating on their private data’s.
- It is able to access members without need of inheriting the class.
- It provides functions that need data which isn’t normally used by the class.

Demerits of friend function:

- It violates the law of data hiding by allowing access to private members of the class from outside the class.
- Breach of data integrity
- Conceptually messy
- Runtime polymorphism in the member cannot be done.
- Size of memory occupied by objects will be maximum

7. Does friend function violate the data hiding? Explain Briefly.[PU:2017 fall]

The concept of data hiding indicates that nonmember functions should not be able to access the private data of class. But, it is possible with the help of a “friend function”. That means, a function has to be declared as friend function to give it the authority to access to the private data.
Hence, friend function is not a member function of the class but can access private members of that class. So that’s why friend function violate data hiding.

Let's illustrate the given concept with the following example.

```
#include<iostream>
using namespace std;
class sample
{
private:
int a,b;
public:
void setdata(int x,int y)
{
a=x;
b=y;
}
friend void sum(sample s);
};
void sum(sample s)
{
cout<<"sum="<<(s.a+s.b)<<endl;
}
int main()
{
sample s;
s.setdata(5,10);
sum(s);
return 0;
}
```

Here in class named sample there are two private data members a and b. The function sum() is not a member function but when it is declared as friend in class sample then sum() can access the private data a and b. which shows that friend function violate the concept of data hiding.

8. What are the limitations of static member functions

Limitations of static member functions:

- It doesn't have a "this" pointer.
- A static member function cannot directly refer to static members.
- Same function can't have both static and non static types.
- It can't be virtual.
- A static member function can't be declared as const or volatile.

9. Data hiding Vs Encapsulation

Data hiding	Encapsulation
1) Data Hiding means protecting the members of a class from an illegal or unauthorized access.	1) Encapsulation means wrapping the implementation of data member and methods inside a class.
2) Data hiding focus more on data security.	2) Encapsulation focuses more on hiding the complexity of the system.
3) The data under data hiding is always private and inaccessible.	3) The data under encapsulation may be private or public.
4) When data member of class are private only member function of that class can access it.	4) When implementation of all the data member and methods inside a class are encapsulated, the method name can only describe what action it can perform on an object of that class.
5) Data hiding is a process as well as technique.	5) Encapsulation is a sub-process in data hiding.

10. Abstraction Vs Data hiding

Abstraction	Data hiding
1) Abstraction is a mechanism of expressing the necessary properties by hiding the details.	1) Data Hiding means protecting the members of a class from an illegal or unauthorized access
2) It's purpose is to hide complexity.	2) It's purpose is to achieve encapsulation.
3) Class uses the abstraction to derive a new user-defined datatype	3) Data hiding is used in a class to make its data private.
4) It focuses on observable behavior of data.	4) It focuses on data security.

Chapter 3 Tutorial solution (Program Only)

1) **WAP to input the name, age, and salary of employee and display the records and total number of employee using the concept of static data members.**

```
#include<iostream>
using namespace std;
class Employee
{
private:
char name[20];
int age;
float salary;
static int count;
public:
void getinfo()
{
cout<<"Enter name of employee"<<endl;
cin>>name;
cout<<"Enter age"<<endl;
cin>>age;
cout<<"Enter salary"<<endl;
cin>>salary;
count++;
}
void dispinfo()
{
        cout<<"Name:"<<name<<endl;
        cout<<"Age:"<<age<<endl;
        cout<<"Salary:"<<salary<<endl;
}
static void disptotal()
{
cout<<"Total number of employees are:"<<count<<endl;
}
};
int Employee::count;
```

```
int main()
{
Employee e1,e2,e3;
cout<<"Enter information of employees"<<endl;
e1.getinfo();
e2.getinfo();
e3.getinfo();
cout<<"Details of employees are:"<<endl;
e1.dispinfo();
e2.dispinfo();
e3.dispinfo();
Employee::disptotal();
return 0;
}
```

2) WAP to find area of rectangle using the concept of parameterized constructor.

```
#include<iostream>
using namespace std;
class rectangle
{
private:
int length,breadth,area;
public:
rectangle(int l,int b)
{
length=l;
breadth=b;
}
void calc()
{
area=length*breadth;
}
void display()
{
cout<<"Area of Rectangle="<<area<<endl;
}
};
```

```
int main()
{
rectangle r1(10,5);
r1.calc();
r1.display();
return 0;
}
```

3) WAP to initialize name, roll and marks of student using constructor and display the obtained information.

```
#include<iostream>
#include<string.h>
using namespace std;
class student
{
private:
char name[20];
int roll;
float marks;
public:
student(char n[],int r,float m)
{
 strcpy(name,n);
 roll=r;
 marks=m;
}
void display()
{
cout<<"Name:"<<name<<endl;
cout<<"Roll no:"<<roll<<endl;
cout<<"Marks:"<<marks<<endl;
}
};
int main()
{
student st("Ram",7,88.5);
st.display();
return 0;
}
```

4) **Create a class student with data members (name, roll, marks in English, Maths and OOPs(in 100) ,total, average), a constructor that initializes the data members to the values passed to its parameters, A function called calculate() that calculates the total of marks obtained and average. And function display() to display name, roll no, total and average.**

```
#include<iostream>
#include<string.h>
using namespace std;
class student
{
private:
char name[20];
int roll;
float me,mm,mo,total,avg;
public:
student(char n[],int r,float e,float m,float o)
{
strcpy(name,n);
roll=r;
me=e;
mm=m;
mo=o;
}
void calculate()
{
total=me+mm+mo;
avg=total/3;
}
void print()
{
cout<<"Name:"<<name<<endl;
cout<<"Roll no:"<<roll<<endl;
cout<<"Total:"<<total<<endl;
cout<<"Average:"<<avg<<endl;
}
};
```

```
int main()
{
char name[20];
int roll;
float meng,mmath,moops;
cout<<"Enter name"<<endl;
cin>>name;
cout<<"Enter roll"<<endl;
cin>>roll;
cout<<"Enter marks in English,Maths and OOPs"<<endl;
cin>>meng>>mmath>>moops;
student st(name,roll,meng,mmath,moops);
st.calculate();
st.print();
return 0;
}
```

5) **WAP to perform the addition of complex number using the concept of constructor**.

```
#include<iostream>
using namespace std;
class complex
{
private:
int real,imag;
public:
complex()
{
real=2;
imag=4;
}
complex(int r,int i)
{
real=r;
imag=i;
}
void addcomplex(complex c1,complex c2)
{
real=c1.real+c2.real;
imag=c1.imag+c2.imag;
}
```

```
void display()
{
cout<<real<<"+i"<<imag<<endl;
}
};

int main()
{
complex c1;
complex c2(10,20);
complex c3;
cout<<"First complex number="<<endl;
c1.display();
cout<<"Second complex number="<<endl;
c2.display();
c3.addcomplex(c1,c2);
cout<<"sum="<<endl;
c3.display();
return 0;
}
```

6) WAP to copy complex number using the concept of constructor.

```
#include<iostream>
using namespace std;
class complex
{
private:
int real,imag;
public:
complex(int r,int i)
{
 real=r;
 imag=i;
}
complex(complex &x)
{
        real=x.real;
        imag=x.imag;
}
```

```
void display()
{
cout<<"Real part="<<real<<endl;
cout<<"Imaginary part"<<imag<<endl;
}
};
int main()
{
        complex c1(5,10);
        complex c2(c1);
        cout<<"Details of c1"<<endl;
        c1.display();
        cout<<"Details of c2"<<endl;
        c2.display();
        return 0;
}
```

7) WAP to concatenate strings of two objects using the concept of Dynamic Constructor.

```
#include<iostream>
#include<string.h>
using namespace std;
class strings
{
char *name;
int length;
public:
strings()
{
length=0;
name=new char[length+1];
}
strings (char *s)
{
length=strlen(s);
name=new char[length+1];
strcpy(name,s);
}
void display()
{
cout<<name<<endl;
}
```

```
void join(strings &a,strings &b)
{
length=a.length+b.length;
delete name;
name=new char[length+1];
strcpy(name,a.name);
strcat(name,b.name);
}
};
int main()
{
char name1[20];
char name2[20];
cout<<"Enter first string"<<endl;
cin>>name1;
cout<<"Enter second string"<<endl;
cin>>name2;
strings s1(name1);
strings s2(name2);
strings s3;
s3.join(s1,s2);
cout<<"String after concatenation"<<endl;
s3.display();
return 0;
}
```

8) Write a simple program using of dynamic memory allocation which should include calculation of marks of 3 subjects of n students and displaying the result as pass or fail and name, roll. Pass mark is 45 out of 100 in each subject.

```
#include<iostream>
using namespace std;
class student
{
private:
char name[20];
int roll;
float m1,m2,m3;
public:
void getdata()
{
cout<<"Enter the name"<<endl;
cin>>name;
cout<<"Enter the roll"<<endl;
cin>>roll;
cout<<"Enter the marks in 3 subjects"<<endl;
cin>>m1>>m2>>m3;
}
void display()
{
cout<<"Name:"<<name<<endl;
cout<<"Roll no:"<<roll<<endl;
if(m1>=45&&m2>=45&&m3>=45)
{
cout<<"Result=Pass"<<endl;
}
else
{
cout<<"Result=Fail"<<endl;
}
}
};
```

```
int main()
{
        int n,i;
        student *ptr;
   cout<<"Enter the number of students"<<endl;
   cin>>n;
   ptr=new student[n];
   for(i=0;i<n;i++)
   {
   cout<<"Enter the information of  student"<<i+1<<endl;
        ptr[i].getdata();
        }
        for(i=0;i<n;i++)
        {
        cout<<"Information of student"<<i+1<<endl;
        ptr[i].display();
        }
        delete []ptr;
        return 0;
}
```

9) **Write a program to find the difference of complex number using the concept of constructors. Input the values from main () and pass argument to the constructor**.

```
#include<iostream>
using namespace std;
class complex
{
private:
int real,imag;
public:
complex()
{
}
complex(int r,int i)
{
real=r;
imag=i;
}
```

```
void diffcomplex(complex c1,complex c2)
{
real=c1.real-c2.real;
imag=c1.imag-c2.imag;
}
void display()
{
cout<<real<<"+i"<<imag<<endl;
}
};

int main()
{
int real1,imag1,real2,imag2;
cout<<"Enter the real and imaginary part of  first complex number"<<endl;
cin>>real1>>imag1;
cout<<"Enter the real and imaginary part of  second complex number"<<endl;
cin>>real2>>imag2;
complex c1(real1,imag1);
complex c2(real2,imag2);
complex c3;
cout<<"First complex number="<<endl;
c1.display();
cout<<"Second complex number="<<endl;
c2.display();
c3.diffcomplex(c1,c2);
cout<<"Difference of complex number="<<endl;
c3.display();
return 0;
}
```

Tutorial solution (Chapter-3) Theory only

1. **What is the difference between message passing and function call? Explain the basic message formalization. [PU:2006 spring]**

Message Passing	Function Call
1) In a message passing there is a designated receiver for that message; the receiver is some object to which message is sent.	**1)** In function call, there is no designated receiver.
2) Interpretation of the message (that is method is used to respond the message) is determined by the receiver and can vary with different receivers.	**2)** Determination of which method to invoke is very early binding of a name to fragment in procedure calls
3) Message passing must involve name of the object, function name and information to be sent.	3) Simply function name and its arguments is used to made function call.
4) A message is always given to some object, called the receiver.	4) Name will be matched to a message to determine when the method should be executed Signature the combination of return type and argument types.
5) Example: st.getdata(2,5)	5) **Example:** getdata(2,5);

Explanation:
Message passing formalization

Message passing means the dynamic process of asking an object to perform a specific action.
•A message is always given to some object, called the receiver.
•The action performed in response to the message is not fixed but may be differ, depending on the class of the receiver .That is different objects may accept the same message the and yet perform different actions**.**
There are three identifiable parts to any message-passing expression. These are
1) Receiver: the object to which the message is being sent
2) Message selector: the text that indicates the particular message is being sent.
3) Arguments used in responding the message.

s.getdata(100,200);

receiver Message arguments

st.getdata(100,200);
receiver Message arguments

Example of message passing

```
#include<iostream>
#include<conio.h>
using namespace std;
class student
{
int roll;
public:
void getdata(int x)
{
roll=x;
}
void display()
{
cout<<"Roll number="<<roll;
}
};

int main()
{
student s;
s.getdata(325); //objects passing message
s.display(); //objects passing message
getch();
return 0;
}
```

2. **What are the possible memory errors in programming.[PU:2014 spring]**

Memory errors occur very commonly in programming, and they can affect application stability and correctness. These errors are due to programming bugs. They can be hard to reproduce, hard to debug, and potentially expensive to correct as well. Applications that have memory errors can experience major problems.

Memory errors can be broadly classified into Heap Memory Errors and Stack Memory Errors. Some of the challenging memory errors are:

1. **Invalid Memory Access in stack and heap:** This error occurs when a read or write instruction references unallocated or deallocated memory.
2. **Memory leaks**
   Memory leaks occur when memory is allocated but not released.
3. **Mismatched Allocation/Deallocation**
   This error occurs when a deallocation is attempted with a function that is not the logical counterpart of the allocation function used.
   To avoid mismatched allocation/deallocation, ensure that the right de-allocator is called. In C++, new[] is used for memory allocation and delete[] for freeing up.
4. **Missing allocation**
   This error occurs when freeing memory which has already been freed. This is also called "repeated free" or "double free".
5. **Uninitialized Memory Access**
   This type of memory error will occur when an uninitialized variable is read in your application. To avoid this type of memory error, always initialize variables before using them.

3. **Is it mandatory to use constructor in class. Explain?**

   Constructor is a 'special' member function whose task is to initialize the object of its class.
   It is not mandatory to use constructor in a class. As we know, Constructor are invoked automatically when the objects are created.
   So that object are initialized at the time of declaration. There is no need to separate function call to initialize the object. Which reduces coding redundancy and minimizes the programming error such as uninitialized memory access.

4. **Differentiate between constructor and destructor.**

Constructor	Destructor
1) Constructor is used to initialize the instance of the class.	1) Destructor destroys the objects when they are no longer needed.
2) Constructors is called when new instances of class is created.	2) Destructor is called when instances of class is deleted or released.
3) Constructor allocates the memory.	3) Destructor releases the memory.
4) Constructor can have arguments.	4) Destructor cannot have any arguments.
5) Overloading of constructor is possible.	5) Overloading of Destructor is not possible.
6) Constructor have same name as class name.	6) Destructor have same name as class name but with **tlide (~)** sign.

7) **Syntax:**
Class_name(arguments)
{
//Body of the constructor
}
	7) **Syntax:**
	~Class_name()
	{
	//Body of the destructor
	}

5. **Discuss the various situations when a copy constructor is automatically invoked. How a default constructor can be equivalent to constructor having default arguments.**

Various situations when the copy constructor is called or automatically invoked are:

- When compiler generates the temporary object.
- When an object is constructed based on the object of the same class.
- When an object of the class is passed to function by values as an argument.
- When an object of the class is returned by value.

Constructor with default arguments is a is parameterized constructor which has default values in arguments. Thus the arguments defined in such constructor are optional. We may or may not pass arguments while defining object of the class. When an object is created with no supplied values, the default values are used. By this way, constructor with default constructor is equivalent to default constructor.

Example:

```
#include<iostream>
using namespace std;
class Box
{
private:
float l,b,h;
public:
Box(float le=10,float br=5,float he=5)
{
        l=le;
        b=br;
        h=he;
}
void displaymember()
{
        cout<<"Length,breadth and height"<<l<<b<<h<<endl;
}
float getvolume()
{
        return (l*b*h);
}
};
int main()
{
        Box b;
        float vol;
        vol=b.getvolume();
        cout<<"Volume="<<vol<<endl;
        return 0;
}
```

6. **What is de-constructor? can you have two destructors in a class? Give example to support your reason.[PU:2014 spring]**

   De-constructor is a member function that destroys the object that have been created by a constructor.
   Destructor doesn't take any arguments, which means destructor cannot be overloaded. So, that there will be only one destructor in a class.
   Destructors are usually used to deallocate memory and do other cleanup for a class object and its class members when the object is destroyed. A destructor is called for a class object when that object passes out of scope or is explicitly deleted.
   So, that there cannot be more than one destructor (two destructor) in a same class.

   (Write example of destructor yourself)

7. **Differentiate methods of argument passing in constructor and destructor**.

A constructor is allowed to accept the arguments as the arguments can be used to initialize the data members of the class.
A destructor does not accept any arguments as its only work is to deallocate the memory of the object.
In class, there can be multiple constructors which are identified by the number arguments passed.
In class, there is only one destructor.
Constructors can be overload to perform different action under the name of the same constructor whereas, destructors cannot be overloaded.

Example:

```
#include <iostream>
using namespace std;
class test
{
private:
int a;
public:

 test()
 {
        a=10;
  cout<<"Default constructor is called"<<endl;
 }

test(int x)
{
        a=x;
  cout<<"Parameterized constructor is called"<<endl;
}
 ~test()
 {
  cout<<"Destructor is called"<<endl;
  }
  void display()
  {
   cout<<"value of a="<<a<<endl;
  }
};
```

```
int main()
{
 test t1;
 test t2(5);
 t1.display();
 t2.display();
 return 0;
}
```

8. **What do you mean by stack vs Heap? Explain the memory recovery. Explain the use of new and delete operator. [PU:2009 spring]**

Stack

- It's a region of computer's memory that stores temporary variables created by each function (including the main() function).
- The stack is a "Last in First Out" data structure and limited in size. Every time a function declares a new variable, it is "pushed" (inserted) onto the stack. Every time a function exits, all of the variables pushed onto the stack by that function, are freed or popped (that is to say, they are deleted).
- Once a stack variable is freed, that region of memory becomes available for other stack variables.

Heap

- The heap is a region of computer's memory that is not managed automatically and is not as tightly managed by the CPU.
- We must allocate and de-allocate variable explicitly. (for allocating variable **new** and for freeing variables **delete** operator is used.
- It does not have a specific limit on memory size.

Memory recovery

Because in most languages objects are dynamically allocated, they must be recovered at run-time. There are two broad approches to this:

- Force the programmer to explicitly say when a value is no longer being used:
  delete aCard; // C++ example
- Use a garbage collection system that will automatically determine when values are no longer being used, and recover the memory.

Use of new and delete operator

new is used to allocate memory blocks at run time (dynamically). While, delete is used to de-allocate the memory which has been allocated dynamically.

Example of new and delete in C+

```
#include <iostream>
using namespace std;
int main ()
{
int i,n;
int *ptr;
int sum=0;
cout << "How many numbers would you like to Enter? ";
cin >>n;
ptr= new int[n];

for (i=0; i<n; i++)
{
cout << "Enter number:"<<i+1<<endl;
cin >> ptr[i];
}
for (i=0; i<n; i++)
{
sum=sum+ptr[i];
}
cout<<"sum of numbers="<<sum<<endl;
delete[] ptr;
return 0;
}
```

9. What are the advantages of dynamic memory allocation? Explain with suitable example. [PU:2016 spring]

The main advantage of using dynamic memory allocation is preventing the wastage of memory or efficient utilization of memory. Let us consider an example:

In static memory allocation the memory is allocated before the execution of program begins (During compilation).In this type of allocation the memory cannot be resized after initial allocation. So it has some limitations. Like

- Wastage of memory
- Overflow of memory

eg. int num[100];
Here, the size of an array has been fixed to 100.If we just enter to 10 elements only, then their will be wastage of 90 memory location and if we need to store more than 100
elements there will be memory overflow.

But, in dynamic memory allocation memory is allocated during runtime.so it helps us to allocate and de-allocate memory during the period of program execution as per requirement. So there will be proper utilization of memory.

In c++ dynamic memory allocation can be achieved by using new and delete operator. **new** is used to allocate memory blocks at run time (dynamically). While, **delete** is used to de-allocate the memory which has been allocated dynamically.

Let us consider an example:

```
#include <iostream>
using namespace std;
int main ()
{
int i,n;
int *ptr;
int sum=0;
cout << "How many numbers would you like to Enter? ";
cin >>n;
ptr= new int[n];
for (i=0; i<n; i++)
{
cout << "Enter number:"<<i+1<<endl;
cin >> ptr[i];
}
for (i=0; i<n; i++)
{
sum=sum+ptr[i];
}
cout<<"sum of numbers="<<sum<<endl;
delete[] ptr;
return 0;
}
```

Here, in above example performs the sum of n numbers .But the value of n will be provided during runtime.so that memory allocation to store n numbers is done during program execution which results proper utilization of memory and preventing from wastage of memory or overflow of memory.

Inheritance Program solution

1. **WAP to enter information of n students and then display is using the concept of multiple inheritance.**

```
#include <iostream>
#include <conio.h>
using namespace std;
class Student_info
{
char name[25];
int age;
public:
void get_info()
{
cout<<"Enter name and age of student"<<endl;
cin>>name>>age;
}
void disp_info()
{
cout<<"Name of student:"<<name<<endl;
cout<<"Age of  student:"<<age<<endl;
}
};
class Faculty
{
char faculty[20];
public:
void get_faculty()
{
cout<<"Enter Faculty of student"<<endl;
cin>>faculty;
}
void disp_faculty()
{
cout<<"Faculty of student:"<<faculty<<endl;
}
};
```

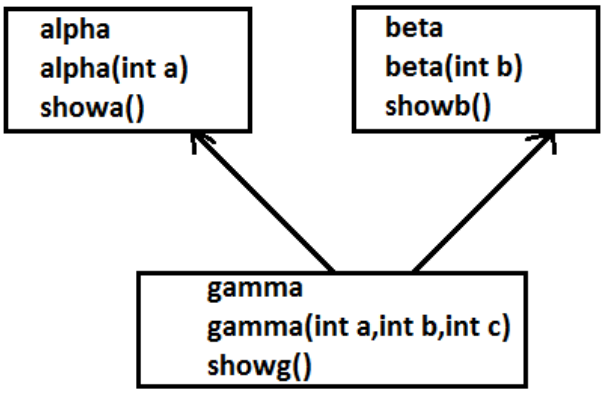
```
class Attendance:public Faculty,public Student_info
{
int attendance;
public:
void get_attendance()
{
cout<<"Enter student's attendance percentage"<<endl;
cin>>attendance;
}

void disp_attendance()
{
cout<<"Student's attendance percentage ="<<attendance<<endl;
}
};
int main()
{
int i,n;
Attendance a[50];
cout<<"Enter Number of students"<<endl;
cin>>n;
for(i=0;i<n;i++)
{
cout<<"Enter information of student:"<<i+1<<endl;
a[i].get_info();
a[i].get_faculty();
a[i].get_attendance();
}
for(i=0;i<n;i++)
{
cout<<"Information of student:"<<i+1<<endl;
a[i].disp_info();
a[i].disp_faculty();
a[i].disp_attendance();
}
return 0;
}
```

2. **WAP to enter information of n students and then display is using the concept of multilevel inheritance,[PU: 2015 fall]**

```
#include <iostream>
#include <conio.h>
using namespace std;
class Student_info
{
char name[25];
int age;
public:
void get_info()
{
cout<<"Enter name and age of student"<<endl;
cin>>name>>age;
}
void disp_info()
{
cout<<"Name of student:"<<name<<endl;
cout<<"Age of  student:"<<age<<endl;
}
};
class Faculty:public Student_info
{
char faculty[20];
public:
void get_faculty()
{
cout<<"Enter Faculty of student"<<endl;
cin>>faculty;
}
void disp_faculty()
{
cout<<"Faculty of student:"<<faculty<<endl;
}
};
class Attendance:public Faculty
{
int attendance;
public:
void get_attendance()
{
cout<<"Enter student's attendance percentage"<<endl;
cin>>attendance;
}
```

```
void disp_attendance()
{
cout<<"Student's attendance percentage ="<<attendance<<endl;
}
};
int main()
{
int i,n;
Attendance a[50];
cout<<"Enter Number of students"<<endl;
cin>>n;
for(i=0;i<n;i++)
{
cout<<"Enter information of student:"<<i+1<<endl;
a[i].get_info();
a[i].get_faculty();
a[i].get_attendance();
}
for(i=0;i<n;i++)
{
cout<<"Information of student:"<<i+1<<endl;
a[i].disp_info();
a[i].disp_faculty();
a[i].disp_attendance();
}
return 0;
}
```

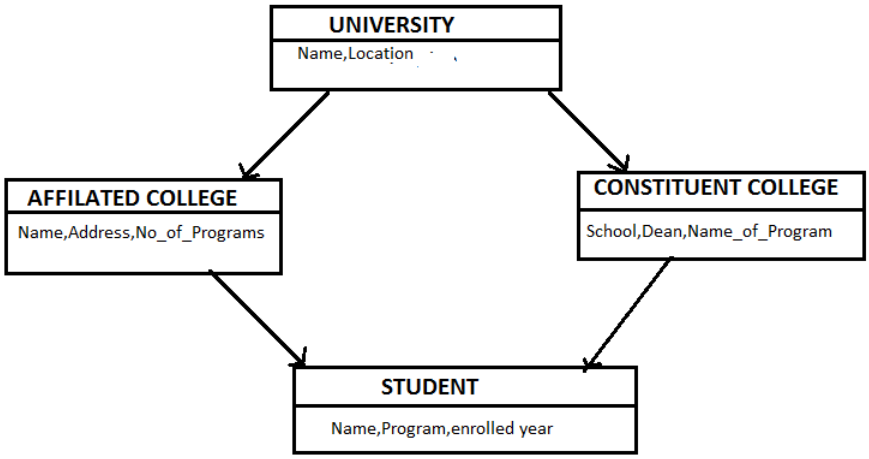
3. **Write a complete program with reference to the given figure.**



```
#include<iostream>
#include<iostream>
using namespace std;
class alpha
{
int x;
public:
alpha(int a)
{
x=a;
}
void showa()
{
cout<<"x="<<x<<endl;
}
};
class beta
{
int y;
public:
beta(int b)
{
y=b;
}
void showb()
{
cout<<"y="<<y<<endl;
}
};
class gamma:public beta,public alpha
{
int z;
public:
gamma(int a,int b,int c):alpha(a),beta(b)
{
z=c;
}
void showg()
{
cout<<"z="<<z<<endl;
}
};
```

```
int main()
{
gamma g(5,10,15);
g.showa();
g.showb();
g.showg();
return 0;
}
```

4. **The following figure shows the minimum information required for each class. Write a program by realizing the necessary member functions to read and display information of individual object. Every class should contain at least one constructor and should be inherited from other classes as well.[PU:2019 fall]**

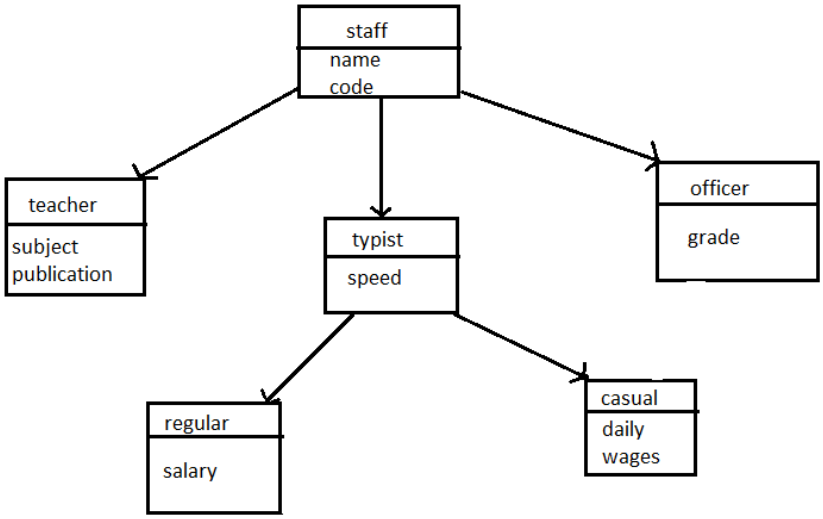



```
#include<iostream>
#include<string.h>
using namespace std;
class University
{
private:
char uname[20];
char location[20];
public:
University(char un[],char loc[])
{
strcpy(uname,un);
strcpy(location,loc);
}
```

```
void display()
{
cout<<"University name="<<uname<<endl;
cout<<"University location="<<location<<endl;
}
};
class Affiliated_College:virtual public University
{
private:
char cname[20];
char address[20];
int no_of_programs;
public:
Affiliated_College(char un[],char loc[],char cn[],char addr[],int nop):University(un,loc)
{
strcpy(cname,cn);
strcpy(address,addr);
no_of_programs=nop;
}
void display()
{
cout<<"Affiliated College Name="<<cname<<endl;
cout<<"Address="<<address<<endl;
cout<<"Number of programs="<<no_of_programs<<endl;
}
};
class Constituent_College:virtual public University
{
private:
char school[20];
char dean[20];
char name_of_program[20];
public:
Constituent_College(char un[],char loc[],char sn[],char d[],char npro[]):University(un,loc)
{
strcpy(school,sn);
strcpy(dean,d);
strcpy (name_of_program,npro);
}
void display()
{
cout<<"School name="<<school<<endl;
cout<<"Dean name="<<dean<<endl;
cout<<"Name of Program="<<name_of_program<<endl;}};
```

```
class Student:public Affiliated_College,public Constituent_College
{
private:
char student_name[20];
char program[20];
int enrolled_year;
public:
Student(char un[],char loc[],char cn[],char addr[],int nop, char sn[],char d[],char npro[],char stn[],char
pro[],int
year):Affiliated_College(un,loc,cn,addr,nop),Constituent_College(un,loc,sn,d,npro),University(un,loc)
{
strcpy(student_name,stn);
strcpy(program,pro);
enrolled_year=year;
}
void display()
{
cout<<"Student name="<<student_name<<endl;
cout<<"Program="<<program<<endl;
cout<<"Enrolled year="<<enrolled_year<<endl;
}
};
int main()
{
Student
st("Pokhara","Dhungepatan","EEC","Sanepa",3,"Engineering","Bharat","Civil","Pradip","Civil",2018);
st.University::display();
st.Affiliated_College::display();
st.Constituent_College::display();
st.display();
return 0;
}
```

5. **An educational institution wishes to maintain a database of its employees. The database is divided into a number of classes whose hierarchical relationship are shown below. The figure also shows minimum information requires for each class. Specify all the classes and define functions to create database and retrieve individual information when required**.



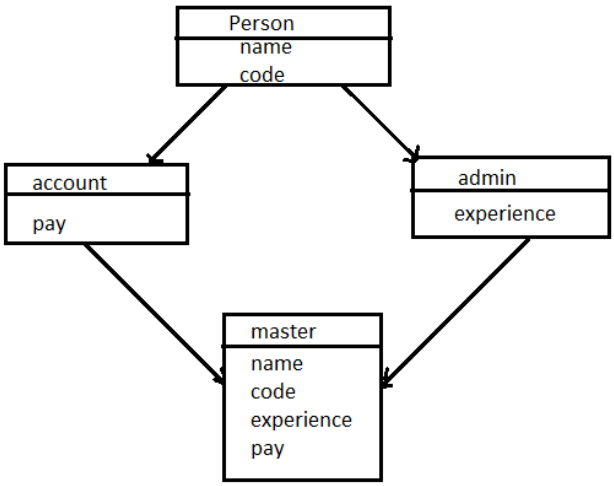

```
#include<iostream>
using namespace std;
class Staff
{
protected:
char name[20];
int code;
public:
void get_staff()
{
cout<<"Enter Name and code of staff"<<endl;
cin>>name>>code;
}
void disp_staff()
{
cout<<"Name="<<name<<endl;
cout<<"Code="<<code<<endl;
}
};
```

```
class Teacher:public Staff
{
char subject[20],publication[20];
public:
void get_teacher()
{
cout<<"Enter Subject and Publication"<<endl ;
cin>>subject>>publication;
}
void disp_teacher()
{
cout<<"Subject="<<subject<<endl;
cout<<"Publication="<<publication<<endl;
}
};
class Officer:public Staff
{
char grade;
public:
void get_officer()
{
cout<<"Enter the grade"<<endl;
cin>>grade;
}
void disp_officer()
{
cout<<"Grade="<<grade<<endl;
}
};
class Typist:public Staff
{
protected:
int speed;
public:
void get_typist()
{
cout<<"Enter Speed"<<endl;
cin>>speed;
}
void disp_typist()
{
cout<<"Speed="<<speed<<endl;
}
};
```

```
class Regular:public Typist
{
int salary;
public:
void get_regular()
{
cout<<"Enter Salary"<<endl;
cin>>salary;
}
void disp_regular()
{
cout<<"Salary="<<salary<<endl;
}
};
class Casual:public Typist
{
int wages;
public:
void get_casual()
{
cout<<"Enter Daily  wages"<<endl;
cin>>wages;
}
void disp_casual()
{
cout<<"Daily wages="<<wages<<endl;
}
};
int main()
{
Teacher t;
Officer o;
Regular r;
Casual c;

t.get_staff();
t.get_teacher();
t.disp_staff();
t.disp_teacher();

o.get_staff();
o.get_officer();
o.disp_staff();
o.disp_officer();
```

```
r.get_staff();
r.get_typist();
r.get_regular();
r.disp_staff();
r.disp_typist();
r.disp_regular();

c.get_staff();
c.get_typist();
c.get_casual();
c.disp_staff();
c.disp_typist();
c.disp_casual();
return 0;
}
```

6. The following figure shows minimum information required for each class.
Write a Program to realize the above program with necessary member functions to create the database and retrieve individual information




```
#include<iostream>
using namespace std;
class Person
{
        protected:
        char name[20];
        int code;
};
```

```
class Account:virtual public Person
{
        protected:
        float pay;
};
class Admin:virtual public Person
{
        protected:
        int experience;
};
class Master:public Account,public Admin
{
public:
void getinfo()
{
        cout<<"Enter name of person"<<endl;
        cin>>name;
        cout<<"Enter code"<<endl;
        cin>>code;
        cout<<"Enter pay for person"<<endl;
        cin>>pay;
        cout<<"Enter experience"<<endl;
        cin>>experience;
}
void display()
{
        cout<<"Name:"<<name<<endl;
        cout<<"Code:"<<code<<endl;
        cout<<"Pay:"<<pay<<endl;
        cout<<"Experience:"<<experience<<"years"<<endl;
}
};
int main()
{
Master m;
m.getinfo();
m.display();
return 0;
}
```

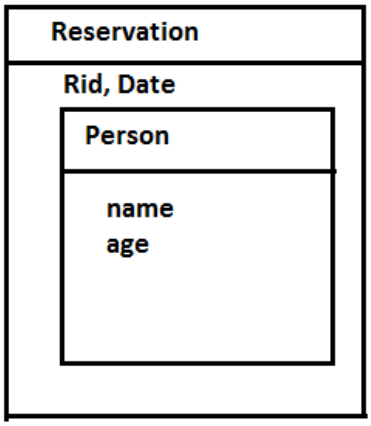
7. **Rewrite the above program using constructor on each class to initialize the data members.**

```
#include<iostream>
#include<string.h>
using namespace std;
```

```
class Person
{
	protected:
	char name[20];
	int code;
	public:
	Person(char n[],int c)
	{
		strcpy(name,n);
		code=c;
	}
};
class Account:virtual public Person
{
	protected:
	float pay;
	public:
	Account(char n[],int c,float p):Person(n,c)
	{
		pay=p;
	}
};
class Admin:virtual public Person
{
	protected:
	int experience;
	Admin(char n[],int c,int e):Person(n,c)
	{
		experience=e;
	}
};
class Master:public Account,public Admin
{
public:
Master(char n[],int c,float p,int e):Admin(n,c,e),Account(n,c,p),Person(n,c)
{
	strcpy(name,n);
	code=c;
	pay=p;
	experience=e;
}
```

```
void display()
{
        cout<<"Name:"<<name<<endl;
        cout<<"Code:"<<code<<endl;
        cout<<"Pay:"<<pay<<endl;
        cout<<"Experience:"<<experience<<"years"<<endl;
}
};
int main()
{
Master m("Pradip",121,23000.56,2);
m.display();
return 0;
}
```

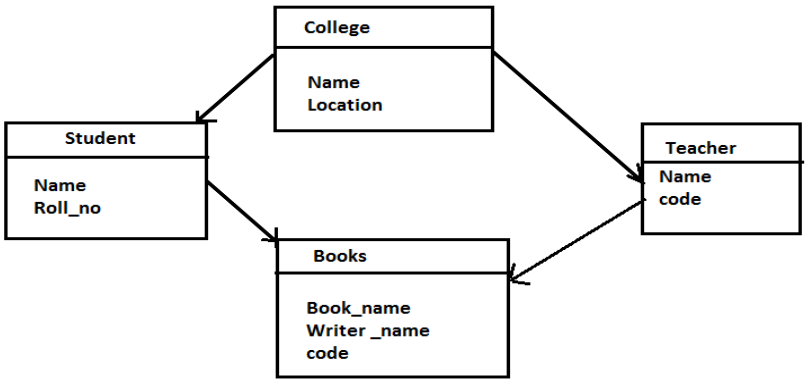
8. **Write a program that allow you to book a ticket for person and use two classes PERSON, RESERVATION. Class RESERVATION is composite class/ container class**.




```
#include<iostream>
using namespace std;
class Person
{
char name[20];
int age;
public:
void getdata()
{
cout<<"Enter name and age of person"<<endl;
cin>>name>>age;
}
```

```
void display()
{
cout<<"Name="<<name<<endl;
cout<<"Age="<<age<<endl;
}
};
class Reservation
{
int rid;
int year,month,date;
Person p;
public:
void getdata()
{
p.getdata();
cout<<"Enter Reservation ID"<<endl;
cin>>rid;
cout<<"Date in terms of YY-MM-DD"<<endl;
cin>>year>>month>>date;
}
void display()
{
p.display();
cout<<"Reservation ID="<<rid<<endl;
cout<<"Reservation date="<<year<<"-"<<month<<"-"<<date<<endl;
}
};
int main()
{
Reservation r;
r.getdata();
r.display();
return 0;
}
```

9. **The following figure shows the minimum information required for each class. Write a program to realize the above program with necessary member functions to create the database and retrieve individual information .Every class should contain at least one constructor and should be inherited to other classes as well.[PU:2010 spring][PU 2009 fall]**

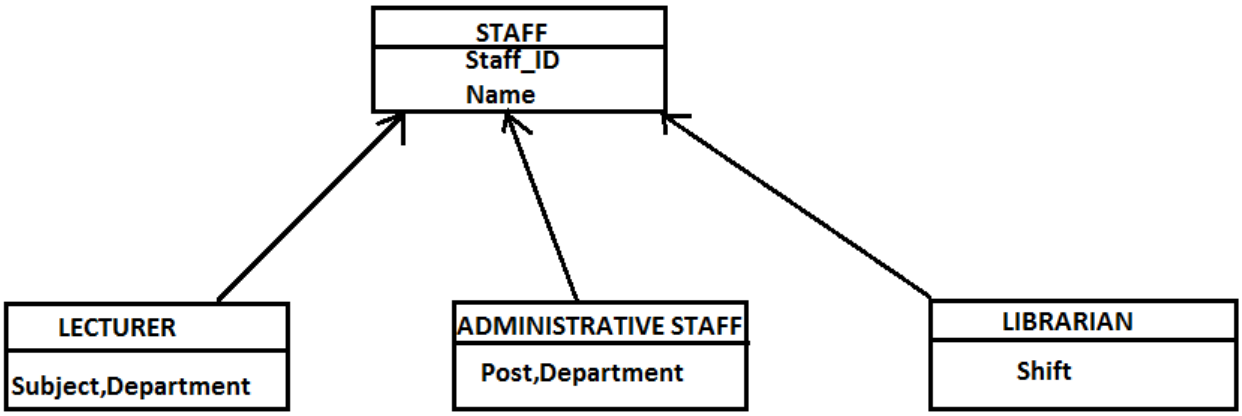



```
#include<iostream>
#include<string.h>
using namespace std;
class College
{
private:
char cname[20];
char location[20];
public:
College(char cn[],char loc[])
{
strcpy(cname,cn);
strcpy(location,loc);
}
void display()
{
cout<<"College name="<<cname<<endl;
cout<<"College location="<<location<<endl;
}
};
class Student:virtual public College
{
private:
char sname[20];
int roll;
public:
Student(char cn[],char loc[],char sn[],int r):College(cn,loc)
{
strcpy(sname,sn);
roll=r;
}
```

```
void display()
{
cout<<"Student name="<<sname<<endl;
cout<<"Roll no="<<roll<<endl;
}
};
class Teacher:virtual public College
{
private:
char tname[20];
int tcode;
public:
Teacher(char cn[],char loc[],char tn[],int tc):College(cn,loc)
{
strcpy(tname,tn);
tcode=tc;
}
void display()
{
cout<<"Teacher name="<<tname<<endl;
cout<<"Teacher Code="<<tcode<<endl;
}
};
class Books:public Student,public Teacher
{
private:
char book_name[20];
char writer_name[20];
int book_code;
public:
Books(char cn[],char loc[],char sn[],int r, char tn[],int tc,char bn[],char wn[],int
bc):Teacher(cn,loc,tn,tc),Student(cn,loc,sn,r),College(cn,loc)
{
strcpy(book_name,bn);
strcpy(writer_name,wn);
book_code=bc;
}
void display()
{
cout<<"Book name="<<book_name<<endl;
cout<<"Writer name="<<writer_name<<endl;
cout<<"Book code="<<book_code<<endl;
}
};
```

```
int main()
{
Books b("EEC","sanepa","Ram",47,"Pradip",151,"OOPs","Timothy Budd",53421);
b.College::display();
b.Student::display();
b.Teacher::display();
b.display();
return 0;
}
```

10. **Develop a complete program for an institution, which wishes to maintain a database of its staff. The database is divided into number of classes whose hierarchical relationship is shown in the following diagram. specify all classes and define constructors and functions to create database and retrieve the individual information as per requirements.**



```
#include<iostream>
#include<string.h>
using namespace std;
class STAFF
{
        private:
        int staff_id;
        char name[20];
        public:
        STAFF(int sid,char sn[])
        {
                staff_id=sid;
           strcpy(name,sn);
        }
```

```
        void display()
        {
                cout<<"Staff ID:"<<staff_id<<endl;
                cout<<"Name:"<<name<<endl;
        }
};
class LECTURER:public STAFF
{
char subject[20];
char department[20];
public:
        LECTURER(int sid,char sn[],char sub[],char dept[]):STAFF(sid,sn)
        {
                strcpy(subject,sub);
                strcpy(department,dept);
        }
        void display()
        {
                cout<<"Subject:"<<subject<<endl;
                cout<<"Department:"<<department<<endl;
        }

};
class ADMINISTRATIVE_STAFF:public STAFF
{
char post[20];
char department[20];
public:
ADMINISTRATIVE_STAFF(int sid,char sn[],char p[],char dept[]):STAFF(sid,sn)
        {
                strcpy(post,p);
                strcpy(department,dept);
        }
        void display()
        {
                cout<<"Post:"<<post<<endl;
                cout<<"Department:"<<department<<endl;
        }
};
```

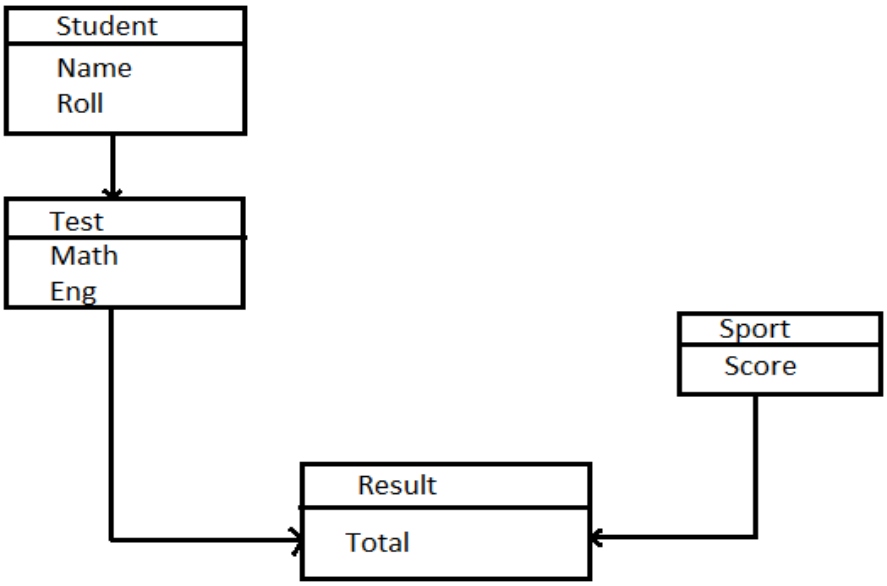
```
class LIBRARIAN:public STAFF
{
char shift[20];
public:
	LIBRARIAN(int sid,char sn[],char s[]):STAFF(sid,sn)
	{
		strcpy(shift,s);
	}
	void display()
	{
		cout<<"Shift:"<<shift<<endl;
	}
};

int main()
{
LECTURER l(101,"Pradip Paudel","C programming","Computer");
l.STAFF::display();
l.display();
ADMINISTRATIVE_STAFF a(212,"Ekraj Acharaya","Admin","Administration");
a.STAFF::display();
a.display();
LIBRARIAN lib(314,"Sita sharma","Morning");
lib.STAFF::display();
lib.display();
return 0;
}
```

11. Develop a complete program for an institution which wishes to maintain a database of its staff. Declare a base class STAFF which include staff_id and name.Now develop a records for the following staffs with the given information below.
Lecturer(subject,department)
Administrative staff (Post,department)

```
#include<iostream>
#include<string.h>
using namespace std;
class STAFF
{
	private:
	int staff_id;
	char name[20];
	public:
	void get_staff()
	{
		cout<<"Enter staff id"<<endl;
		cin>>staff_id;
		cout<<"Enter name"<<endl;
		cin>>name;
	}
	void display_staff()
	{
		cout<<"Staff ID:"<<staff_id<<endl;
		cout<<"Name:"<<name<<endl;
	}
};
class LECTURER:public STAFF
{
char subject[20];
char department[20];
public:
	void get_lecturer()
	{
		cout<<"Enter subject"<<endl;
		cin>>subject;
		cout<<"Enter department"<<endl;
		cin>>department;
	}
	void display_lecturer()
	{
		cout<<"Subject:"<<subject<<endl;
		cout<<"Department:"<<department<<endl;
	}

};
```

```
class ADMINISTRATIVE_STAFF:public STAFF
{
char post[20];
char department[20];
public:

	void get_administrative()
	{
		cout<<"Enter post"<<endl;
		cin>>post;
		cout<<"Enter department"<<endl;
		cin>>department;
	}
	void display_administrative()
	{
		cout<<"Post:"<<post<<endl;
		cout<<"Department:"<<department<<endl;
	}
};

int main()
{
LECTURER l;
l.get_staff();
l.get_lecturer();
l.display_staff();
l.display_lecturer();
ADMINISTRATIVE_STAFF a;
a.get_staff();
a.get_administrative();
a.display_staff();
a.display_administrative();
return 0;
}
```

12. Implement the below given in class diagram in C++.Assume necessary function yourself.




```
#include<iostream>
using namespace std;
class Student
{
private:
char name[20];
int roll;
public:
void get_student()
{
        cout<<"Enter name and roll no"<<endl;
        cin>>name>>roll;
}
void disp_student()
{
        cout<<"Name="<<name<<endl;
        cout<<"Rollno="<<roll<<endl;
}
};
```

```
class Test:public Student
{
	protected:
	float math,eng;
	public:
	void get_test()
	{
		cout<<"Enter marks in math and english"<<endl;
		cin>>math>>eng;
	}
	void disp_test()
	{
		cout<<"marks in math="<<math<<endl;
		cout<<"marks in english="<<eng<<endl;
	}
};
class Sport
{
	protected:
	float score;
	public:
	void get_sport()
	{
		cout<<"Enter score"<<endl;
		cin>>score;
	}
	void  disp_sport()
	{
		cout<<"Score="<<score<<endl;
	}
};
class Result:public Test,public Sport
{
private:
float total;
public:
void disp_total()
{
total=eng+math+score;
cout<<"Total="<<total<<endl;
}
};
```

```
int main()
{
Result r;
r.get_student();
r.get_test();
r.get_sport();
r.disp_student();
r.disp_test();
r.disp_sport();
r.disp_total();
return 0;
}
```

Inheritance Old question solution(Theory)

1. **When base class and derived class have the same function name what happens when derived class object calls the function?[PU 2017 fall]**

When the base class and derived class have the same function name, the derived class function overrides the function that is inherited from base class, which is known as function overriding. Now, when derived class object calls that overridden function, the derived class member function is accessed.

For example:

```
#include<iostream>
using namespace std;
class Base
{
public:
void display()
{
        cout<<"This is base class"<<endl;
}
};
class Derived:public Base
{
public:
void display()
{
        cout<<"This is derived class"<<endl;
}
};
int main()
{
Derived d;
d.display();
return 0;
}
```

Output:

```
This is derived class
```

In this example, the class derived inherits the public member function display() .When we redefine this function in derived class then the inherited members from base are overridden.so when derived class object calls the function display() it actually refers the function in derived class but not the inherited member function in base class.

2. **How inheritance support reusability features of OOP? Explain with example. [PU:2010 spring]**

Using the concept of inheritance the data member and member function of classes can be reused. When once a class has been written and tested, it can be adapted by another programmer to suit their requirements. This is basically done by creating new classes, reusing the properties of the existing ones. This mechanism of deriving a new class from an old one is called inheritance.

A derived class includes all features of the base class and then it can add additional features specific to derived class.

Example:

```
#include<iostream>
using namespace std;
class Sum
{
protected:
int a,b;
public:
void getdata()
{
        cout<<"Enter two numbers"<<endl;
        cin>>a>>b;
}
void display()
{
cout<<"a="<<a<<endl;
cout<<"b="<<b<<endl;
}
};
class Result:public Sum
{
        private:
        int total;
        public:
                void disp_result()
                {
                        total=a+b;
                        cout<<"sum="<<total<<endl;
                }
};
```

```
int main()
{
Result r;
r.getdata();
r.display();
r.disp_result();
return 0;
}
```

Here, In above example **Sum** is base class and **Result** is derived class. The data member **named a and b** and member function display () of base class are inherited and they are used by using the object of derived class named **Result.** Hence, we can see that inheritance provides reusability.

3. **How are arguments are sent to base constructors in multiple inheritance ?Who is responsibility of it.[PU:2013 spring]**

   In Multiple Inheritance arguments are sent to base class in the order in which they appear in the declaration of the derived class**.**
   For example:

   ```
   Class gamma: public beta, public alpha
   {
   }
   ```

   Order of execution

   beta(); base constructor (first)
   alpha(); base constructor(second)
   gamma();derived (last)

   The constructor of derived class is responsible to supply values to the base class constructor.

Program:

```
#include<iostream>
using namespace std;
```

```
class alpha
{
int x;
public:
alpha(int a)
{
x=a;
cout<<"Alpha is initialized"<<endl;
}
void showa()
{
cout<<"x="<<x<<endl;
}
};
class beta
{
int y;
public:
beta(int b)
{
y=b;
cout<<"Beta is initialized"<<endl;
}
void showb()
{
cout<<"y="<<y<<endl;
}
};
class gamma:public beta,public alpha
{
int z;
public:
gamma(int a,int b,int c):alpha(a),beta(b)
{
z=c;
cout<<"Gamma is initialized"<<endl;
}
void showg()
{
cout<<"z="<<z<<endl;
}
};
```

```
int main()
{
gamma g(5,10,15);
g.showa();
g.showb();
g.showg();
return 0;
}
```

Output:

```
Beta is initialized
Alpha is initialized
Gamma is initialized
x=5
y=10
z=15
```

Here, **beta** is initialized first although it appears second in the derived constructor *as it has been* declared first in the derived class header line

class gamma: public beta, public alpha
{ }

If we change the order *to*

class gamma: public alpha, public beta
{ }

then alpha will be initialized first

4. **Class 'Y' has been derived from class 'X' .The class 'Y' does not contain any data members of its own. Does the class 'Y' require constructors? If yes why.[PU:2013 spring]**

When Class 'Y' has been derived from class 'X' and class 'Y' does not contain any data members of its own then,

- It is mandatory have constructor in derived class 'Y', whether it has data members to be initialized or not, if there is constructor with arguments(parameterized constructor) in base class 'X'.
- It not necessary to have constructor in derived class 'Y' if base class 'X' does not contain a constructor with arguments (parameterized constructor).
  Derived class constructor is used to provide the values to the base class constructor.

Example

```
#include<iostream>
using namespace std;
class X
{
        private:
        int a;
        public:
        X (int m)
        {
                a=m;
        }
        void display()
        {
                cout<<"a="<<a<<endl;
        }
};
class Y:public X
{
public:
Y(int b):X(b)
{

}
};
int main()
{
Y obj(5);
obj.display();
return 0;
}
```

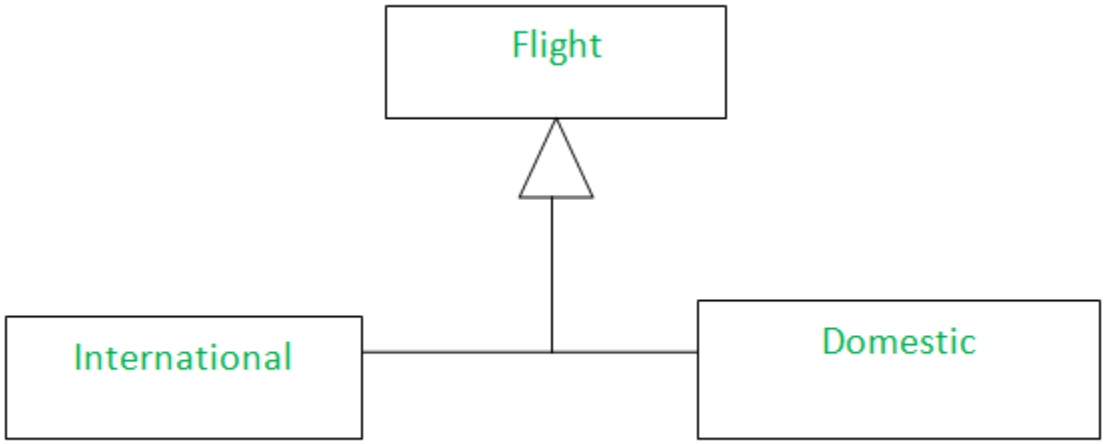
Here, in above example, class 'Y' does not have any data members but there is a parameterized constructor in class 'X' so, there is necessary to have constructor in class 'Y'.

5. **Write a short notes on:**

Generalization[PU:2013 spring]

Generalization is the process of taking out common properties and functionalities from two or more classes and combining them together into another class which acts as the parent class of those classes or what we may say the generalized class of those specialized classes. All the subclasses are a type of superclass. So we can say that subclass "is-A" superclass. Therefore Generalization is termed as "is-A relationship".

Here is an example of generalization:



In this figure, we see that there are two types of flights so we made a flight class which will contain common properties and then we has an international and domestic class which are an extension of flight class and will have properties of flight as well as their own. Here flight is the parent/superclass and the other two are child/subclass. International Flight "is-a" flight as well as the domestic flight.

6. **Explain how composition provide reusability.**

In composition one class contains object of another class as its member data, which means members of one class is available in another class. Composition exhibits "has-a" relationship. For example, Company **has an** employee.

So, properties of one class can be used by another class independently.

Let us consider an example

```
#include<iostream>
using namespace std;
class Employee
{
int eid;
float salary;
public:
void getdata()
{
cout<<"Enter id and salary of employee"<<endl;
cin>>eid>>salary;
}
void display()
{
cout<<"Emp ID:"<<eid<<endl;
cout<<"Salary:"<<salary<<endl;
}
};
class Company
{
char cname[20];
char department[20];
Employee e;
public:
void getdata()
{
e.getdata();
cout<<"Enter company name and Deparment:"<<endl;
cin>>cname>>department;
}
void display()
{
e.display();
cout<<"Company name:"<<cname<<endl;
cout<<"Department:"<<department<<endl;
}
};
```

```
int main()
{
Company c;
c.getdata();
c.display();
return 0;
}
```

In above example class company contains the object of another class employee. As we know "company **has a** employee" sounds logical .so there exits has a relationship between company and employee. Class company contains the object of class employee and members of class employee are used in class company which provides reusability.

POLYMORPHISM (THEORY SOLUTION)

1) **How can polymorphism be achieved during compile time and during runtime? Explain with examples in C++.**

Compile time polymorphism can be achieved in two ways:

- Function overloading
- Operator Overloading

Runtime polymorphism can be achieved by using virtual function.

Now, let us discuss them briefly.

Compile time polymorphism

Compile time polymorphism means that an object is bound to its function call at the compile time. That means, there is no ambiguity at the compile time about which a function is linked to a particular function call. This mechanism is called early binding or static binding or static linking.

Function overloading

- The method of using same function name but with different parameter list along with different data type to perform the variety of different tasks is known as function overloading.
- The correct function is to be invoked is determined by checking the number and type of arguments but not function return type.

```
#include<iostream>
using namespace std;
class calcarea
{
public:
int area(int s)
{
return (s*s);
}
int area(int l,int b)
{
return(l*b);
}
```

```
float area(float r)
{
return(3.14*r*r);
}
};
int main()
{
calcarea c1,c2,c3;
cout<<"Area of square="<<c1.area(5)<<endl;
cout<<"Area of Rectangle="<<c2.area(5,10)<<endl;
cout<<"Area of Circle="<<c3.area(2.5f)<<endl;
return 0;
}
```

Operator overloading

```
#include<iostream>
using namespace std;
class space
{
private:
int x,y,z;
public:
space(int a,int b,int c)
{
x=a;
y=b;
z=c;
}
void display()
{
cout<<"x="<<x<<endl;
cout<<"y="<<y<<endl;
cout<<"z="<<z<<endl;
}
void operator -()
{
x=-x;
y=-y;
z=-z;
}
}
```

```
int main()
{
space s(5,10,15);
cout<<"s:"<<endl;
s.display();
-s;
cout<<"-s:"<<endl;
s.display();
return 0;
}
```

Runtime polymorphism

We should use virtual functions and pointers to objects to achieve run time polymorphism. For this, we use functions having same name, same number of parameters, and similar type of parameters in both base and derived classes. The function in the base class is declared as virtual using the keyword virtual.
A virtual function uses a single pointer to base class pointer to refer to all the derived objects. When a function in the base class is made virtual, C++ determines which function to use at run time based on the type of object pointed by the base class pointer, rather than the type of the pointer.

```
#include<iostream>
using namespace std;
class base
{
public:
virtual void show()
{
cout<<"Base Class Show function"<<endl;
}
};
class derived:public base
{
public:
void show()
{
cout<<"Derived Class Show function "<<endl;
}
};
```

```
int main()
{
base b1,*bptr;
derived d1;
bptr=&b1;
bptr->show();
bptr=&d1;
bptr->show();
return 0;
}
```

Output:

```
Base Class Show function
Derived Class Show function
```

2) Explain importance of polymorphism with a suitable example.

The word polymorphism means having many forms.
Real life example of polymorphism, a person at the same time can have different characteristic. Like a man at the same time is a father, a husband, an employee. So the same person posses different behavior in different situations. This is called polymorphism.

Polymorphism (function overloading) allows one to write more than one method with the same name but with different number of arguments. Hence same method name can be used to perform operations on different data types.

Suppose we want to calculate the area of square, rectangle and circle. We can use the same function named area for all of these by just changing the number and type of arguments.

```
#include<iostream>
using namespace std;
class calcarea
{
public:
int area(int s)
{
return (s*s);
}
int area(int l,int b)
{
return(l*b);
}
```

```
float area(float r)
{
return(3.14*r*r);
}
};
int main()
{
calcarea c1,c2,c3;
cout<<"Area of square="<<c1.area(5)<<endl;
cout<<"Area of Rectangle="<<c2.area(5,10)<<endl;
cout<<"Area of Circle="<<c3.area(2.5f)<<endl;
return 0;
}
```

C++ polymorphism means that a call to a member function will cause a different function to be executed depending on the type of object that invokes the function

```
#include<iostream>
using namespace std;
class shape
{
public:
virtual void draw()=0;
};
class square:public shape
{
public:
void draw()
{
cout<<"Implementing method to draw square"<<endl;
}
};
class circle:public shape
{
public:
void draw()
{
cout<<"Implementing method to draw circle"<<endl;
}
};
```

```
int main()
{
shape *bptr;
square s;
circle c;
bptr=&s;
bptr->draw();
bptr=&c;
bptr->draw();
return 0;
}
```

Similarly, let us consider an example, operator symbol '+' is used for arithmetic operation between two numbers, however by overloading (means given additional job) it can be used over Complex Object like currency that has Rs and Paisa as its attributes, complex number that has real part and imaginary part as attributes. By overloading same operator '+' can be used for different purpose like concatenation of strings. When same function name is used in defining different function to operate on different data (type or number of data) then this feature of polymorphism is function overloading.

```
#include<iostream>
using namespace std;
class complex
{
private:
int real,imag;
public:
complex()
{ }
complex(int r,int i)
{
real=r;
imag=i;
}
void display()
{
cout<<real<<"+i"<<imag<<endl;
}
complex operator +(complex);
};
```

```
complex complex::operator +(complex c2)
{
complex temp;
temp.real=real+c2.real;
temp.imag=imag+c2.imag;
return temp;
}

int main()
{
complex c1(2,3);
complex c2(2,4);
complex c3;
c3=c1+c2;
cout<<"c1=";
c1.display();
cout<<"c2=";
c2.display();
cout<<"c3=";
c3.display();
return 0;
}
```

3) **How do we make use of a virtual destructor when we need to make sure that the different destructors in inheritance chain are called in order? Explain with an example in C++.**

Let's first see what happens when we do not have a virtual Base class destructor.

```
class Base
{
public:
~Base()
{
cout << "Base class destructor"<<endl;
}
};
```

```
class Derived: public Base
{
public:
~Derived()
{
cout<< "Derived class destructor"<<endl;
}
};
int main()
{
Base* ptr = new Derived; //Base class pointer points to derived class object
delete ptr;
}
```

Output:

```
Base class Destructor
```

In the above example, delete ptr will only call the Base class destructor, which is undesirable because, then the object of Derived class remains un-destructed, because its destructor is never called. Which leads to memory leak situation.

To make sure that the derived class destructor is mandatory called, we make base class destructor as virtual

```
class Base
{
public:
virtual ~Base()
{
cout << "Base class destructor"<<endl;
}
};
```

Output:

```
Derived class Destructor
Base class Destructor
```

When we have Virtual destructor inside the base class, then first Derived class's destructor is called and then Base class's destructor is called, which is the desired behavior.

Virtual function vs Pure virtual function [pu:2016 spring]

Virtual function	Pure virtual function
1. A virtual function is a member function of base class which can be redefined by derived class.	1. A pure virtual function is a member function of base class whose only declaration is provided in base class and should be defined in derived class otherwise derived class also becomes abstract.
2. Classes having virtual functions are not abstract.	2. Base class containing pure virtual function becomes abstract.

3. Virtual return_type function_name(arglist)
{
// code
}
	3. Virtual return_type function_name(arglist)=0;

4. Base class having virtual function can be instantiated i.e. its object can be made.	4. Base class having pure virtual function becomes abstract i.e. it cannot be instantiated
5. All derived class may or may not redefine virtual function of base class.	5. All derived class must redefine pure virtual function of base class otherwise derived class also becomes abstract just like base class.

Function Overloading Vs Function overriding

Function Overloading	Function Overriding
1. It allows us to declare two or more function having same name with different number of parameters or different datatypes of argument.	1. It allow us to declare a function in parent class and child class with same name and signature.
2. Overloading is utilized to have the same number of various functions which act distinctively relying	2. Overriding is required when a determined class function needs to perform some additional or unexpected job in comparison to the base class function.
3. It can occur without inheritance concept.	3. Overriding can only be done when one class is inherited by another classes.

4. It is an example of compile time polymorphism.	4. It is an example of runtime polymorphism.
5. The overloaded functions are always in the same scope.	5. Functions are always in the different scope.
6. we can have any number of overloaded functions	6. We can have only one overriding function in the child class.

Friend function vs Virtual function

Friend function	**Virtual Function**
1. It is non-member functions that usually have private access to class representation.	1. It is a base class function that can be overridden by a derived class.
2. It is used to access private and protected classes.	2. It is used to ensure that the correct function is called for an object no matter what expression is used to make a function class.
3. It is declared outside the class scope. It is declared using the 'friend' keyword.	3. It is declared within the base class and is usually redefined by a derived class. It is declared using a 'virtual' keyword.
4. It is generally used to give non-member function access to hidden members of a class.	4. It is generally required to tell the compiler to execute dynamic linkage of late binding on function.
5. They support sharing information of class that was previously hidden, provides method of escaping data hiding restrictions of C++, can access members without inheriting class, etc.	5. They support object-oriented programming, ensures that function is overridden, can be friend of other function, etc.
6. It can access private members of the class even while not being a member of that class.	6. It is used so that polymorphism can work.

Operator overloading [PU: 2016 fall]

The mechanism of adding special meaning to an operator is called operator overloading. It provides a flexibility for the creation of new definitions for most C++ operators. Using operator overloading we can give additional meaning to normal C++ operations such as (+,-,=,<=,+= etc.) when they are applied to user defined data types.

let us consider an example, operator symbol '+' is used for arithmetic operation between two numbers, however by overloading (means given additional job) it can be used over Complex Object like currency that has Rs and Paisa as its attributes, complex number that has real part and imaginary part as attributes.

By overloading same operator '+' can be used for different purpose like concatenation of strings, Addition of complex numbers, Addition of two vectors , Addition of two times etc.

General form:

```
return_type operator op(arglist)
{
function body //task defined
}
```

Where,

- return_type is the type of value returned by the specified operation.
- op is the operator being overloaded.
- Operator op is function name, where operator is keyword.

Polymorphism (Program solution)

1. **Write a program finding area of square, rectangle, triangle. Use function overloading technique**.

```
#include<iostream>
using namespace std;
class calcarea
{
public:
int area(int x)
{
return (x*x);
}
int area(int x,int y)
{
return (x*y);
}
float area(float x,float y)
{
return (0.5*x*y);
}
};
int main()
{
int length,breadth,side;
float base,height;
calcarea c1,c2,c3;
cout<<"Enter side of square:"<<endl;
cin>>side;
cout<<"Area of square="<<c1.area(side)<<endl;
cout<<"Enter length and breadth of rectangle:"<<endl;
cin>>length>>breadth;
cout<<"Area of rectangle="<<c2.area(length,breadth)<<endl;
cout<<"Enter base and height of triangle:"<<endl;
cin>>base>>height;
cout<<"Area of Triangle="<<c3.area(base,height)<<endl;
return 0;
}
```

2. WAP to overload multiplication operator showing (*) showing the multiplication of two objects.**[PU:2020 fall]**

```
#include<iostream>
using namespace std;
class Arithmetic
{
private:
float num;
public:
void getdata()
{
cout<<"Enter the number"<<endl;
cin>>num;
}
void display()
{
cout<<num<<endl;
}
Arithmetic operator*(Arithmetic b);
};
Arithmetic Arithmetic::operator*(Arithmetic b)
{
Arithmetic temp;
temp.num=num*b.num;
return temp;
}

int main()
{
Arithmetic a,b,c;
a.getdata();
b.getdata();
c=a*b;
cout<<"Multiplication of two objects="<<endl;
c.display();
return 0;
}
```

3. Write a program with class fibo to realize the following code snippet. **[PU: 2014 fall]**

```
fibo f=1;
for (i=1;i<=10;i++)
{
++f;
f.display();
}
```

[Hint: overload ++ operator and conversion technique.]

```
#include<iostream>
using namespace std;
class fibo
{
private:
int a,b,c;
public:
fibo(int x)
{
a=-x;
b=x;
c=a+b;
}
void display()
{
cout<<c<<",";
}
void operator++()
{
a=b;
b=c;
c=a+b;
}
};
int main()
{
fibo f=1;
int i;
for(i=1;i<=10;i++)
{
++f;
f.display();
}
return 0;
}
```

4. Design a soccer player class that includes three ineger fields:a player's jersey number,number of goals,number of assists and necessary constructors to initialize the data members.Overload the > operator (Greater than) .One player is considered greater than another if the sum of goals plus assists is greater than that of others. Create an array of 11 soccer players, then use the overloaded > operator to find the greater total of goal plus assists**.[PU:2015 fall]**

```
#include<string.h>
#include<iostream>
using namespace std;
class Soccerplayer
{
private:
int jerseyno;
int goals;
int assists;
public:
Soccerplayer()
{ }
Soccerplayer(int jn,int g,int a)
{
jerseyno=jn;
goals=g;
assists=a;
}
void display()
{
cout<<"Jersey number="<<jerseyno<<endl;
cout<<"Number of Goals="<<goals<<endl;
cout<<"Number of assists="<<assists<<endl;
}
friend int operator >(Soccerplayer &s1,Soccerplayer &s2);
};
int operator >(Soccerplayer &s1,Soccerplayer &s2)
{
int sum1 =s1.goals +s1.assists;
int sum2 =s2.goals +s2.assists;
if(sum1 >sum2 )
{
return 1;
}
else
{
return 0;
} }
```

```
int main ()
{
int ngoals,jno,nassists,max;
Soccerplayer *s[11];
for(int i=0;i<11;i++)
{
cout<<"Enter player jersey number"<<endl;
cin>>jno;
cout<<"Enter number of goals"<<endl;
cin>>ngoals;
cout<<"Enter number of assists"<<endl;
cin>>nassists;
s[i]= new Soccerplayer(jno,ngoals,nassists);
}
cout<<"The details of players are:"<<endl;
for(int i=0;i<11;i++)
{
s[i]->display();
}
max=0;
for(int i=0;i<10;i++)
{
if(*s[i+1]>*s[max])
{
max=i+1;
}
}
cout<<"The details of player with highest points(goals+assists) :" <<endl;
s[max]->display();
return 0;
}
```

5. Make a class called memory with member data to represent bytes, kilobytes and megabytes .Create an object of memory and initialize data members and then convert them into number of bytes using suitable conversion method.

```
#include<iostream>
using namespace std;
class memory
{
private:
int mb;
int kb;
int byte;
```

```
public:
memory(int m,int k,int b)
{
mb=m;
kb=k;
byte=b;
}
void display()
{
cout<<mb<<"megabytes"<<endl;
cout<<kb<<"kilobytes"<<endl;
cout<<byte<<"bytes"<<endl;
}
operator long int()
{
        return(mb*1024*1024+1024*kb+byte);
}
};
int main()
{
memory m1(1,38,177);
long int total;
total=m1;
cout<<"Given memory is"<<endl;
m1.display();
cout<<"After type conversion total number of bytes="<<total<<endl;
return 0;
}
```

6. Write a program to create a class age with attributes YY, MM, DD and convert the object of class age to basic data type int days.

```
#include<iostream>
using namespace std;
class Age
{
private:
int yy,mm,dd;
public:
Age(int y,int m,int d)
{
yy=y;
mm=m;
dd=d;
}
```

```
void display()
{
cout<<"year="<<yy<<endl;
cout<<"month="<<mm<<endl;
cout<<"Day="<<dd<<endl;
}
operator int()
{
return(365*yy+30*mm+dd);
}
};
int main()
{
Age a1(25,6,15);
int days;
a1.display();
days=a1;
cout<<"Number of days="<<days<<endl;
return 0;
}
```

7. Define two classes named ‘Polar’ and ‘Rectangle’ to represent points in polar and rectangle systems. Use conversion routines to convert from one system to another system.**[PU:2005 fall][PU:2014 fall]**

```
#include <iostream>
#include <math.h>
using namespace std;
class Polar
{
private:
float radius;
float angle;
public:
Polar()
{
radius=0.0;
angle=0.0;
}
Polar(float r, float a)
{
radius=r;
angle=a;
}
```

```
void display()
{
cout<<"("<<radius<<","<<angle<<")"<<endl;
}
float getr()
{
return radius;
}
float geta()
{
return angle;
}
};
class Rectangle
{
private:
float xco;
float yco;
public:
Rectangle()
{
xco=0.0;
yco=0.0;
}
Rectangle(float x,float y)
{
    xco=x;
    yco=y;
}
void display()
{
cout<<"("<<xco<<","<<yco<<")"<<endl;
}
operator Polar()
{
float a=atan(yco/xco);
float r=sqrt(xco*xco+yco*yco);
return Polar(r,a);
}
```

```
Rectangle(Polar p)
{
float r=p.getr();
float a=p.geta();
xco=r*cos(a);
yco=r*sin(a);
}
};

int main()
{
cout<<"Conversion from Polar to Rectangular coordinates"<<endl;
Polar p1(10.0,0.785398);
Rectangle r1;
r1=p1;
cout<<"Polar coordinates:"<<endl;
p1.display();
cout<<"Rectangular coordinates:"<<endl;
r1.display();
cout<<"Conversion from Rectagular to Polar coordinates"<<endl;
Rectangle r2(7.07107,7.07107);
Polar p2;
p2=r2;
cout<<"Rectangular coordinates:"<<endl;
r2.display();
cout<<"Polar coordinates:"<<endl;
p2.display();
return 0;
}
```

8. Create a base class student. Use the class to store name, dob, rollno and includes the member function getdata(),discount().Derive two classes PG and UG from student. make dispresult() as virtual function in the derived class to suit the requirement.**[PU:2013 spring]**

```
#include<iostream>
using namespace std;
class Student
{
protected:
char name[20],dob[10];
int roll;
float dis,fees;
```

```
public:
void getdata()
{
cout<<"Enter the name and roll.no of student"<<endl;
cin>>name>>roll;
cout<<"Enter the date of birth format in yy-mm-dd"<<endl;
cin>>dob;
cout<<"Enter the fees"<<endl;
cin>>fees;
}
void discount()
{
cout<<"Enter discount given to student"<<endl;
cin>>dis;
}
virtual void dispresult()//Empty virtual function
{ }
};
class UG:public Student
{
private:
float paidamount;
public:

void dispresult()
{
paidamount=fees-dis;
cout<<"Name:"<<name<<endl;
cout<<"Roll no:"<<roll<<endl;
cout<<"Date of Birth:"<<dob<<endl;
cout<<"Discount:"<<dis<<endl;
cout<<"Fees:"<<fees<<endl;
cout<<"Fees to be paid="<<paidamount<<endl;
}
};
class PG:public Student
{
private:
float paidamount;
public:
```

```
void dispresult()
{
paidamount=fees-dis;
cout<<"Name:"<<name<<endl;
cout<<"Roll no:"<<roll<<endl;
cout<<"Date of Birth:"<<dob<<endl;
cout<<"Discount:"<<dis<<endl;
cout<<"Fees:"<<fees<<endl;
cout<<"Fees to be paid="<<paidamount<<endl;
}
};


int main()
{
Student *st1,*st2;
PG p;
UG u;
st1=&p;
st2=&u;
cout<<"Enter PG student details:"<<endl;
st1->getdata();
st1->discount();
cout<<"Enter UG student details:"<<endl;
st2->getdata();
st2->discount();
cout<<"Details of PG student:"<<endl;
st1->dispresult();
cout<<"Details of UG student:"<<endl;
st2->dispresult();
return 0;
}
```

9. Create a abstract class shape with two members base and height, a member function for initialization and a pure virtual function to compute area().Derive two specific classes, Triangle and Rectangle which override the function area ().use these classes in main function and display the area of triangle and rectangle.[PU:2009 spring]

```
#include<iostream>
using namespace std;
class Shape
{
protected:
float base, height;
```

```
public:
void setdimension(float x, float y)
{
base=x;
height=y;
}
virtual void area() =0;
} ;


class Triangle : public Shape
{
public:
void area()
{
cout<<"Area of triangle="<<(0.5*base*height)<<endl;
}
};
class Rectangle : public Shape
{
public:
void area()
{
cout<<"Area of Rectangle="<<(base*height)<<endl;
}
};
int main()
{
Shape *bptr;
Triangle t;
Rectangle r;
t.setdimension(10.0, 5.0);
r.setdimension(20.0, 10.0);
bptr= &t;
bptr->area();
bptr = &r;
bptr->area();
return 0;
}
```

10. Write a program to convert Celsius into Fahrenheit using the concept of conversion from one class type to another class type.

```
#include<iostream>
using namespace std;
class Fahrenheit
{
private:
float f;
public:
Fahrenheit()
{
f=0;
}
Fahrenheit(float x)
{
f=x;
}
void display()
{
cout<<"Temperature in fahrenheit="<<f<<endl;
}
};
class Celsius
{
private:
float c;
public:
Celsius()
{
c=0;
}
Celsius(float x)
{
c=x;
}
void display()
{
cout<<"Temprature in celius="<<c<<endl;
}
operator Fahrenheit()
{
float temp;
temp=c*9/5+32;
```

```
return Fahrenheit(temp);
}
};
int main()
{
Celsius c1(37);
Fahrenheit f1;
f1=c1;
c1.display();
f1.display();
return 0;
}
```

11. **Write a program to implement vector addition using operator overloading**

i) Using Friend Function

ii) Without using Friend Function(using member function)

Note:

Addition of vectors: Addition of vectors is done by adding the corresponding X, Y and Z magnitudes of the two vectors to get the resultant vector.

Example:

v1 = 1i + 2j + 3k

v2 = 3i + 2j + 1k

Therefore the resultant vector,

v3 = v1 + v2 = 4i + 4j + 4k

i) Using friend function

```
#include<iostream>
using namespace std;
class Vector
{
private:
   int x, y, z;
public:
     Vector()
     {

     }
```

```
   Vector(int a, int b, int c)
   {
      x = a;
      y = b;
      z = c;
   }
     void display()
     {
                cout<<x<<"i+"<<y<<"j+"<<z<<"k"<<endl;
     }
     friend Vector operator +(Vector v1,Vector v2);
};
 Vector operator +(Vector v1,Vector v2)
     {
   Vector temp;
   temp.x = v1.x + v2.x;
   temp.y= v1.y + v2.y;
   temp.z = v1.z + v2.z;
   return temp;
     }


int main()
{
   Vector v1(3,4,2);
   Vector v2(6,3,9);
   Vector v3;
    v3=v1+v2;
    cout<<"v1= " ;
    v1.display();
    cout<<"v2= " ;
    v2.display();
   cout<<"v1+v2= ";
   v3.display();
   return 0;
}
```

ii) Without using friend function(using member function)

```
#include<iostream>
using namespace std;
class Vector
{
private:
   int x, y, z;
public:
          Vector()
          {

          }
   Vector(int a, int b, int c)
   {
      x = a;
      y = b;
      z = c;
   }

Vector operator +(Vector v)

{

   Vector temp;
   temp.x = x + v.x;
   temp.y= y + v.y;
   temp.z = z + v.z;
   return temp;
 }
  void display()
 {
 cout<<x<<"i+"<<y<<"j+"<<z<<"k"<<endl;
}
};
```

```
int main()
{
   Vector v1(3,4,2);
   Vector v2(6,3,9);
    Vector v3;
   v3=v1+v2;
   cout<<"v1=" ;
   v1.display();
   cout<<"v2=" ;
   v2.display();
   cout <<"v1+v2=";
   v3.display();
   return 0;
}
```

Output:

```
v1=3i+4j+2k

v2=6i+3j+9k

v1+v2=9i+7j+11k
```