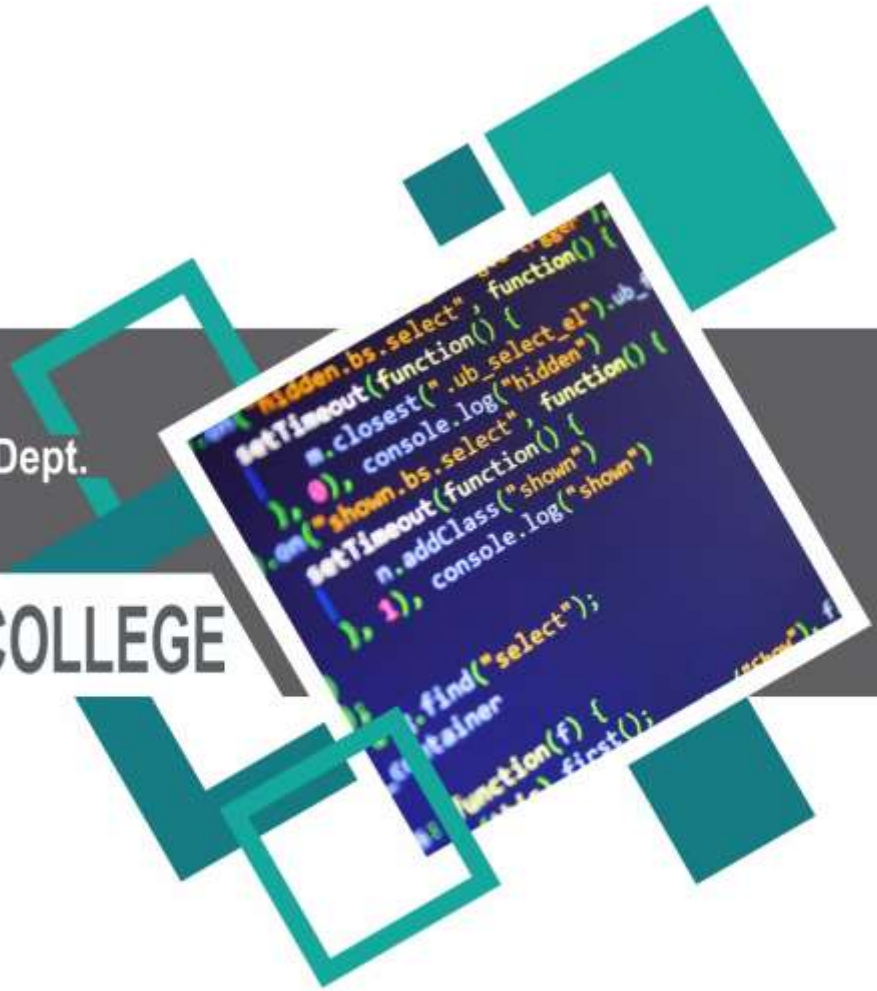
B.Sc. IN
COMPUTER SCIENCE LAB MANUAL
4th Semester

Prepared By
Pure and Applied Science Dept.
Computer Science



MIDNAPORE CITY COLLEGE

OOPs USING C++
LABORATORY MANUAL
(Course Code: COSHMJ05P)

INSTRUCTIONS TO STUDENTS

• Before entering the lab, the student should carry the following things (MANDATORY)

1. Identity card issued by the college.
2. Class notes
3. Lab observation book
4. Lab Manual
5. Lab Record

• Student must sign in and sign out in the register provided when attending the lab session without fail.

• Come to the laboratory in time. Students, who are late more than 10 min., will not be allowed to attend the lab.

• Students need to maintain 80% attendance in lab if not a strict action will be taken.

• All students must follow a Dress Code while in the laboratory.

• Foods, drinks are NOT allowed.

• All bags must be left at the indicated place.

• Refer to the lab staff if you need any help in using the lab.

• Respect the laboratory and its other users.

• Workspace must be kept clean and tidy after experiment is completed.

• Read the Manual carefully before coming to the laboratory and be sure about what you are supposed to do.

• Do the experiments as per the instructions given in the manual.

• Copy all the programs to observation which are taught in class before attending the lab session.

• Students are not supposed to use floppy disks, pen drives without permission of lab- in charge.

• Lab records need to be submitted on or before the date of submission.

1. Write a C++ Program to display Names, Roll No., and grades of 3 students who have appeared in the examination. Declare the class of name, Roll No. and grade. Create an array of class objects. Read and display the contents of the array.

Program:

```
#include <iostream>
 using namespace std;
 #define MAX 10

class student
{
private:
char name[30]; int rollNo;
int total; float perc;
public:
void getDetails(void);          //member function to get student's details
 void putDetails(void);         //member function to print student's details
};

void student:: getDetails(void)          //member function definition, outside of the class
{
cout << "Enter name: " ; cin >> name;
cout << "Enter roll number: "; cin >> rollNo;
cout << "Enter total marks outof 500: "; cin >> total;
perc=(float)total/500*100;
}

void student:: putDetails(void)          //member function definition, outside of the class
{
cout << "Student details:\n";
cout << "Name:"<< name << ",Roll Number:" << rollNo << ",Total:" << total <<
",Percentage:" << perc;

}

int main()
{
student std[MAX];     //array of objects creation int n,loop;
cout << "Enter total number of students: "; cin >> n;
for (loop=0;loop< n; loop++)
{
cout << "Enter details of student " << loop+1 << ":\n"; std[loop].getDetails();
}
```

```
cout << endl; for(loop=0;loop< n; loop++)
{
cout << "Details of student " << (loop+1) << ":\n"; std[loop].putDetails();
}
return 0;
}
```

Output:

Enter total number of students: 3 Enter details of student 1:
Enter name: Karthik Enter roll number: 1201
Enter total marks out of 500: 456

Enter details of student 2:
Enter name: Mahesh Enter roll number: 1202
Enter total marks out of 500: 398

Enter details of student 3:
Enter name: Kiran Enter roll number: 1203
Enter total marks out of 500: 456

Details of student 1:
Student details:
Name: Karthik, Roll Number: 101, Total: 456, Percentage: 91.2 Details of student 2:

Student details:
Name: Mahesh, Roll Number: 1202, Total: 398, Percentage:79.6

Details of student 3:
Student details:
Name: Kiran, Roll Number: 1203, Total: 398, Percentage:79.6

2. ***Write a C++ program to declare Struct. Initialize and display contents of member variables.***

Program:

```
#include  <iostream>
using namespace std;
struct student
{
char name[50];
 int roll;
float marks;
```

```
};
int main()
{
student s;
cout << "Enter information," << endl;
cout << "Enter name: ";
cin >> s.name;
cout << "Enter roll number: "; cin >> s.roll;
cout << "Enter marks: "; cin >> s.marks;
cout << "\nDisplaying Information," << endl; cout << "Name: " << s.name <<
endl;
cout << "Roll: " << s.roll << endl; cout << "Marks: " << s.marks << endl;
 return 0;
}
```

Output:

```
Enter information,
Enter name: Bill
Enter roll number: 4
Enter marks: 55.6

Displaying Information
Name: Bill
Roll: 4
Marks: 55.6
```

3. Write a C++ program to declare a class. Declare pointer to class. Initialize and display the contents of the class member.

```
#include  <iostream>
using namespace std;
class Box
{
public:
Box(double l = 2.0, double b = 2.0, double h = 2.0)
{
cout <<"Constructor called." << endl;
```

```
length = l;
breadth = b;
height = h;
}
double Volume()
{
return length * breadth * height;
}
private:
double length;
double breadth;
double height;
};

int main(void)
{
Box Box1(3.3, 1.2, 1.5);
Box Box2(8.5, 6.0, 2.0);
Box *ptrBox;
ptrBox = &Box1;
cout << "Volume of Box1: " << ptrBox->Volume() << endl; ptrBox = &Box2;
cout << "Volume of Box2: " << ptrBox->Volume() << endl; return 0;
}
```

Output:

```
Constructor called.
Constructor called.
Volume of Box1: 5.94
Volume of Box2: 102
```

4. Given that an EMPLOYEE class contains following members: data members: Employee number, Employee name, Basic, DA, IT, Net Salary and print data members.

Program:

```
#include<iostream.h>
#include<conio.h>
class employee
{
int emp_num;
char emp_name[20]; float emp_basic; float sal;
float emp_da; float net_sal; float emp_it; public:
void get_details(); void find_net_sal();
void show_emp_details();
};
void employee :: get_details()
{
cout<<"\n Enter employee number:\n";
cin>>emp_num;
cout<<"\n Enter employee name:\n";
cin>>emp_name;
cout<<"\n Enter employee basic:\n";
cin>>emp_basic;
}
void employee :: find_net_sal()
{
emp_da=0.52*emp_basic;
emp_it=0.30*(emp_basic+emp_da);
net_sal=(emp_basic+emp_da)-emp_it;
}

void employee :: show_emp_details()
{
cout<<"\n\n\n Details of : "<<emp_name;

cout<<"\n\n Employee number: "<<emp_num; cout<<"\n Basic salary :
"<<emp_basic;
cout<<"\n Employee DA : "<<emp_da; cout<<"\n Income Tax  :"<<emp_it;
cout<<"\n Net Salary       :  "<<net_sal;
}
```

```
int main()
{
employee emp[10]; int i,num;
clrscr();
cout<<"\n Enter number of employee details\n";
 cin>>num;
for(i=0;i<num;i++)
emp[i].get_details();
for(i=0;i<num;i++)
emp[i].find_net_sal();
for(i=0;i<num;i++)
emp[i].show_emp_details();
getch();
return 0;
}
```

Output:

```
Enter number of employee details
Enter employee number: 5123
Enter employee name: Madhav
Enter employee basic: 10000

Details of : Madhav
Employee number: 5123
Basic salary :                  10000
Employee DA                      5200
Income Tax          4560
Net Salary    : 10640
```

5. ***Write a C++ program to read the data of N employee and compute Net salary of each employee (DA=52% of Basic and Income Tax (IT) =30% of the gross salary).***

Program:

```
#include<iostream.h>
#include<conio.h>
#define SIZE 5
class emp
{
float basic,da,it,netsal;
char name[20],num[10];
public:
void getdata();
void net_sal();
void dispdata();
};
void emp::getdata()
{
cout<<"\n Enter employee number: " ;
 cin>>name;
cout<<"\n Enter employee name: " ;
 cin>>num;
cout<<"Enter employee basic salary in Rs: " ;
cin>>basic;
}
void emp::net_sal()
{
da=((0.52)*basic );
float gsal=da+basic;
it=((0.3)*gsal);
netsal=gsal-it;
}

void emp::dispdata()
{
cout <<"\n Employee number: "<<name cout <<"\n Employee name: "<<num
cout <<"\n Employee netsalary: "<<netsal<<" Rs.";
}
void main()
{
clrscr();

emp ob[SIZE]; int n;
```

```
cout<<"\n\n************************************"<<"\n Calculation of
Employee Net Salary"<<"\n************************************"
<<"\n Enter the number of employees";
cin>>n;
for(int i=0;i<n;i++)
{
ob[i].getdata();
ob[i].net_sal();
}
clrscr();
cout<<"\n     "<<"\n Employee Detail::"<<"\n          ";
 for( i=0;i<n;i++)
{
cout<<"\n\n Employee:"<<i+1<<"\n    ";
ob[i].dispdata();
}
getch();
}
```

Output:

```
************************************" Calculation of Employee Net
Salary
************************************" Enter the number of employees: 1

Enter employee number: 22
 Enter employee name: Sanath
Enter employee basic salary in Rs: 10000


Employee Detail::

Employee:1 Employee number: 22
Employee name: Sanath
Employee netsalary: 10000 RS.
```

6. Write a C++ to illustrate the concepts of console I/O operations.

Program:

```
#include <iostream>
```

```
#include <fstream>
#include <cstdlib>
#include <string>
using namespace std;

int main()
{
string filename = "test.txt";
ofstream fout(filename.c_str()); // default mode is ios::out | ios::trunc

if (!fout)
{
cerr << "error: open file for output failed!" << endl;
abort();
// in <cstdlib> header
}

fout << "apple" << endl; fout << "orange" << endl; fout << "banana" << endl;
fout.close();
ifstream fin(filename.c_str()); // default mode ios::in

if (!fin)
{
cerr << "error: open file for input failed!" << endl;
abort();
}
char ch;

while (fin.get(ch))
{ // till end-of-file cout << ch;
}
fin.close();
return 0;
}
```

Output:

apple orange banana

7. Write a C++ program to use scope resolution operator. Display the various values of the same variables declared at different scope levels.

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

class programming
{
public: void output(); //function declaration
};
void programming::output()
{
cout << "Function defined outside the class.\n";
}
int main()
{
programming x; x.output(); return 0;
}
```

Ouput:

Function defined outside class

8. Write a C++ program to allocate memory using new operator.

Program:

```
#include  <iostream>
using namespace std;
int main ()
{
int* p = NULL;
p = new(nothrow) int; if (!p)
cout << "allocation of memory failed\n";
else
{
*p = 29;
cout << "Value of p: " << *p << endl;
}
float *r = new float(75.25);
cout << "Value of r: " << *r << endl;
```

```
int n = 5;
int *q = new(nothrow) int[n];

if (!q)
cout << "allocation of memory failed\n"; else
{
for (int i = 0; i < n; i++) q[i] = i+1;
cout << "Value store in block of memory: ";
for (int i = 0; i < n; i++)
cout << q[i] << " ";
}
delete p; delete r;
delete[] q;
return 0;
}
```

Output:

```
Value of p: 29
Value of r: 75.25
Value store in block of memory: 1 2 3 4 5
```

9. Write a Program to design a class having static member function named showcount() which has the property of displaying the number of objects created of the class.

Program:

```
#include<iostream.h>
#include<conio.h>
class test
{
int code;
static int count;

public:
void setcode(void)
```

```
{
code = ++count;
}
void showcode(void)
{
cout<<"object number:"<<code<<"\n";
}
static void showcount(void)
{
cout<<"count:"<<count<<"\n";
}
};

int test :: count; int main()
{
test t1,t2;

t1.setcode();
t2.setcode();

test :: showcount();

test t3; t3.setcode();

test :: showcount(); t1.showcode(); t2.showcode(); t3.showcode(); return 0;
}
```

10. Write a Program using class to process Shopping List for a Departmental Store. The list include details such as the Code No and Price of each item and perform the operations like Adding, Deleting Items to the list and Printing the Total value of a Order.

Program:

```
#include<iostream.h>
 const m=50;
class ITEMS
{
int itemCode[m];
 float itemPrice[m];
```

```
int count;
public:
void CNT(void){count=0;}
 void getitem(void);
void displaySum(void);
void remove(void);
void displayItems(void);
};
void ITEMS :: getitem(void)
{
cout<<"Enter item code"; cin>>itemCode[count]; cout<<"Enter Item cost";
cin>>itemPrice[count]; count++;
}
void ITEMS :: displaySum(void)
{
float sum=0;
for(int i=0;i<count;i++) sum=sum+itemPrice[i];
cout<<"\n Total Value:"<<sum<<"\n";
}
void ITEMS :: remove(void)
{
int a;
cout<<"Enter Item Code"; cin>>a;
for(int i=0;i<count;i++) if(itemCode[i] == a)
itemPrice[i]=0;
}
void ITEMS :: displayItems(void)
{
cout<<"\n Code      Price\n";

for(int i=0;i<count;i++)
{
cout<<"\n"<<itemCode[i]; cout<<"      "<<itemPrice[i];
}
cout<<"\n";
}



int main()
```

```
{
ITEMS order; order.CNT(); int x;
do
{
cout<<"\n You can do the following;"<<"Enter appropriate number\n";
cout<<"\n1 : Add an Item";
cout<<"\n2 : Display Total Value";
cout<<"\n3 : Delete an Item"; cout<<"\n4 : Display all items";
 cout<<"\n5 : Quit";
cout<<"\n\n What is your option?";
cin>>x;
switch(x)
{
case 1 : order.getitem(); break;
case 2 : order.displaySum(); break;
case 3 : order.remove(); break;
case 4 : order.displayItems(); break;
default : cout<<"Error in input";
}
}while(x!=5); return 0;
}
```

11. Write a Program which creates & uses array of object of a class.(for eg. implementing the list of Managers of a Company having details such as Name, Age, etc..).

Program:

```
#include<iostream.h>
#include<conio.h>
class employee
{
char name [30]; float age;
public:
void getdata(void); void putdata(void);
};
void employee :: getdata(void)
{
cout<<"Enter Name"; cin>>name; cout<<"Enter Age"; cin>>age;
```

```
}
void employee :: putdata(void)
{
cout<<"Name:"<<name<<"\n"; cout<<"Age:          "<<age<<"\n";
}
const int size=3; int main()
{

employee manager[size]; for(int i=0; i<size; i++)
{
cout<<"\n Details of manager"<<i+1<<"\n"; manager[i].getdata();
}
cout<<"\n";
for(i=0; i<size; i++)
{
cout<<"\n Manager"<<i+1<<"\n"; manager[i].putdata();
}

return 0;
}
```

12. Write a Program to find Maximum out of Two Numbers using friend function.

Note: Here one number is a member of one class and the other number is member of some other class.

Program:

```
#include<iostream.h>
#include<conio.h>
class ABC;
class XYZ
{
int x; public:
void setvalue(int i)
{
x=i;
}
friend void max(XYZ, ABC);
};
```

```
class ABC
{
int a; public:
void setvalue(int i)
{
a=i;
}
friend void max(XYZ, ABC);
};
void max (XYZ m, ABC n)
{
if(m.x>=n.a)
cout<<m.x;

else

}


cout<<n.a;

int main()
{
ABC abc; abc.setvalue(10); XYZ xyz; xyz.setvalue(20); max(xyz,abc);

return 0;
}
```

13. Write a Program to swap private data members of classes named as class_1, class_2 using friend function.

Program:

```
#include<iostream.h>
#include<conio.h>
class class_2;
class class_1
{
int value1; public:
void indata(int a)
{
```

```
value1=a;
}
void display(void)
{
cout<<value1<<"\n";
}
friend void exchange(class_1 &, class_2 &);
};
class class_2
{
int value2; public:
void indata(int a)
{
value2=a;
}
void display(void)
{
cout<<value2<<"\n";
}
friend void exchange(class_1 &, class_2 &);
};
void exchange(class_1 &x, class_2 &y)
{
int temp = x.value1; x.value1 = y.value2; y.value2 = temp;
}
int main()
{
class_1 C1;
class_2 C2;

C1.indata(100);
C2.indata(200);
cout<<"Values before exchange"<<"\n";

C1.display();
C2.display();
exchange(C1, C2);
cout<<"Values after exchange"<<"\n";
 C1.display();
C2.display();
```

```
 return 0;
}
```

14. Write a Program to design a class complex to represent complex numbers. The complex class shuold use an external function (use it as a friend function) to add two complex numbers.The function should return an object of type complex representing the sum of two complex numbers.

Program:

```
#include<iostream.h>
#include<conio.h>
class complex
{
float  x;
float  y;
public:
void input(float real, float img)
{
x=real; y=img;
}
friend complex sum(complex, complex); void show(complex);
};
complex sum(complex c1, complex c2)
{
complex c3;
c3.x = c1.x + c2.x; c3.y = c1.y + c2.y; return (c3);
}
void complex :: show(complex c)
{
cout<<c.x<<"+j"<<c.y<<"\n";
}
int main()
{
complex A,B,C; A.input(3.1, 5.65);
B.input(2.75, 1.2);

C=sum(A,B);
cout<<"A="; A.show(A); cout<<"B="; B.show(B); cout<<"C="; C.show(C);

return 0;
```

```
}
```

15. Write a Program using copy constructor to copy data of an object to another object.

```
#include<iostream.h>
#include<conio.h>
class code
{
int id;
public:
code(){}
code(int a)
{
id = a;
}
code(code & x)
{
id = x.id;
}
void display(void)
{
cout<<id;
}
};
int main()
{

code A(100);
code B(A);
code C = A;
code D;
D = A;
cout<<"\n id of A:";
A.display();
cout<<"\n id of B:";
B.display();
cout<<"\n id of C:";
C.display();
cout<<"\n id of D:";
```

```
D.display();

return 0;
}
```

16. Write a Program to allocate memory dynamically for an objects of a given class using class's constructor.

Program:

```
#include<iostream.h>
#include<string.h>
#include<conio.h>
class String
{
char *name; int length;
public:
String()
{
length = 0;
name = new char[length +1];
}
String (char *s)
{
length = strlen(s);
name= new char[length + 1]; strcpy(name, s);
}
void display(void)
{
cout<<name<<"\n";
}
void join(String &a, String &b);
};

void String :: join (String &a, String &b)
{
length = a.length + b.length; delete name;
name = new char [length + 1];

strcpy(name,a.name); strcat(name, b.name);
};
```

```
int main()
{

char *first = "Joseph";
String name1(first), name2("Louis "), name3("Lagrange"),s1,s2; s1.join(name1,
name2);
s2.join(s1, name3); name1.display(); name2.display(); name3.display();
s1.display();
s2.display();

return 0;
}
```

17. Write a Program to design a class to represent a matrix. The class should have the functionality to insert and retrieve the elements of the matrix.

```
#include<iostream.h>
class matrix
{
int **p; int d1,d2;
public:
matrix(int x, int y);
void get_element(int i, int j, int value)
{
p[i][j]=value;
}
int & put_element(int i, int j)
{
return p[i][j];
}
};
matrix ::matrix(int x, int y)
{
d1 = x; d2 = y;
p = new int *[d1];
for(int i = 0; i < d1; i++) p[i] = new int[d2];
}

int main()
```

```
{
int m, n;

cout<<"Enter size of matrix"; cin>>m>>n;
matrix A(m,n);
cout<<"Enter Matrix Element row by row:"; int i,j,value;

for(i=0;i<m;i++)
for(j=0;j<n;j++)
{




}
cout<<"\n";

cin>>value; A.get_element(i,j,value);

cout<<A.put_element(1,2); return 0;
}
```

18. Write a program to design a class representing complex numbers and having the functionality of performing addition & multiplication of two complex numbers using operator overloading.

```
#include<iostream.h>
class complex
{
private:
float real,
imag;
public:
complex( )
{
}
complex( float r, float i )
{
real = r; imag = i;
}
```

```
void getdata( )
{
float r,
i;
cout << endl << "Enter real and imaginary part "; cin >> r >> i;
real = r; imag = i;
}

void setdata( )
{
real = r; imag = i;
}

void displaydata( )
{
cout << endl << "real = " << real; cout<<endl<<Imaginary = "<<imag;
}

complex operator +( complex c )
{
complex t;
t.real = real + c.real; t.imag = imag + c.imag;
}

complex operator *( complex c )
{
complex t;
t.real = real * c.real - imag * c.imag; t.imag = real * c.imag + c.real * imag;
return t;
}
}       ;
void main( )
{

complex c1,c2 ( 1.2, -2.5 ),c3,c4;
c1.setdata( 2.0, 2.0 );
c3 = c1 + c2;
c3.displaydata( );
c4.getdata( );
complex c5 ( 2.5, 3.0 ),c6;
```

```
 c6 = c4 * c5;
c6.displaydata( );
complex c7;
c7 = c1 + c2 * c3;
 c7.displaydata( );
}
```

19. Write a Program to overload operators like *, <<, >> using friend function. The following overloaded operators should work for a class vector.

```
#include<iostream.h>
#include<conio.h>
const size = 3;
class vector
{
int v[size];

public:
vector(); vector(int *x);
friend vector operator *(int a, vector b); friend vector operator *(vector b, int a);
friend istream & operator >>(istream &, vector &); friend ostream & operator
<<(ostream &, vector &);
};

vector ::vector()
{
for(int i=0;i<size;i++) v[i]=0;
}

vector :: vector(int *x)
{
for(int i=0; i<size; i++) v[i] = x[i];
}

vector operator *(int a, vector b)
{
vector c;
for(int i=0; i<size; i++) c.v[i] = a * b.v[i];
return c;
```

```
}

vector operator *(vector b, int a)
{
vector c;
for(int i=0; i<size; i++) c.v[i] = b.v[i] * a;
return c;
}

istream & operator >> (istream &din, vector &b)
{
for(int i=0; i<size; i++) din>>b.v[i];
return(din);
}


ostream & operator << (ostream &dout, vector &b)
{

dout<<"("<<b.v [0];

for(int i=1; i<size; i++) dout<<","<<b.v[i];
dout<<")"; return(dout);
}

int x[size] = {2,4,6};

int main()
{

vector m; vector n = x;

cout<<"Enter Elements of vector m"<<"\n"; cin>>m;

cout<<"\n"; cout<<"m="<<m<<"\n";

vector p,q;

p = 2 * m;
q = n * 2;
```

```
cout<<"\n"; cout<<"p="<<p<<"\n"; cout<<"q="<<q<<"\n";

return 0;
}
```

20. Write a program for developing a matrix class which can handle integer matrices of different dimensions. Also overload the operator for addition, multiplication & comparison of matrices.

```
#include<iostream.h>
 #include<iomanip.h>
 class matrix
{
int maxrow, maxcol; int * ptr;
public:
matrix( int r, int c )
{
maxrow = r; maxcol = c;
ptr      = new int [r * c];
}
void getmat( )
{
int i,j, mat_off,temp;
cout << endl << "enter elements matrix:" << endl; for( i = 0; i < maxrow; i++ )
{
for( j = 0; j < maxcol; j++ )
{
mat_off = i * maxcol + j; cin >> ptr[ mat_off ];
}
}
}
void printmat( )
{
int i, j, mat_off;
for( i = 0; i < maxrow; i++ )
{
cout << endl;
for( j = 0; j < maxcol; j++ )
{
```

```
mat_off = i * maxcol + j;
cout << setw( 3 ) << ptr[ mat_off ];
}
}
}
int delmat( )
{
matrix q ( maxrow - 1, maxcol - 1 );
int      sign = 1, sum = 0, i, j,k,count; int        newsize,newpos,pos,order;
order = maxrow; if( order == 1 )
{
return ( ptr[ 0 ] );
}
for( i = 0; i < order; i++, sign *= -1 )
{
for( j = 1; j < order; j++ )
{
for( k = 0, count = 0; k < order; k++ )

{
if( k == i )
continue;
pos = j * order + k;
newpos = ( j - 1 ) * ( order - 1 ) + count; q.ptr[ newpos ] = ptr[ pos ];
count++;
}
}
sum = sum + ptr[ i ] * sign * q.delmat( );
}
return ( sum );
}
matrix operator +( matrix b )
{
matrix c ( maxrow, maxcol ); int         i,j,mat_off;
for( i = 0; i < maxrow; i++ )
{
for( j = 0; j < maxcol; j++ )
{
mat_off = i * maxcol + j;
c.ptr[ mat_off ] = ptr[ mat_off ] + b.ptr[ mat_off ];
```

```
}
}
return ( c );
}
matrix operator *( matrix b )
{
matrix c ( b.maxcol, maxrow );
int      i,j,k,mat_off1, mat_off2, mat_off3; for( i = 0; i < c.maxrow; i++ )
{
for( j = 0; j < c.maxcol; j++ )
{
mat_off3 - i * c.maxcol + j; c.ptr[ mat_off3 ] = 0;
for( k = 0; k < b.maxrow; k++ )
{
mat_off2 = k * b.maxcol + j; mat_off1 = i * maxcol + k;
c.ptr[mat_off3]+=ptr[mat_off1]* b.ptr[mat_off2 ];
}
}
}
return ( c );
}
int operator ==( matrix b )
{
int i,j, mat_off;
if( maxrow != b.maxrow
|| maxcol != b.maxcol ) return ( 0 );
for( i = 0; i < maxrow; i++ )
{
for( j = 0; j < maxcol; j++ )
{
mat_off = i * maxcol + j; if( ptr[ mat_off ]

!= b.ptr[ mat_off ] ) return ( 0 );
}
}
return ( 1 );
}
}       ;

void main( )
```

```
{
int rowa, cola, rowb, colb;
cout << endl << "Enter dimensions of matrix A "; cin >> rowa >> cola;
matrix a ( rowa, cola ); a.getmat( );
cout << endl << "Enter dimensions of matrix B"; cin >> rowb >> colb;
matrix b ( rowb, colb ); b.getmat( );
matrix c ( rowa, cola ); c = a + b;
cout << endl << "The sum of two matrics = "; c.printmat( );
matrix d ( rowa, colb ); d = a * b;
cout << endl << "The product of two matrics = "; d.printmat( );
cout << endl << "Determinant of matrix a =" << a.delmat( ); if( a == b )
cout << endl << "a & b are equal"; else
cout << endl << "a & b are not equal";
}
```

21. Write a program to overload new/delete operators in a class.

```
#include<iostream.h>
#include      <stdlib.h>
#include       <string.h>
#include       <new.h>

const int MAX = 5;
 const int FREE = 0;
const int OCCUPIED = 1;

void memwarning( )
{
cout << endl << "Free store has now gone empty"; exit( 1 );
}

class employee
{
private:
char name[ 20 ]; int          age;
float sal;

public:
void *operator new(size_t bytes) void operator delete( void * q );
void setdata( char * n, int a, float s ); void showdata( );
```

```
~employee( );
}       ;

struct pool
{
employee obj; int   status;
}       ;

int     flag = 0; struct pool * p = NULL;

void * employee::operator new( size_t sz )
{
int i;
if( flag == 0 )
{
p = ( pool * )malloc( sz * MAX ); if( p == NULL )
memwarning( );
for( i = 0; i < MAX; i++ ) p[ i ].status = FREE;
flag    = 1;
p[ 0 ].status = OCCUPIED; return &p[ 0 ].obj;
}

else
{
for( i = 0; i < MAX; i++ )

{
if( p[ i ].status = FREE )
{
p[ i ].status = OCCUPIED; return &p[ i ].obj;
}
}
memwarning( );
}
}

void employee::operator delete( void * q )
{
if( q == NULL )
return;
```

```
for( int i = 0; i < MAX; i++)
{
if( q == &p[ i ].obj )
{
p[ i ].status = FREE;
strcpy( p[ i ].obj.name, "" ); p[ i ].obj.age = 0;
p[ i ].obj.sal = 0.0;
}
}
}

void employee::setdata( char * n, int a, float s )
{
strcpy( name, n ); age = a;
sal = s;
}

void employee::showdata( )
{
cout << endl << name << "\t" << age << "\t" << sal;
}

employee::~employee( )
{
cout << endl << "reached destructor"; free( p );
}

void main( )
{
void memwarning( ); set_new_handler( memwarning ); employee *
e1,*e2,*e3,*e4,*e5,*e6; e1 = new employee;
e1->setdata( "ajay",          23,     4500.50        );
e2 = new employee; e2->setdata( "amol",     25,     5500.50        );
e3 = new employee; e3->setdata( "anil",
26,
3500.50
);

e4 = new employee;
e4->setdata( "anuj", 30, 6500.50 );
```

```
e5 = new employee;
e5->setdata( "atul", 23, 4200.50 );

e1->showdata( ); e2->showdata( ); e3->showdata( ); e4->showdata( ); e5-
>showdata( );

delete e4; delete e5;

e4->showdata( ); e5->showdata( );

e4 = new employee; e5 = new employee; e6 = new employee;

cout << endl << "Done!!";
}
```

22. Write a program in C++ to highlight the difference between overloaded assignment operator and copy constructor.

```
#include<iostream.h>
class circle
{
private:
int      radius; float x, y;

public:
circle( )
{
}
circle( int rr, float xx, float yy )
{
radius = rr; x          = xx;
y        = yy;
}
circle operator =( circle & c )
{
cout << endl << "Assignment operator invoked"; radiius = c.radius;
x        = c.x;
y        = c.y;
return circle( radius, x, y );
}
```

```
circle( circle & c )
{
cout << endl << "copy constructor invoked"; radius = c.radius;
x       = c.x;
y       = c.y;
}
void showdata( )
{
cout << endl << "Radius = " << radius; cout << endl << "X-Coordinate=" << x;
cout << endl << "Y-Coordinate=" << y;
}
}       ;

void main( )
{
circle c1 ( 10, 2.5, 2.5 ); circle c2,c4;
c4 = c2 = c1; circle c3 = c1; c1.showdata( ); c2.showdata( ); c3.showdata( );
c4.showdata( );
}
```

23. Write a program to implement the exception handling with the functionality of testing the throw restrictions.

```
#include<iostream.h>
void test(int x) throw(int, double)
{
if(x==0)
throw 'x';

else


if(x == 1)
throw x;




}

int main()
```

```
{

else


if(x == -1)
throw 1.0;
cout<<"End of Function Block\n";

try
{









}



cout<<"Testting Throw Restrictions\n"; cout<<"x == 0\n";
test(0); cout<<"x == 1\n"; test(1);
cout<<"x == -1\n"; test(-1); cout<<"x == 2\n"; test(2);

catch(char c)
{
cout<<"Caught a Character\n";
}

catch(int m)
{
cout<<"Caught an Integer\n";
}

catch(double d)
{
cout<<"Caught a Double\n";
```

```
}

cout<<"End of Try-catch system\n"; return 0;
}
```

24. Write a function template that will sort an array of implicit types like int,float,char etc. it can also sort user-defined objects like strings & date. The necessary classes contains overloading of operators.

```
#include<iostream.h>
#include<string.h>

class mystring
{
private:
enum
{
sz = 100       //       < >
}       ;
char str[ sz ];

public:
mystring( char * s = "" )
{
strcpy( str, s );
}

int operator <( mystring ss )
{
if( strcmp( str, ss.str ) <= 0 ) return 1;
else
return 0;
}

int operator <=( mystring ss )
{
if( strcmp( str, ss.str ) <= 0 ) return 1;
else
return 0;
}
```

```
int operator >( mystring ss )
{
if( strcmp( str, ss.str ) > 0 ) return 1;
else
return 0;
}

friend ostream & operator <<( ostream & o,mystring & dd );

}       ;

ostream operator <<( ostream & o, mystring & ss )
{
o << ss.str; return o;
}


class date
{

private:
int  day,
mth, yr;
public:
date( int d = 0, int m = 0, int y = 0 )
{
day = d; mth = m; yr = y;
}

int operator <( date dt )
{
if( yr < dt.yr ) return 1;
if( yr == dt.yr && mth < dt.mth ) return 1;
if( yr == dt.yr && mth == dt.mth && day = dt.day ) return 1;
return 0;
}

class date
{
```

```
private:
int day, mth, yr; public:
date( int d = 0, int m = 0, int y = 0 )
{
day = d; mth = m; yr = y;
}

int operator <( date dt )
{
if( yr < dt.yr ) return 1;
if( yr == dt.yr && mth < dt.mth ) return 1;
if( yr == dt.yr && mth == dt.mth && day < dt.day )
return 1;
return 0;
}
int operator <=( date dt )
{
if( yr <= dt.yr ) return 1;
if( yr == dt.yr && mth <= dt.mth ) return 1;
if( yr == dt.yr && mth == dt.mth && day <= dt.yr )
return 1;
return 0;
}
int operator >( date dt )
{

if( yr > dt.yr ) return 1;
if( yr == dt.yr && mth > dt.mth ) return 1;
if( yr == dt.yr && mth == dt.mth && day > dt.day )
return 1;
return 0;
}

friend ostream & operator <<( ostream & o, date & dd );
}       ;

ostream & operator <<( ostream & o, date & dd )
{
o << dd.day << "\t" << dd.mth << "\t" << dd.yr; return 0;
}
```

```
template<class T> void quick( T * n, int low, int high )
{
int pos;
if( low < high )
{
pos = split( n, low, high ); quick( n, low, pos - 1 ); quick( n, pos + 1, high );
}
}

template<class T> int split( T * n, int low, int high )
{
int pos,
left, right;
T       item, t;

item = n[ low ]; left = low; right = high;

while( left < right )
{
while( n[ right ] > item ) right = right - 1;

while( ( left < right )
&& ( n[ left ] <= item ) ) left = left + 1;

if( left < right )
{
t       = n[ left ]; n[ left ] = n[ right ]; n[ right ] = t;
}
}
pos     = right;
t       = n[ low ];

n[ low ] = n[ pos ]; n[ pos ] = t; return pos;
}


void main( )
{
float num[]={5.4f,3.23f,2.15f,1.09f,34.66f,23.3452f};
```

```
int  arr[]={-12,23,14,0,245,78,66,-9};

date dtarr[]={date(17,11,62),date(23,12,65),date(12,12,78)
,date(23,1,69)};

mystring strarr[]={mystring("Kamal"),mystring("Anuj"),
mystring("Sachin"),mystring("Anil")};

int      i;
cout << endl << endl;

quick( num, 0, 5 );
for( i = 0; i <= 5; i++ ) cout << num[ i ] << endl;

cout << endl << endl; quick( arr, 0, 7 );
for( i = 0; i <= 7; i++ ) cout << arr[ i ] << endl;

cout << endl << endl; quick( dtarr, 0, 3 ); for( i = 0; i <= 3; i++ )
cout << dtarr[ i ] << endl;

cout << endl << endl; quick( strarr, 0, 3 ); for( i = 0; i <= 3; i++ )
cout << strarr[ i ] << endl;

}
```

25. Write a program implementing stack and it's operations using template class.

```
#include<iostream.h>
const int MAX = 10;
template<class T>
class stack
{
private:
T       stk[ MAX ]; int top;

public:
stack( )
{
top = -1;
```

```
}
void push( T data )
{
if( top == MAX - 1 )
cout << endl << "Stack is full"; else
{
top++;
stk[ top ] = data;
}
}

T pop( )
{
if( top == -1 )
{
cout << endl << "Stack is empty"; return NULL;
}
else
{
T data = stk[ top ]; top--;
return data;
}
}
}       ;

class complex
{
private:
float real,
imag;

public:
complex( float r = 0.0, float i = 0.0 )
{
real = r; imag = i;
}
friend ostream & operator <<( ostream & o,
complex & c );

}       ;
```

```
ostream & operator <<( ostream & o, complex & c )
{
o << c.real << "\t" << c.imag; return o;
}

void main( )
{
stack< int > s1; s1.push( 10 );
s1.push( 20 );
s1.push( 30 );

cout << endl << s1.pop( ); cout << endl << s1.pop( ); cout << endl << s1.pop( );
stack< float >        s2; s2.push( 3.14 );
s2.push( 6.28 );
s2.push( 8.98 );

cout << endl << s2.pop( ); cout << endl << s2.pop( ); cout << endl << s2.pop( );

complex       c1 ( 1.5, 2.5 ),
c2 ( 3.5, 4.5 ),
c3 ( -1.5, -0.6 );
stack< complex >  s3; s3.push( c1 );
s3.push( c2 );
s3.push( c3 );

cout << endl << s3.pop( ); cout << endl << s3.pop( ); cout << endl << s3.pop( );

}
```

26. Write a program implementing linked list & some required operations on it using class template.

```
#include<string.h>
#include<iostream.h>

class emp
{
private:
char name[ 20 ];
```

```
 int     age;
float sal;

public:
emp( char * n = "", int a = 0, float s = 0.0 )
{
strcpy( name, n );
age = a;
sal = s;
}

friend ostream & operator <<( ostream & s, emp & e );

}       ;
ostream operator <<( ostream & s, emp & e )
{
cout << e.name << "\t" << e.age << "\t" << e.sal;
return s;
}

template<class T>class linklist
{
private:
struct node
{
T       data; node * link;
}       * p;

public:
linklist( );
~linklist( ); void append( T );
void addatbeg( T );
void addafter( int, T ); void del( int );
void display( ); int count( );
}       ;

template<class T> linklist< T >::linklist( )
{
p = NULL;
}
```

```
template<class T> linklist< T >::~linklist( )
{
node * t;

while( p != NULL )
{
t = p;
p = p->link; delete t;
}
}

template<class T> void linklist< T >::append( T num )
{
node * q,
*       t;
if( p == NULL )
{
p       = new node; p->data = num;
p->link = NULL;
}
else
{
q = p;
while( q->link != NULL ) q = q->link;
t       = new node; t->data = num;
t->link = NULL; q->link = t;
}
}

template<class T> void linklist< T >::addatbeg( T num )
{
node * q;
q       = new node; q->data = num;
q->link = p; p        = q;
}

template<class T> void linklist< T >::addafter( int c,
T num )
```

```
{
node * q,
*       t;
int     i;

for( i = q, q = p; i <= c; i++ )
{
q = q->link; if( q == NULL )
{
cout << endl << "There are less than" << c << "element"; return;
}
}

t       = new node; t->data = num;
t->link = q->link;

q->link = t;
}

template<class T> void linklist< T >::del( int n )
{
node * q,
*       r;
int     i = 1; q = p;
if( n == 1 )
{
p = q->link; delete q; return;
}
r = q;
while( q != NULL )
{
if( i == n )
{
r->link = q->link; delete q;
return;
}
r = q;
q = q->link; i++;
}
cout << endl << "Element" << n << "not found";
```

```
}

template<class T> void linklist< T >::display( )
{
node * q; cout << endl;
for( q = p; q != NULL; q = q->link ) cout << q->data << endl;
}

template<class T> int linklist< T >::count( )
{
node  * q; int         c = 0;
for( q = p; q != NULL; q = q->link ) c++;
return ( c );
}

void main( )
{
linklist< int >        l1;
cout << endl << "No. of elements in linked list = " << l1.count( );

l1.append( 11 );
l1.append( 22 );
l1.append( 33 );
l1.append( 44 );
l1.append( 55 );
l1.append( 66 );

l1.addatbeg( 100 );
l1.addatbeg( 200 );

l1.addafter( 3, 333 );
l1.addafter( 4, 444 ); l1.display( );
cout << endl << "No. of elements in linked list=" << l1.count( );

l1.del( 200 );
l1.del( 66 );
l1.del( 0 );
l1.del( 333 );

l1.display( );
```

```
cout << endl << "no. of elements in linked list = " << l1.count( ); linklist< emp
>       l2;
cout << endl << "No. of elements in linked list = " << l2.count( ); emp e1 (
"Sanjay", 23, 1100.00 );
emp e2 ( "Rahul", 33, 3500.00 ); emp e3 ( "Rakesh", 24, 2400.00 ); emp e4 (
"Sanket", 25, 2500.00 ); emp e5 ( "Sandeep", 26, 2600.00 );

l2.append( e1 ); l2.append( e2 ); l2.append( e3 ); l2.append( e4 ); l2.append( e5
);

l2.display( );

l2.del( 3 );
l2.display( );

cout << endl << "No. of elements in linked list = " << l2.count( );
l2.addatbeg( e5 );
l2.display( );

l2.addafter( 3, e1 ); l2.display( );

cout << endl << "No. of elements in linked list = " << l2.count( );
}
```

COSHMJ06P:
OPERATING SYSTEMS LABORATORY MANUAL

SL.NO.	Experiments
1.	Write a program (using fork () and/or exec () commands) where parent and child execute: a) same program, same code. b) same program, different code. c) before terminating, the parent waits for the child to finish its task.
2.	Write a program to report behaviour of Linux kernel including kernel version, CPU type and model. (CPU information)
3.	Write a program to report behaviour of Linux kernel including information on configured memory, amount of free and used memory (memory information).
4.	Write a program to print file details including owner access permissions, file access time, where file name is given as argument.
5.	Write a program to copy files using system calls.
6.	Write program to implement FCFS scheduling algorithm.
7.	Write program to implement Round Robin scheduling algorithm.
8.	Write program to implement SJF scheduling algorithm.
9.	Write program to calculate sum of n numbers using thread library.
10.	Write a program to implement first-fit, best-fit and worst-fit allocation strategies

1. Write a program (using fork () and/or exec () commands) where parent and child execute:

a) same program, same code.

Program:

```
sanjoy@SANJUVAI:~$ gedit same.c
#include<stdio.h>
#include<unistd.h>
#include<stdlib.h>
int main(){
int pid_t,pid,p;
p=fork();
pid=getpid();
if(p<0){
        fprintf(stderr,"Frok failded");
return 1;
}
printf("Output of fork id: %d \n",p);
printf("process id is : %d \n",pid);
return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ gcc same.c -o sh.out
sanjoy@SANJUVAI:~$ ./sh.out
Output of fork id: 564
process id is : 563
Output of fork id: 0
process id is : 564
sanjoy@SANJUVAI:~$
```

b) same program, different code.

Program:

```
sanjoy@SANJUVAI:~$ gedit different.c
#include<stdio.h>
#include<unistd.h>
#include<stdlib.h>
int main(){
int pid;
pid=fork();
if(pid<0){
printf("\n Error ");
exit(1);
}
 else if(pid==0){
   printf("\n Hello I am child process ");
   printf("\n my pid is %d \n",getpid());
   exit(0);
 }
  else{
  printf("\n Hello i am parent process  ");
  printf("\n My actual pid is %d \n",getpid());
  exit(1);
  }
return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ gcc different.c -o sh.out
sanjoy@SANJUVAI:~$ ./sh.out

 Hello i am parent process
 My actual pid is 714

 Hello I am child process
 my pid is 715
```

c) before terminating, the parent waits for the child to finish its task.

Program:

```
sanjoy@SANJUVAI:~$ gedit parentwait.c
```

```
#include<stdio.h>
#include<unistd.h>
#include<stdlib.h>
int main(){
int pid;
pid=fork();
if(pid<0){
printf("\n Error ");
exit(1);
}
 else if(pid==0){
   printf("\n Hello I am child process ");
   printf("\n my pid is %d \n",getpid());
   exit(0);
 }
  else if(pid>0){
  printf("\n Hello i am parent process  ");
  printf("\n My actual pid is %d \n",getpid());
  //wait(NULL);
  exit(1);
  }
return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ gcc parentwait.c -o sh.out
sanjoy@SANJUVAI:~$ ./sh.out

 Hello i am parent process
 My actual pid is 907

 Hello I am child process
 my pid is 908
```

2. Write a program to report behaviour of Linux kernel including kernel version, CPU type and model. (CPU information)

Program:

```
#include<stdio.h>
#include<stdlib.h>
#include<sys/utsname.h>
using namespace std;
int main()
```

```
{
   int m=0;
   struct utsname s1;
   m=uname(&s1);

   if(m==0)
   {
      printf("\n The name of System:%s , system" , s1.sysname);
      printf("\n The version:%s" , s1.version);
      printf("\n The Machine:%s" , s1.machine);
      printf("\n");
      system("cat /proc/cpuinfo | awk 'NR==3, NR==4{print}' \n");
   }

   else
   {
      printf("Error");
   }
   return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ touch question2.cpp
sanjoy@SANJUVAI:~$ g++ question2.cpp
sanjoy@SANJUVAI:~$ ./a.out

 The name of System:Linux , system
 The version:#1 SMP Wed Nov 23 01:01:46 UTC 2022
 The Machine:x86_64
cpu family      : 6
model           : 126
```

3. Write a program to report behaviour of Linux kernel including information on configured memory, amount of free and used memory (memory information).

Program:

```
#include<stdlib.h>
#include<iostream>
using namespace std;
int main()
{
```

```
cout<<"\nThe kernel version is, \n";
system("cat /proc/sys/kernel/osrelease") ;
cout<<"\nThe CPU space: \n";
system("cat /proc/cpuinfo | awk 'NR==3, NR==4{print}' \n ");
cout<<"\nAmount of cpu time since system was last booted is: ";
system("cat /proc/uptime \n");
cout<<"\nThe configured memory is : \n";
system("cat /proc/meminfo | awk 'NR==1, NR==4{print $2}' \n ");
//cout<<"\nAmount of free memory: \n";
//system("cat /proc/meminfo |awk 'NR = 2{Print $2}' \n ");
cout<<"Amount of used memory is: \n";
system("cat /proc/meminfo | awk '{ if (NR==1) a=$2; if(NR==2) b=$2
    }END {print a-b} ' \n");
return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ g++ memory.cpp
sanjoy@SANJUVAI:~$ ./a.out

The kernel version is,
5.15.79.1-microsoft-standard-WSL2

The CPU space:
cpu family      : 6
model           : 126

3531.89 28231.67
Amount of cpu time since system was last booted is:
The configured memory is :
3880936
3286912
3380688
11896
Amount of used memory is:
594024
```

4. Write a program to print file details including owner access permissions, file access time, where file name is given as argument.

Program:

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

```
#include<stdlib.h>
#include<stdio.h>
#include<sys/stat.h>
#include<sys/types.h>
#include<unistd.h>
int main(int argc, char *argv[])
{
int i;
struct stat s;
if (argc < 2)
{
cout<<"\n enter filename in";
//exit();
}
for(i=1;i<argc; i++)
{
cout<<"File : "<<argv[i]<<"\n";
if(stat(argv[i],&s)<0)
cout<<"error in obtaining stats In";
else
{
cout<<"owner UID : "; cout<<s.st_uid; cout<<"\n";
cout<<"group ID :"; cout<<s.st_gid; cout<<"\n";
cout<<"Access permissions : "; cout<<s.st_mode; cout<<"\n";
cout<<"Access Time :" ;cout<<s.st_atime; cout<<"\n";
cout<<"File Size : "; cout<<s.st_size; cout<<"\n";
cout<<"File Size(in blocks) : "; cout<<s.st_blksize; cout<<"\n";
}
}
return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ cat>f1
Well, Come to Midnapore City College.
^Z
[3]+  Stopped                 cat > f1
sanjoy@SANJUVAI:~$ g++ test2.cpp
sanjoy@SANJUVAI:~$ ./a.out f1
File : f1
owner UID : 1000
group ID :1000
Access permissions : 33188
```

Access Time :1674936817
File Size : 37
File Size(in blocks) : 4096

5. Write a program to copy files using system calls.

Program:
sanjoy@SANJUVAI:~$ gedit copyfile.c

```
#include <stdio.h>
#include <unistd.h>
#include <fcntl.h>
#include <stdlib.h>
int main(int argc, char *argv[])
 {
  int f1, f2;
  char buff[50];
  long int n;

 if(((f1 = open(argv[1], O_RDONLY)) == -1 || ((f2=open(argv[2],
    O_CREAT |
 O_WRONLY | O_TRUNC, 0700))== 1)))
   {
     perror("problem in file");
     exit(1);
   }

 while((n=read(f1, buff, 50))>0)

    if(write(f2, buff, n)!=n)
      {
        perror("problem in writing");
        exit(3);
      }

    if(n==-1)
      {
        perror("problem in reading");
        exit(2);
      }

     close(f2);
     exit(0);
```

```
}
```

Input and Output Section:

```
    sanjoy@SANJUVAI:~$ cc copyfile.c
sanjoy@SANJUVAI:~$ cat>bsc.txt
This is BSc Computer Science File.
BSc Computer Science File is copy into BCA File.
^Z
[7]+  Stopped                 cat > bsc.txt
sanjoy@SANJUVAI:~$ ./a.out bsc.txt bca.txt
sanjoy@SANJUVAI:~$ cat bca.txt
This is BSc Computer Science File.
BSc Computer Science File is copy into BCA File.
```

6. Write program to implement FCFS scheduling algorithm.

Program:

```
// C program for implementation of FCFS scheduling
#include<stdio.h>
// Function to find the waiting time for all processes
void findWaitingTime(int processes[], int n, int bt[], int wt[])
{
    // waiting time for first process is 0
    wt[0] = 0;

    // calculating waiting time
    for (int i = 1; i < n ; i++ )
        wt[i] = bt[i-1] + wt[i-1] ;
}

// Function to calculate turn around time
void findTurnAroundTime( int processes[], int n, int bt[], int wt[], int tat[])
{
    // calculating turnaround time by adding bt[i] + wt[i]
    for (int i = 0; i < n ; i++)
        tat[i] = bt[i] + wt[i];
}
//Function to calculate average time
void findavgTime( int processes[], int n, int bt[])
{
    int wt[n], tat[n], total_wt = 0, total_tat = 0;
    //Function to find waiting time of all processes
```

```
    findWaitingTime(processes, n, bt, wt);
    //Function to find turn around time for all processes
    findTurnAroundTime(processes, n, bt, wt, tat);
    //Display processes along with all details
    printf("Processes Burst time Waiting time Turn around time\n");
    // Calculate total waiting time and total turn around time
    for (int i=0; i<n; i++)
    {
        total_wt = total_wt + wt[i];
        total_tat = total_tat + tat[i];
        printf(" %d ",(i+1));
        printf("\t   %d", bt[i] );
        printf("\t\t %d",wt[i] );
        printf("\t\t %d\n",tat[i] );
    }
    int s=(float)total_wt / (float)n;
    int t=(float)total_tat / (float)n;
    printf("Average waiting time = %d",s);
    printf("\n");
    printf("Average turn around time = %d ",t);
}
int main()
{
    //process id's
    int processes[] = { 1, 2, 3};
    int n = sizeof processes / sizeof processes[0];

    //Burst time of all processes
    int burst_time[] = {10, 5, 8};

    findavgTime(processes, n, burst_time);
    return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ gcc fcfs.c -o a.out
sanjoy@SANJUVAI:~$ ./a.out
Processes Burst time Waiting time Turn around time
 1        10          0           10
 2        5           10          15
 3        8           15          23
Average waiting time = 8
Average turn around time = 16
```

7. Write program to implement Round Robin scheduling algorithm.

Program:

```
#include<stdio.h>
//#include<conio.h>
int main()
{
   // initlialize the variable name
   int i, NOP, sum=0,count=0, y, quant, wt=0, tat=0, at[10], bt[10],
    temp[10];
   float avg_wt, avg_tat;
   printf(" Total number of process in the system: ");
   scanf("%d", &NOP);
   y = NOP; // Assign the number of process to variable y

// Use for loop to enter the details of the process like Arrival time and the
    Burst Time
for(i=0; i<NOP; i++)
{
printf("\n Enter the Arrival and Burst time of the Process[%d]\n", i+1);
printf(" Arrival time is: \t");  // Accept arrival time
scanf("%d", &at[i]);
printf(" \nBurst time is: \t"); // Accept the Burst time
scanf("%d", &bt[i]);
temp[i] = bt[i]; // store the burst time in temp array
}
// Accept the Time qunat
printf("Enter the Time Quantum for the process: \t");
scanf("%d", &quant);
// Display the process No, burst time, Turn Around Time and the waiting
    time
printf("\n Process No \t\t Burst Time \t\t TAT \t\t Waiting Time ");
for(sum=0, i = 0; y!=0; )
{
if(temp[i] <= quant && temp[i] > 0) // define the conditions
{
   sum = sum + temp[i];
   temp[i] = 0;
   count=1;
   }
   else if(temp[i] > 0)
   {
```

```
        temp[i] = temp[i] - quant;
        sum = sum + quant;
    }
    if(temp[i]==0 && count==1)
    {
        y--; //decrement the process no.
        printf("\nProcess No[%d] \t\t %d\t\t\t\t %d\t\t\t %d", i+1, bt[i], sum-
     at[i], sum-at[i]-bt[i]);
        wt = wt+sum-at[i]-bt[i];
        tat = tat+sum-at[i];
        count =0;
    }
    if(i==NOP-1)
    {
        i=0;
    }
    else if(at[i+1]<=sum)
    {
        i++;
    }
    else
    {
        i=0;
    }
}
// represents the average waiting time and Turn Around time
avg_wt = wt * 1.0/NOP;
avg_tat = tat * 1.0/NOP;
printf("\n Average Turn Around Time: \t%f", avg_wt);
printf("\n Average Waiting Time: \t%f", avg_tat);
//getch();
return 0;
}
```

Input and Output Section:

```
Total number of process in the system: 4

 Enter the Arrival and Burst time of the Process[1]
 Arrival time is:       0

Burst time is:  8

 Enter the Arrival and Burst time of the Process[2]
```

```
 Arrival time is:       1

Burst time is:  5

 Enter the Arrival and Burst time of the Process[3]
 Arrival time is:       2

Burst time is:  10

 Enter the Arrival and Burst time of the Process[4]
 Arrival time is:       3

Burst time is:  11
Enter the Time Quantum for the process:         6

 Process No          Burst Time          TAT          Waiting Time
Process No[2]         5                   10              5
Process No[1]         8                   25              17
Process No[3]         10                   27              17
Process No[4]         11                   31              20
 Average Turn Around Time:      14.750000
 Average Waiting Time:  23.250000
```

8. Write program to implement SJF scheduling algorithm.

Program:

```
sanjoy@SANJUVAI:~$ gedit sjf.cpp
#include <bits/stdc++.h>
using namespace std;
//structure for every process
struct Process {
   int pid; // Process ID
   int bt; // Burst Time
   int art; // Arrival Time
};
void findTurnAroundTime(Process proc[], int n, int wt[], int tat[]) {
   for (int i = 0; i < n; i++)
   tat[i] = proc[i].bt + wt[i];
}
//waiting time of all process
void findWaitingTime(Process proc[], int n, int wt[]) {
   int rt[n];
   for (int i = 0; i < n; i++)
```

```
    rt[i] = proc[i].bt;
    int complete = 0, t = 0, minm = INT_MAX;
    int shortest = 0, finish_time;
    bool check = false;
    while (complete != n) {
      for (int j = 0; j < n; j++) {
        if ((proc[j].art <= t) && (rt[j] < minm) && rt[j] > 0) {
          minm = rt[j];
          shortest = j;
          check = true;
        }
      }
      if (check == false) {
        t++;
        continue;
      }
      // decrementing the remaining time
      rt[shortest]--;
      minm = rt[shortest];
      if (minm == 0)
        minm = INT_MAX;
        // If a process gets completely
        // executed
        if (rt[shortest] == 0) {
          complete++;
          check = false;
          finish_time = t + 1;
          // Calculate waiting time
          wt[shortest] = finish_time -
          proc[shortest].bt -
          proc[shortest].art;
          if (wt[shortest] < 0)
            wt[shortest] = 0;
        }
        // Increment time
        t++;
    }
  }
  // Function to calculate average time
  void findavgTime(Process proc[], int n) {
    int wt[n], tat[n], total_wt = 0,
    total_tat = 0;
    // Function to find waiting time of all
```

```
  // processes
  findWaitingTime(proc, n, wt);
  // Function to find turn around time for
  // all processes
  findTurnAroundTime(proc, n, wt, tat);
  cout << "Processes " << " Burst time " << " Waiting time " << " Turn
    around time\n";
  for (int i = 0; i < n; i++) {
     total_wt = total_wt + wt[i];
     total_tat = total_tat + tat[i];
     cout << " " << proc[i].pid << "\t\t" << proc[i].bt << "\t\t " << wt[i] <<
    "\t\t " << tat[i] << endl;
  }
    cout << "\nAverage waiting time = " << (float)total_wt / (float)n;
cout << "\nAverage turn around time = " << (float)total_tat / (float)n;
}
int main() {
  Process proc[] = { { 1, 5, 1 }, { 2, 3, 1 }, { 3, 6, 2 }, { 4, 5, 3 } };
  int n = sizeof(proc) / sizeof(proc[0]);
  findavgTime(proc, n);
  return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ g++ sjf.cpp
sanjoy@SANJUVAI:~$ ./a.out
Processes  Burst time  Waiting time  Turn around time
 1          5           3           8
 2          3           0           3
 3          6           12           18
 4          5           6           11

Average waiting time = 5.25
Average turn around time = 10
```

9. Write program to calculate sum of n numbers using thread library.

Program:

```
sanjoy@SANJUVAI:~$ gedit thread.c
#include <pthread.h>
#include <stdlib.h>
#include <stdio.h>
```

```
typedef struct data{
   int* arr;
   int thread_num;
} data;
int arrSize = 10;
void* halfSum(void* p){
   data* ptr = (data*)p;
   int n = ptr->thread_num;
   // Declare sum dynamically to return to join:
   int* thread_sum = (int*) calloc(1, sizeof(int));

   if(n == 0){
      for(int i = 0; i < arrSize/2; i++)
         thread_sum[0] = thread_sum[0] + ptr->arr[i];
   }
   else{
      for(int i = arrSize/2; i < arrSize; i++)
         thread_sum[0] = thread_sum[0] + ptr->arr[i];
   }

   pthread_exit(thread_sum);
}
int main(void){
   // Declare integer array [1,2,3,4,5,6,7,8,9,10]:
   int* int_arr = (int*) calloc(arrSize, sizeof(int));
   for(int i = 0; i < arrSize; i++)
      int_arr[i] = i + 1;
   // Declare arguments for both threads:
   data thread_data[2];
   thread_data[0].thread_num = 0;
   thread_data[0].arr = int_arr;
   thread_data[1].thread_num = 1;
   thread_data[1].arr = int_arr;
   // Declare thread IDs:
   pthread_t tid[2];
   // Start both threads:
   pthread_create(&tid[0], NULL, halfSum, &thread_data[0]);
   pthread_create(&tid[1], NULL, halfSum, &thread_data[1]);
   // Declare space for sum:
   int* sum0;
   int* sum1;
   // Retrieve sum of threads:
   pthread_join(tid[0], (void**)&sum0);
```

```
    pthread_join(tid[1], (void**)&sum1);
    printf("Sum of whole array = %i\n", *sum0 + *sum1);
    return 0;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ gcc thread.c -o a.out
sanjoy@SANJUVAI:~$ ./a.out
Sum of whole array = 55
```

10. Write a program to implement first-fit, best-fit and worst-fit allocation strategies.

First-fit allocation strategies:

Program:

```
sanjoy@SANJUVAI:~$ gedit firstfit.c
// C implementation of First - Fit algorithm
#include<stdio.h>

// Function to allocate memory to blocks as per First fit algorithm
void firstFit(int blockSize[], int m, int processSize[], int n)
{
    int i, j;
    // Stores block id of the block allocated to a process
    int allocation[n];

    // Initially no block is assigned to any process
    for(i = 0; i < n; i++)
    {
        allocation[i] = -1;
    }
    for (i = 0; i < n; i++)        //here, n -> number of processes
    {
        for (j = 0; j < m; j++)       //here, m -> number of blocks
        {
            if (blockSize[j] >= processSize[i])
            {
                // allocating block j to the ith process
                allocation[i] = j;

                // Reduce available memory in this block.
                blockSize[j] -= processSize[i];
```

```
                        break; //go to the next process in the queue
                    }
                }
            }

            printf("\nProcess No.\tProcess Size\tBlock no.\n");
            for (int i = 0; i < n; i++)
            {
                printf(" %i\t\t", i+1);
                printf("%i\t\t", processSize[i]);
                if (allocation[i] != -1)
                    printf("%i", allocation[i] + 1);
                else
                    printf("Not Allocated");
                printf("\n");
            }
        }

        int main()
        {
            int m; //number of blocks in the memory
            int n; //number of processes in the input queue
            int blockSize[] = {100, 500, 200, 300, 600};
            int processSize[] = {212, 417, 112, 426};
            m = sizeof(blockSize) / sizeof(blockSize[0]);
            n = sizeof(processSize) / sizeof(processSize[0]);

            firstFit(blockSize, m, processSize, n);

            return 0 ;
        }
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ gcc firstfit.c -o a.out
sanjoy@SANJUVAI:~$ ./a.out

Process No.     Process Size    Block no.
 1              212             2
 2              417             5
 3              112             2
 4              426             Not Allocated
```

Best-fit allocation strategies:

Program:

```
sanjoy@SANJUVAI:~$ touch bestfit.cpp
// C++ implementation of Best - Fit algorithm
#include<iostream>
using namespace std;

// Method to allocate memory to blocks as per Best fit algorithm
void bestFit(int blockSize[], int m, int processSize[], int n)
{
    // Stores block id of the block allocated to a process
    int allocation[n];

    // Initially no block is assigned to any process
    for (int i = 0; i < n; i++)
            allocation[i] = -1;

    // pick each process and find suitable blocks according to its size ad
assign to it
    for (int i = 0; i < n; i++)
    {
            // Find the best fit block for current process
            int bestIdx = -1;
            for (int j = 0; j < m; j++)
            {
                    if (blockSize[j] >= processSize[i])
                    {
                            if (bestIdx == -1)
                                    bestIdx = j;
                            else if (blockSize[bestIdx] > blockSize[j])
                                    bestIdx = j;
                    }
            }

            // If we could find a block for current process
            if (bestIdx != -1)
            {
                    // allocate block j to p[i] process
                    allocation[i] = bestIdx;

                    // Reduce available memory in this block.
```

```
                blockSize[bestIdx] -= processSize[i];
            }
        }

        cout << "\nProcess No.\tProcess Size\tBlock no.\n";
        for (int i = 0; i < n; i++)
        {
            cout << " " << i+1 << "\t\t" << processSize[i] << "\t\t";
            if (allocation[i] != -1)
                cout << allocation[i] + 1;
            else
                cout << "Not Allocated";
            cout << endl;
        }
}
int main()
{
    int blockSize[] = {100, 500, 200, 300, 600};
    int processSize[] = {212, 417, 112, 426};
    int m = sizeof(blockSize) / sizeof(blockSize[0]);
    int n = sizeof(processSize) / sizeof(processSize[0]);

    bestFit(blockSize, m, processSize, n);

    return 0 ;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ g++ bestfit.cpp
sanjoy@SANJUVAI:~$ ./a.out

Process No.     Process Size    Block no.
 1              212             4
 2              417             2
 3              112             3
 4              426             5
```

Worst-fit allocation strategies:

Program:

```
sanjoy@SANJUVAI:~$ gedit worstfit.cpp
// C++ implementation of worst - Fit algorithm
#include<bits/stdc++.h>
```

```
using namespace std;

// Function to allocate memory to blocks as per worst fit
// algorithm
void worstFit(int blockSize[], int m, int processSize[],

    int n)
{
    // Stores block id of the block allocated to a
    // process
    int allocation[n];

    // Initially no block is assigned to any process
    memset(allocation, -1, sizeof(allocation));

    // pick each process and find suitable blocks
    // according to its size ad assign to it
    for (int i=0; i<n; i++)
    {
            // Find the best fit block for current process
            int wstIdx = -1;
            for (int j=0; j<m; j++)
            {
                    if (blockSize[j] >= processSize[i])
                    {
                            if (wstIdx == -1)
                                    wstIdx = j;
                            else if (blockSize[wstIdx] < blockSize[j])
                                    wstIdx = j;
                    }
            }

            // If we could find a block for current process
            if (wstIdx != -1)
            {
                    // allocate block j to p[i] process
                    allocation[i] = wstIdx;

                    // Reduce available memory in this block.
                    blockSize[wstIdx] -= processSize[i];
            }
    }
```

```
    cout << "\nProcess No.\tProcess Size\tBlock no.\n";
    for (int i = 0; i < n; i++)
    {
            cout << " " << i+1 << "\t\t" << processSize[i] << "\t\t";
            if (allocation[i] != -1)
                    cout << allocation[i] + 1;
            else
                    cout << "Not Allocated";
            cout << endl;
    }
}

// Driver code
int main()
{
    int blockSize[] = {100, 500, 200, 300, 600};
    int processSize[] = {212, 417, 112, 426};
    int m = sizeof(blockSize)/sizeof(blockSize[0]);
    int n = sizeof(processSize)/sizeof(processSize[0]);
    worstFit(blockSize, m, processSize, n);
    return 0 ;
}
```

Input and Output Section:

```
sanjoy@SANJUVAI:~$ g++ worstfit.cpp
sanjoy@SANJUVAI:~$ ./a.out

Process No.     Process Size    Block no.
 1              212             5
 2              417             2
 3              112             5
 4              426             Not Allocated
```

COMPUTER NETWORK LABORATORY MANUAL (Course: COSHMJ07P)

Assignments

1. Simulate Cyclic Redundancy Check (CRC) error detection algorithm for noisy channel.
2. Simulate and implement stop and wait protocol for noiseless channel.
3. Simulate and implement stop and wait protocol for noisy channel.
4. Simulate and implement go back n sliding window protocol.
5. Simulate and implement selective repeat sliding window protocol.
6. Simulate and implement Hamming Code error correction.
7. Simulate and implement distance vector routing algorithm.
8. Simulate and implement Dijkstra algorithm for shortest path routing.

1. Simulate Cyclic Redundancy Check (CRC) error detection algorithm for noisy channel.

Program:

```
#include <iostream>
#include <conio.h>
using namespace std;
int main()
{
   int i,j,k,l;

   //Get Frame
   int fs;
   cout<<"\n Enter Frame size: ";
   cin>>fs;

   int f[20];

   cout<<"\n Enter Frame:";
   for(i=0;i<fs;i++)
   {
      cin>>f[i];
   }

   //Get Generator
   int gs;
   cout<<"\n Enter Generator size: ";
   cin>>gs;

   int g[20];

   cout<<"\n Enter Generator:";
   for(i=0;i<gs;i++)
   {
      cin>>g[i];
   }

   cout<<"\n Sender Side:";
   cout<<"\n Frame: ";
   for(i=0;i<fs;i++)
   {
      cout<<f[i];
   }
```

```
cout<<"\n Generator :";
for(i=0;i<gs;i++)
{
   cout<<g[i];
}

//Append 0's
int rs=gs-1;
cout<<"\n Number of 0's to be appended: "<<rs;
for (i=fs;i<fs+rs;i++)
{
   f[i]=0;
}

int temp[20];
for(i=0;i<20;i++)
{
   temp[i]=f[i];
}

cout<<"\n Message after appending 0's :";
for(i=0; i<fs+rs;i++)
{
   cout<<temp[i];
}

//Division
for(i=0;i<fs;i++)
{
   j=0;
   k=i;
   //check whether it is divisible or not
   if (temp[k]>=g[j])
   {
      for(j=0,k=i;j<gs;j++,k++)
      {
         if((temp[k]==1 && g[j]==1) || (temp[k]==0 && g[j]==0))
         {
            temp[k]=0;
         }
         else
         {
            temp[k]=1;
```

```
            }
        }
    }
}

//CRC
int crc[15];
for(i=0,j=fs;i<rs;i++,j++)
{
    crc[i]=temp[j];
}

cout<<"\n CRC bits: ";
for(i=0;i<rs;i++)
{
    cout<<crc[i];
}

cout<<"\n Transmitted Frame: ";
int tf[15];
for(i=0;i<fs;i++)
{
    tf[i]=f[i];
}
for(i=fs,j=0;i<fs+rs;i++,j++)
{
    tf[i]=crc[j];
}
for(i=0;i<fs+rs;i++)
{
    cout<<tf[i];
}

cout<<"\n Receiver side : ";
cout<<"\n Received Frame: ";
for(i=0;i<fs+rs;i++)
{
    cout<<tf[i];
}

for(i=0;i<fs+rs;i++)
{
    temp[i]=tf[i];
```

```
}

//Division
for(i=0;i<fs+rs;i++)
{
   j=0;
   k=i;
   if (temp[k]>=g[j])
   {
      for(j=0,k=i;j<gs;j++,k++)
      {
         if((temp[k]==1 && g[j]==1) || (temp[k]==0 && g[j]==0))
         {
            temp[k]=0;
         }
         else
         {
            temp[k]=1;
         }
      }
   }
}

cout<<"\n Reaminder: ";
int rrem[15];
for (i=fs,j=0;i<fs+rs;i++,j++)
{
   rrem[j]= temp[i];
}
for(i=0;i<rs;i++)
{
   cout<<rrem[i];
}

int flag=0;
for(i=0;i<rs;i++)
{
   if(rrem[i]!=0)
   {
      flag=1;
   }
}
```

```
    if(flag==0)
    {
       cout<<"\n Since Remainder Is 0 Hence Message Transmitted From
Sender To Receiver Is Correct";
    }
    else
    {
       cout<<"\n Since Remainder Is Not 0 Hence Message Transmitted From
Sender To Receiver Contains Error";
    }
    getch();
}
```

Input and Output Section:

Enter Frame size: 8

Enter Frame:1 0 0 1 1 0 0 1

Enter Generator size: 4

Enter Generator:1 0 0 1

Sender Side:

Frame: 10011001

Generator :1001

Number of 0's to be appended: 3

Message after appending 0's :10011001000

CRC bits: 000

Transmitted Frame: 10011001000

Receiver side :

Received Frame: 10011001000

Remainder: 000

Since Remainder Is 0 Hence Message Transmitted From Sender To Receiver Is Correct

2. Simulate and implement stop and wait protocol for noiseless channel.

Program:

```
#include<iostream>
#include<stdio.h>
#include<stdlib.h>
#include<conio.h>
#include<dos.h>
using namespace std;
#define time 5
#define max_seq 1
#define tot_pack 5
int randn(int n)
{
   return rand()%n + 1;
}
typedef struct
{
      int data;
}packet;
typedef struct
{
       int kind;
       int seq;
       int ack;
       packet info;
}frame;
typedef enum{ frame_arrival,error,time_out}event_type;
frame data1;
```

```
//creating prototype
void from_network_layer(packet *);
void to_physical_layer(frame *);
void to_network_layer(packet *);
void from_physical_layer(frame*);
void sender();
void receiver();
void wait_for_event_sender(event_type *);
void wait_for_event_receiver(event_type *);
//end
#define inc(k) if(k<max_seq)k++;else k=0;
int i=1;
char turn;
int disc=0;
int main()
{
  while(!disc)
  {  sender();
    // delay(400);
     receiver();
  }
   getchar();
}
void sender()
{
    static int frame_to_send=0;
    static frame s;
    packet buffer;
    event_type event;
```

```
    static int flag=0;       //first place
    if (flag==0)
    {
  from_network_layer(&buffer);
  s.info=buffer;
  s.seq=frame_to_send;
  cout<<"\nsender information \t"<<s.info.data<<"\n";
  cout<<"\nsequence no. \t"<<s.seq;
  turn='r';
  to_physical_layer(&s);
  flag=1;
    }
wait_for_event_sender(&event);
if(turn=='s')
{
    if(event==frame_arrival)
     {
     from_network_layer(&buffer);
     inc(frame_to_send);
     s.info=buffer;
     s.seq=frame_to_send;
     cout<<"\nsender information \t"<<s.info.data<<"\n";
     cout<<"\nsequence no. \t"<<s.seq<<"\n";
     getch();
     turn='r';
     to_physical_layer(&s);
     }
 }
}                  //end of sender function
```

```
void from_network_layer(packet *buffer)
{
    (*buffer).data=i;
    i++;
}                       //end of from network layer function
void to_physical_layer(frame *s)
{
    data1=*s;
}           //end of to physical layer function
void wait_for_event_sender(event_type *e)
{
     static int timer=0;
     if(turn=='s')
     {   timer++;
   //timer=0;
   return ;
  }
  else                  //event is frame arrival
    {
      timer=0;
      *e=frame_arrival;
    }
}           //end of wait for event function
void receiver()
{
    static int frame_expected=0;
    frame s,r;
    event_type event;
    wait_for_event_receiver(&event);
```

```
    if(turn=='r')
    {  if(event==frame_arrival)
   {
        from_physical_layer(&r);
        if(r.seq==frame_expected)
   {
     to_network_layer(&r.info);
     inc (frame_expected);
   }
   else
   cout<<"\nReceiver :Acknowledgement resent \n";
   getch();
   turn='s';
   to_physical_layer(&s);
     }
    }
}                    //end of receiver function
void wait_for_event_receiver(event_type *e)
{
    if(turn=='r')
    {
  *e=frame_arrival;
    }
}
void from_physical_layer(frame *buffer)
{
   *buffer=data1;
}
void to_network_layer(packet *buffer)
```

```
{
    cout<<"\nReceiver : packet received \t"<< i-1;
    cout<<"\n Acknowledgement  sent \t";
    getch();
    if(i>tot_pack)
     { disc=1;
 cout<<"\ndiscontinue\n";
     }
}       //end of network layer function
```

Input and Output Section:

sender information 1

sequence no. 0

Receiver : packet received 1

Acknowledgement sent

sender information 2

sequence no. 1

Receiver : packet received 2

Acknowledgement sent

sender information 3

sequence no. 0

Receiver : packet received 3

Acknowledgement sent

sender information 4

sequence no. 1

Receiver : packet received 4

Acknowledgement sent

sender information 5

sequence no. 0

Receiver : packet received 5

Acknowledgement sent

Discontinue

3. Simulate and implement stop and wait protocol for noisy channel.

Program:

```
#include<iostream>
#include <time.h>
#include <cstdlib>
#include<ctime>
#include <unistd.h>
using namespace std;
class timer {
   private:
    unsigned long begTime;
   public:
    void start() {
     begTime = clock();
    }
  unsigned long elapsedTime() {
     return ((unsigned long) clock() - begTime) / CLOCKS_PER_SEC;
```

```
    }
   bool isTimeout(unsigned long seconds) {
      return seconds >= elapsedTime();
     }
};
int main()
{
 int frames[] = {1,2,3,4,5,6,7,8,9,10};
 unsigned long seconds = 5;
 srand(time(NULL));
 timer t;
 cout<<"Sender has to send frames : ";
 for(int i=0;i<10;i++)
    cout<<frames[i]<<" ";
 cout<<endl;
 int count = 0;
 bool delay = false;
 cout<<endl<<"Sender\t\t\t\tReceiver"<<endl;
 do
 {
    bool timeout = false;
    cout<<"Sending Frame : "<<frames[count];
    cout.flush();
    cout<<"\t\t";
    t.start();
    if(rand()%2)
    {
       int to = 24600 + rand()%(64000 - 24600)  + 1;
       for(int i=0;i<64000;i++)
```

```
        for(int j=0;j<to;j++) {}
}
if(t.elapsedTime() <= seconds)
{
   cout<<"Received Frame : "<<frames[count]<<" ";
   if(delay)
   {
      cout<<"Duplicate";
      delay = false;
   }
   cout<<endl;
   count++;
}
else
{
   cout<<"---"<<endl;
   cout<<"Timeout"<<endl;
   timeout = true;
}
t.start();
if(rand()%2 || !timeout)
{
   int to = 24600 + rand()%(64000 - 24600)  + 1;
   for(int i=0;i<64000;i++)
      for(int j=0;j<to;j++) {}
   if(t.elapsedTime() > seconds )
   {
      cout<<"Delayed Ack"<<endl;
      count--;
```

```
            delay = true;
        }
        else if(!timeout)
            cout<<"Acknowledgement : "<<frames[count]-1<<endl;
    }
  }while(count!=10);
  return 0;
 }
```

Input and Output Section:

Sender has to send frames : 1 2 3 4 5 6 7 8 9 10

Sender	Receiver
Sending Frame : 1	---
Timeout	
Sending Frame : 1	Received Frame : 1
Acknowledgement : 1	
Sending Frame : 2	Received Frame : 2
Acknowledgement : 2	
Sending Frame : 3	Received Frame : 3
Acknowledgement : 3	
Sending Frame : 4	---
Timeout	
Sending Frame : 4	Received Frame : 4
Acknowledgement : 4	
Sending Frame : 5	---
Timeout	

Sending Frame : 5 Received Frame : 5

Acknowledgement : 5

Sending Frame : 6 Received Frame : 6

Acknowledgement : 6

Sending Frame : 7 Received Frame : 7

Delayed Ack

Sending Frame : 7 ---

Timeout

Sending Frame : 7 Received Frame : 7 Duplicate

Delayed Ack

Sending Frame : 7 Received Frame : 7 Duplicate

Acknowledgement : 7

Sending Frame : 8 Received Frame : 8

Delayed Ack

Sending Frame : 8 ---

Timeout

Sending Frame : 8 Received Frame : 8 Duplicate

Delayed Ack

Sending Frame : 8 Received Frame : 8 Duplicate

Delayed Ack

Sending Frame : 8 ---

Timeout

Sending Frame : 8 Received Frame : 8 Duplicate

Delayed Ack

Sending Frame : 8 Received Frame : 8 Duplicate

Delayed Ack

Sending Frame : 8 ---

Timeout

Sending Frame : 8 ---

Timeout

Sending Frame : 8 Received Frame : 8 Duplicate

Acknowledgement : 8

Sending Frame : 9 ---

Timeout

Sending Frame : 9 Received Frame : 9

Acknowledgement : 9

Sending Frame : 10 Received Frame : 10

Delayed Ack

Sending Frame : 10 Received Frame : 10 Duplicate

Delayed Ack

Sending Frame : 10 Received Frame : 10 Duplicate

Acknowledgement : 0

4. Simulate and implement go back n sliding window protocol.

Program:

```
#include<iostream>
#include<ctime>
#include<cstdlib>
using namespace std;
int main()
{
 int nf,N;
 int no_tr=0;
 srand(time(NULL));
 cout<<"Enter the number of frames : ";
```

```
cin>>nf;
cout<<"Enter the Window Size : ";
cin>>N;
int i=1;
while(i<=nf)
{
   int x=0;
   for(int j=i;j<i+N && j<=nf;j++)
   {
      cout<<"Sent Frame "<<j<<endl;
      no_tr++;
   }
   for(int j=i;j<i+N && j<=nf;j++)
   {
      int flag = rand()%2;
      if(!flag)
         {
            cout<<"Acknowledgment for Frame "<<j<<endl;
            x++;
         }
      else
         {   cout<<"Frame "<<j<<" Not Received"<<endl;
            cout<<"Retransmitting Window"<<endl;
            break;
         }
   }
   cout<<endl;
   i+=x;
}
```

```
 cout<<"Total number of transmissions : "<<no_tr<<endl;
 return 0;
}
```

Input and Output Section:

Enter the number of frames : 9

Enter the Window Size : 3

Sent Frame 1

Sent Frame 2

Sent Frame 3

Frame 1 Not Received

Retransmitting Window

Sent Frame 1

Sent Frame 2

Sent Frame 3

Frame 1 Not Received

Retransmitting Window

Sent Frame 1

Sent Frame 2

Sent Frame 3

Frame 1 Not Received

Retransmitting Window

Sent Frame 1

Sent Frame 2

Sent Frame 3

Frame 1 Not Received

Retransmitting Window

Sent Frame 1

Sent Frame 2

Sent Frame 3

Acknowledgment for Frame 1

Frame 2 Not Received

Retransmitting Window

Sent Frame 2

Sent Frame 3

Sent Frame 4

Acknowledgment for Frame 2

Frame 3 Not Received

Retransmitting Window

Sent Frame 3

Sent Frame 4

Sent Frame 5

Acknowledgment for Frame 3

Acknowledgment for Frame 4

Acknowledgment for Frame 5

Sent Frame 6

Sent Frame 7

Sent Frame 8

Acknowledgment for Frame 6

Frame 7 Not Received

Retransmitting Window

Sent Frame 7

Sent Frame 8

Sent Frame 9

Acknowledgment for Frame 7

Acknowledgment for Frame 8

Frame 9 Not Received

Retransmitting Window

Sent Frame 9

Acknowledgment for Frame 9

Total number of transmissions : 28

5. Simulate and implement selective repeat sliding window protocol.

Program:

```
#include<iostream>
using namespace std;
#include<conio.h>
#include<stdlib.h>
#include<time.h>
#include<math.h>
#define TOT_FRAMES 500
#define FRAMES_SEND 10
class sel_repeat
{
private:
int fr_send_at_instance;
int arr[TOT_FRAMES];
int send[FRAMES_SEND];
int rcvd[FRAMES_SEND];

char rcvd_ack[FRAMES_SEND];
int sw;
int rw;       //tells expected frame
public:
```

```
void input();
void sender(int);
void receiver(int);
};
void sel_repeat::input()
{
int n;     //no. of bits for the frame
int m;    //no. of frames from n bits
int i;
cout<<"Enter the no. of bits for the sequence no. : ";
cin>>n;
m=pow(2,n);
int t=0;
fr_send_at_instance=(m/2);
for(i=0;i<TOT_FRAMES;i++)
{
arr[i]=t;
t=(t+1)%m;
}

for(i=0;i<fr_send_at_instance;i++)
{
send[i]=arr[i];
rcvd[i]=arr[i];
rcvd_ack[i]='n';
}
rw=sw=fr_send_at_instance;
sender(m);
}
```

```
void sel_repeat::sender(int m)
{
for(int i=0;i<fr_send_at_instance;i++)
{
if(rcvd_ack[i]=='n')
cout<<"SENDER : Frame "<<send[i]<<" is sent\n";
}
receiver(m);
}
void sel_repeat::receiver(int m)
{
time_t t;
int f;
int j;
int f1;
int a1;
char ch;
srand((unsigned)time(&t));
for(int i=0;i<fr_send_at_instance;i++)
{
if(rcvd_ack[i]=='n')
{
f=rand()%10;
//if f=5 frame is discarded for some reason
//else frame is correctly recieved
if(f!=5)
{
for(int j=0;j<fr_send_at_instance;j++)
if(rcvd[j]==send[i])
```

```
{
cout<<"reciever:Frame"<<rcvd[j]<<"recieved correctly\n";
rcvd[j]=arr[rw];
rw=(rw+1)%m;
break;
}
int j;
if(j==fr_send_at_instance)
cout<<"reciever:Duplicate frame"<<send[i]<<"discarded\n";
a1=rand()%5;
//if al==3 then ack is lost
//else recieved
if(a1==3)
{
cout<<"(acknowledgement "<<send[i]<<" lost)\n";
cout<<"(sender timeouts-->Resend the frame)\n";
rcvd_ack[i]='n';
}
else
{
cout<<"(acknowledgement "<<send[i]<<" recieved)\n";
rcvd_ack[i]='p';
}
}
else
{int ld=rand()%2;
//if =0 then frame damaged
//else frame lost
if(ld==0)
```

```
{
cout<<"RECEIVER : Frame "<<send[i]<<" is damaged\n";
cout<<"RECEIVER : Negative Acknowledgement "<<send[i]<<" sent\n";
}
else
{
cout<<"RECEIVER : Frame "<<send[i]<<" is lost\n";
cout<<"(SENDER TIMEOUTS-->RESEND THE FRAME)\n";
}
rcvd_ack[i]='n';
}
}
}
for(int j=0;j<fr_send_at_instance;j++)
{
if(rcvd_ack[j]=='n')
break;
}
int i=0;
for(int k=j;k<fr_send_at_instance;k++)
{
send[i]=send[k];

if(rcvd_ack[k]=='n')
rcvd_ack[i]='n';
else
rcvd_ack[i]='p';
i++;
```

```
}
if(i!=fr_send_at_instance)
{
for(int k=i;k<fr_send_at_instance;k++)
{
send[k]=arr[sw];
sw=(sw+1)%m;
rcvd_ack[k]='n';
}
}
cout<<"Want to continue";
cin>>ch;
cout<<"\n";
if(ch=='y')
sender(m);
else
exit(0);

}
int main()
{
sel_repeat sr;
sr.input();
}
```

Input and Output Section

Enter the no. of bits for the sequence no. : 4

SENDER : Frame 0 is sent

SENDER : Frame 1 is sent

SENDER : Frame 2 is sent

SENDER : Frame 3 is sent

SENDER : Frame 4 is sent

SENDER : Frame 5 is sent

SENDER : Frame 6 is sent

SENDER : Frame 7 is sent

reciever:Frame0recieved correctly

(acknowledgement 0 recieved)

reciever:Frame1recieved correctly

(acknowledgement 1 recieved)

reciever:Frame2recieved correctly

(acknowledgement 2 recieved)

reciever:Frame3recieved correctly

(acknowledgement 3 recieved)

reciever:Frame4recieved correctly

(acknowledgement 4 lost)

(sender timeouts-->Resend the frame)

reciever:Frame5recieved correctly

(acknowledgement 5 lost)

(sender timeouts-->Resend the frame)

reciever:Frame6recieved correctly

(acknowledgement 6 recieved)

reciever:Frame7recieved correctly

(acknowledgement 7 recieved)

Want to continue n

6. Simulate and implement Hamming Code error correction.

Program:

```
#include<iostream>
#include<cmath>
#include<string>
using namespace std;
class Hamming

{

 string message;
 int codeword[50],temp[50];
 int n,check;
 char parity;
public:
Hamming()
 {
    parity = 'E';
    message = "";
    n=check=0;
    for(int i=0;i<50;i++)
    {
       temp[i]=codeword[i]=0;
```

```
    }
}

void generate()
{
    do
    {
        cout<<"Enter the message in binary : ";
        cin>>message;
    }while(message.find_first_not_of("01") != string::npos);
    n=message.size();
    cout<<"Odd(O)/Even(E) Parity ? ";
    cin>>parity;
    for(unsigned int i=0;i<message.size();i++)
    {
        if(message[i] == '1')
            temp[i+1]=1;
        else
            temp[i+1]=0;
    }
    computeCode();
}
 void computeCode()
{
    check = findr();
    cout<<"Number of Check Bits : "<<check<<endl;
    cout<<"Number of Bits in Codeword : "<<n+check<<endl;
    for(int i=(n+check),j=n;i>0;i--)
    {
```

```
        if((i & (i - 1)) != 0)
            codeword[i] = temp[j--];
        else
            codeword[i] = setParity(i);
    }
    cout<<"Parity Bits - ";
    for(int i=0;i<check;i++)
     cout<<"P"<<pow(2,i)<<" : "<<codeword[(int)pow(2,i)]<<"\t";
    cout<<endl;
    cout<<"Codeword :"<<endl;
    for(int i=1;i<=(n+check);i++)
       cout<<codeword[i]<<" ";
    cout<<endl;
}
 int findr()
{
    for(int i=1;;i++)
    {
        if(n+i+1 <= pow(2,i))
            return i;
    } }
 int setParity(int x)
{
    bool flag = true;
    int bit;
    if(x == 1)
    {
        bit = codeword[x+2];
        for(int j=x+3;j<=(n+check);j++)
```

```
        {
            if(j%2)
            {
                bit ^= codeword[j];
            }
        }
    }
    else
    {
        bit = codeword[x+1];
        for(int i=x;i<=(n+check);i++)
        {
            if(flag)
            {
                if(i==x || i==x+1)
                    bit = codeword[x+1];
                else
                    bit ^= codeword[i];
            }
            if((i+1)%x == 0)
                flag = !flag;
        }
    }
    if(parity == 'O' || parity == 'o')
        return !bit;
    else
        return bit;
}
    void correct()
```

```
{
   do
   {
      cout<<"Enter the received codeword : ";
      cin>>message;
   }while(message.find_first_not_of("01") != string::npos);
   for(unsigned int i=0;i<message.size();i++)
   {
      if(message[i] == '1')
         codeword[i+1]=1;
      else
         codeword[i+1]=0;
   }
   detect();
}
void detect()
{
   int position = 0;
   cout<<"Parity Bits - ";
   for(int i=0;i<check;i++)
   {
      bool flag = true;
      int x = pow(2,i);
      int bit = codeword[x];
      if(x == 1)
      {
         for(int j=x+1;j<=(n+check);j++)
         {
            if(j%2)
```

```
            {
                bit ^= codeword[j];
            }
        }
    }
    else
    {
        for(int k=x+1;k<=(n+check);k++)
        {
            if(flag)
            {
                bit ^= codeword[k];
            }
            if((k+1)%x == 0)
                flag = !flag;
        }
    }
    cout<<"P"<<x<<": "<<bit<<"\t";
    if((parity=='E' || parity == 'e') && bit==1)
        position += x;
    if((parity=='O' || parity == 'o') && bit==0)
        position += x;
}
cout<<endl<<"Received Codeword :"<<endl;
for(int i=1;i<=(n+check);i++)
    cout<<codeword[i]<<" ";
cout<<endl;
if(position != 0)
{
```

```
        cout<<"Error at bit : "<<position<<endl;
        codeword[position] = !codeword[position];
        cout<<"Corrected Codeword : "<<endl;
        for(int i=1;i<=(n+check);i++)
            cout<<codeword[i]<<" ";
        cout<<endl;
    }
    else
        cout<<"No Error in Received code."<<endl;
    cout<<"Received Message is : ";
    for(int i=1;i<=(n+check);i++)
        if((i & (i - 1)) != 0)
            cout<<codeword[i]<<" ";
    cout<<endl;
 }
};
 int main()
{
 char choice;
 do
 {
    Hamming a;
    cout<<"At Sender's side : "<<endl;
    a.generate();
    cout<<endl<<"At Receiver's Side : "<<endl;
    a.correct();
    cout<<endl<<"Enter another code ? (Y/N) : ";
    cin>>choice;
    cout<<endl;
```

```
 }while(choice == 'y' || choice == 'Y');
 return 0;
}
```

Input and Output Section:

At Sender's side :

Enter the message in binary : 1001101

Odd(O)/Even(E) Parity ? E

Number of Check Bits : 4

Number of Bits in Codeword : 11

Parity Bits - P1 : 0 P2 : 1 P4 : 1 P8 : 0

Codeword :

0 1 1 1 0 0 1 0 1 0 1

At Receiver's Side :

Enter the received codeword : 01110010101

Parity Bits - P1: 0 P2: 0 P4: 0 P8: 0

Received Codeword :

0 1 1 1 0 0 1 0 1 0 1

No Error in Received code.

Received Message is : 1 0 0 1 1 0 1

Enter another code ? (Y/N) : N

7. Simulate and implement distance vector routing algorithm.

Program:

```
#include<stdio.h>
#include<iostream>
using namespace std;
struct node
{
   unsigned dist[6];
   unsigned from[6];
}DVR[10];
int main()
{
   cout<<"\n\n PROGRAM TO IMPLEMENT DISTANCE VECTOR
ROUTING ALGORITHM ";
   int costmat[6][6];
   int nodes, i, j, k;
   cout<<"\n\n Enter the number of nodes : ";
   cin>>nodes; //Enter the nodes
   cout<<"\n Enter the cost matrix : \n" ;
   for(i = 0; i < nodes; i++)
    {
      for(j = 0; j < nodes; j++)
      {
         cin>>costmat[i][j];
         costmat[i][i] = 0;
         DVR[i].dist[j] = costmat[i][j]; //initialise the distance equal to cost
matrix
         DVR[i].from[j] = j;
```

```
        }
    }
        for(i = 0; i < nodes; i++) //We choose arbitary vertex k and we
calculate the
        //direct distance from the node i to k using the cost matrix and add
the distance from k to node j
        for(j = i+1; j < nodes; j++)
        for(k = 0; k < nodes; k++)
          if(DVR[i].dist[j] > costmat[i][k] + DVR[k].dist[j])
          {  //We calculate the minimum distance
            DVR[i].dist[j] = DVR[i].dist[k] + DVR[k].dist[j];
            DVR[j].dist[i] = DVR[i].dist[j];
            DVR[i].from[j] = k;
            DVR[j].from[i] = k;

          }
      for(i = 0; i < nodes; i++)
      {
        cout<<"\n\n For router: "<<i+1;
        for(j = 0; j < nodes; j++)
          cout<<"\t\n node "<<j+1<<" via "<<DVR[i].from[j]+1<<"
Distance "<<DVR[i].dist[j];
      }
   cout<<" \n\n ";
   return 0;
}
```

Input and Output Section:

PROGRAM TO IMPLEMENT DISTANCE VECTOR ROUTING ALGORITHM

Enter the number of nodes : 3

Enter the cost matrix :

0

2

7

2

0

1

7

1

0

For router: 1

node 1 via 1 Distance 0

node 2 via 2 Distance 2

node 3 via 2 Distance 3

For router: 2

node 1 via 1 Distance 2

node 2 via 2 Distance 0

node 3 via 3 Distance 1

For router: 3

node 1 via 2 Distance 3

node 2 via 2 Distance 1

node 3 via 3 Distance 0

8. Simulate and implement Dijkstra algorithm for shortest path routing.

Program:

```
#include<iostream>
#include<conio.h>
#include<stdio.h>
using namespace std;
int shortest(int ,int);
int cost[10][10],dist[20],i,j,n,k,m,S[20],v,totcost,path[20],p;
main()
{
int c;
cout <<"enter no of vertices";
cin >> n;
cout <<"enter no of edges";
```

```
cin >>m;
cout <<"\nenter\nEDGE Cost\n";
for(k=1;k<=m;k++)
{
cin >> i >> j >>c;
cost[i][j]=c;
}
for(i=1;i<=n;i++)
for(j=1;j<=n;j++)
if(cost[i][j]==0)
cost[i][j]=31999;
cout <<"enter initial vertex";
cin >>v;
cout << v<<"\n";
shortest(v,n);
 }

int shortest(int v,int n)
{
int min;
for(i=1;i<=n;i++)
{
S[i]=0;
dist[i]=cost[v][i];
}
path[++p]=v;
S[v]=1;
dist[v]=0;
for(i=2;i<=n-1;i++)
```

```
{
k=-1;
min=31999;
for(j=1;j<=n;j++)
{
if(dist[j]<min && S[j]!=1)
{
min=dist[j];
k=j;
}
}
if(cost[v][k]<=dist[k])
p=1;
path[++p]=k;
for(j=1;j<=p;j++)
cout<<path[j];
cout <<"\n";
//cout <<k;
S[k]=1;
for(j=1;j<=n;j++)
if(cost[k][j]!=31999 && dist[j]>=dist[k]+cost[k][j] && S[j]!=1)
 dist[j]=dist[k]+cost[k][j];
}
}
```

Input and Output Section:

enter no of vertices5

enter no of edges7

enter

EDGE Cost

1

2

10

1

3

2

1

5

100

2

4

3

3

25

5

4

5

5

4

3

15

enter initial vertex1

1

13

12

124

COSHMIN04P:
DATA STRUCTURES LABORATORY MANUAL

SL. No.	Experiments
1.	Write a program to search an element from a list. Give user the option to perform Linear or Binary search. Use Template functions.
2.	WAP using templates to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or Selection sort.
3.	Implement Linked List include functions for insertion, deletion and search of a number, reverse the list and concatenate two linked lists.
4.	Implement Circular Linked List include functions for insertion and deletion.
5.	Perform Stack operations using Linked List implementation.
6.	Perform Stack operations using Array implementation.
7.	Perform Queues operations using Circular Array implementation.
8.	WAP to scan a polynomial using linked list and add two polynomials.
9.	WAP to calculate factorial of a given no. (i) using recursion, (ii) using iteration.
10.	WAP to display Fibonacci series (i)using recursion, (ii) using iteration.
11.	WAP to calculate GCD of 2 number (i) with recursion (ii) without recursion.
12.	WAP to create a Binary Search Tree and include following operations in tree: (a) Insertion (Recursive and Iterative Implementation) (b) Deletion.
13.	WAP to create Binary Tree and display its pre-order, post-order and in-order traversals Recursively.
14.	WAP to create Binary Tree and display its pre-order, post-order and in-order traversals Iteratively.
15.	WAP to implement Diagonal Matrix using one-dimensional array.
16.	WAP to implement Lower Triangular Matrix using one-dimensional array.
17.	WAP to implement Upper Triangular Matrix using one-dimensional array.

1. ***Write a program to search an element from a list. Give user the option to perform Linear or Binary search. Use Template functions.***

Program:

```
#include<iostream>
#include<conio.h>
using namespace std;
//Linear Search Method using Template class
template <class T>
 T Linear_Search(T Iarr[],T key,int n){
    for(int i=0;i<n;i++){
       if(Iarr[i]==key){
          return i;
       }
    }
    return -1;
 }
 //Binary Search Method using Tempalte class
template <class T>
T Binary_Search(T *Iarr,T key,int n)
{
 int l,mid,h;
 l=0;
 h=n-1;
 while(l<=h)
 {
 mid=(l+h)/2;
 if(key==Iarr[mid])
    return mid;
 else if(key<Iarr[mid])
   h=mid-1;
 else
   l=mid+1;
 }
   return -1;
```

```
}
int main()
{
//Integer elements
 int Iarr[20],Ielement,i,no;
 cout<<"Enter the number of elements of Integer array: "<<endl;
 cin>>no;
 for(i=0;i<no;i++){
    cin>>Iarr[i];
 }
 cout<<"Elements of Integer Array "<<endl;
 for(i=0;i<no;i++)
 {
  cout<<Iarr[i]<<" ";
 }
 cout<<"\nEnter an item to be search using Linear_Search Method: ";
 cin>>Ielement;
 //Linear Search technique is used for Searching the Integer element
 int result=Linear_Search(Iarr,Ielement,no);
 if(result==-1){
    cout<<"Linear_Search Method Element not found in the list ";
 }
 else{
    cout<<"Linear_Search Method Element is found at position:
    "<<result<<endl;
 }
//Binary Search technique is used for Searching the Integer element
cout<<"\nEnter an item to be search using Binary_Search Method: ";
 cin>>Ielement;
result=Binary_Search(Iarr,Ielement,no);
if(result==-1){
    cout<<"Binary_Search Method Element not found in the list "<<endl;
 }
 else{
    cout<<"Binary_Search Method Element is found at position:
    "<<result<<endl;
 }
 //Float elements
 float  F_arr[10],F_element;
 cout<<"Enter the "<<no<<" elements of Float array: "<<endl;
 for(i=0;i<no;i++){
    cin>>F_arr[i];
 }
```

```
cout<<"\nElements of Float Array \n";
for(int i=0;i<no;i++)
{
 cout<<F_arr[i]<<" ";
}
//Linear Search technique is used for Searching the Floating element
cout<<"\nEnter an item to be search using Linear_Search Method: ";
cin>>F_element;
result=Linear_Search(F_arr,F_element,no);
if(result==-1){
   cout<<"Linear_Search Method Element not found in the list ";
}
else{
   cout<<"Linear_Search Method Element is found at position: "<<result;
}
//Binary Search technique is used for Searching the Floating element
cout<<"\nEnter an item to be search using Binary_Search Method: ";
cin>>F_element;
result=Binary_Search(F_arr,F_element,no);
if(result==-1){
   cout<<"Binary_Search Method Element not found in the list "<<endl;
}
else{
   cout<<"Binary_Search Method Element is found at position:
   "<<result<<endl;
}
//Character elements
char Carr[10]={'a','b','c','d','e','f','g','h','i','j'};
char Celement;
cout<<"Elements of Character Array "<<endl;
for(i=0;i<10;i++)
{
 cout<<Carr[i]<<" ";
}
//Linear Search technique is used for Searching the Character element
cout<<"\nEnter an item to be search using Linear_Search Method: ";
cin>>Celement;
result=Linear_Search(Carr,Celement,10);
if(result==-1){
   cout<<"Linear_Search Method Element not found in the list ";
}
else{
   cout<<"Linear_Search Method Element is found at position:
```

```
    "<<result<<endl;
 }
 //Binary search technique is used for Searching the Character element
 cout<<"\nEnter an item to be search using Binary_Search Method: ";
 cin>>Celement;
result=Binary_Search(Carr,Celement,10);
if(result==-1){
    cout<<"Binary_Search Method Element not found in the list "<<endl;
 }
 else{
    cout<<"Binary_Search Method Element is found at position:
    "<<result<<endl;
 }
 getch();
 return 0;
}
```

Input and Output Section:

Enter the number of elements of Integer array:
8
10 20 30 40 50 60 70 80
Elements of Integer Array
10 20 30 40 50 60 70 80
Enter an item to be search using Linear_Search Method: 20
Linear_Search Method Element is found at position: 1
Enter an item to be search using Binary_Search Method: 70
Binary_Search Method Element is found at position: 6
Enter the 8 elements of Float array:
1.1 2.3 4.5 6.4 6.55 7.1 7.11 2.1
Elements of Float Array
1.1 2.3 4.5 6.4 6.55 7.1 7.11 2.1
Enter an item to be search using Linear_Search Method: 2.1
Linear_Search Method Element is found at position: 7
Enter an item to be search using Binary_Search Method: 3.7
Binary_Search Method Element not found in the list
Elements of Character Array
a b c d e f g h i j
Enter an item to be search using Linear_Search Method: f
Linear_Search Method Element is found at position: 5
Enter an item to be search using Binary_Search Method: k
Binary_Search Method Element not found in the list

2. WAP using templates to sort a list of elements. Give user the option to perform sorting using Insertion sort, Bubble sort or Selection sort.

Program:

```
#include <iostream>
#include<conio.h>
using namespace std;
template <class T>
void swap(T *x,T *y)
{
   T temp=*x;
   *x=*y;
   *y=temp;
}
//Bubble sort Method using template class
template <class T>
void Bubble(T A[],int n)
{
 int i,j;
 for(i=0;i<n-1;i++)
 {
   for(j=0;j<n-i-1;j++)
   {
      if(A[j]>A[j+1]){
          swap(&A[j],&A[j+1]);
         }
    }
 }
}
//Insersion sort Method using Template class
template <class T>
void Insersion(T A[],int n)
{
 int i,j;
 T x;
 for(i=1;i<n;i++)
 {
   j=i-1;
   x=A[i];
      while(j>-1 && A[j]>x)
   {
      A[j+1]=A[j];
      j--;
```

```
    }
    A[j+1]=x;
 }
}
//Selection Sort Method using Template Class
template <class T>
void SelectionSort(T A[],int n)
{
 int i,j,k;
 for(i=0;i<n-1;i++)
 {
    for(j=k=i;j<n;j++)
    {
       if(A[j]<A[k])
        k=j;
    }
    swap(&A[i],&A[k]);
 }
}

int main()
{

    //Bubble sort technique is used for Integer type array
    int A[100],i,n;
    cout<<"Enter the how many integer elements to be sort using Bubble
sorting:"<<endl;
    cin>>n;
    cout<<"Elements of integer array are: "<<endl;
    for(i=0;i<n;i++){
       cin>>A[i];
    }
    cout<<"Before Bubble sorting the elements are: "<<endl;
    for(i=0;i<n;i++){
       cout<<A[i]<<" ";
    }
    Bubble(A,n);
    cout<<"\nAfter Bubble sorting the elements are: "<<endl;
    for(i=0;i<n;i++)
    printf("%d ",A[i]);
    printf("\n");
    //Bubble sort technique is used for Floating type array
    float B[100];
```

```
    cout<<"Enter the how many float elements to be sort using Bubble
sorting:"<<endl;
    cin>>n;
    cout<<"Elements of floating array are: "<<endl;
    for(i=0;i<n;i++){
       cin>>B[i];
    }
    cout<<"Before Bubble sorting the elements are: "<<endl;
    for(i=0;i<n;i++){
       cout<<B[i]<<" ";
    }
    Bubble(B,n);
    cout<<"\nAfter Bubble sorting the elements are: "<<endl;
    for(i=0;i<n;i++)
    printf("%f ",B[i]);
    printf("\n");

//Insersion sort technique is used for integer type array
    //int A[100],i,n;
    cout<<"Enter the how many integer elements to be sort using Insersion
sorting:"<<endl;
    cin>>n;
    cout<<"Elements of integer array are: "<<endl;
    for(i=0;i<n;i++){
       cin>>A[i];
    }
    cout<<"Before Insersion sorting the elements are: "<<endl;
    for(i=0;i<n;i++){
       cout<<A[i]<<" ";
    }
    Insersion(A,n);
    cout<<"\nAfter Insersion sorting the elements are: "<<endl;
    for(i=0;i<n;i++)
    printf("%d ",A[i]);
    printf("\n");
    //Insersion sort technique is used for Floating type array
    //float B[100];
    cout<<"Enter the how many float elements to be sort using Insersion
sorting:"<<endl;
    cin>>n;
    cout<<"Elements of floating array are: "<<endl;
    for(i=0;i<n;i++){
       cin>>B[i];
```

```
    }
    cout<<"Before Insersion sorting the elements are: "<<endl;
    for(i=0;i<n;i++){
       cout<<B[i]<<" ";
    }
    Insersion(B,n);
    cout<<"\nAfter Insersion sorting the elements are: "<<endl;
    for(i=0;i<n;i++)
    printf("%f ",B[i]);
    printf("\n");

//Selection sort technique is used for integer type array
    //int A[100],i,n;
    cout<<"Enter the how many integer elements to be sort using Selection
sorting:"<<endl;
    cin>>n;
    cout<<"Elements of integer array are: "<<endl;
    for(i=0;i<n;i++){
       cin>>A[i];
    }
    cout<<"Before Selection sorting the elements are: "<<endl;
    for(i=0;i<n;i++){
       cout<<A[i]<<" ";
    }
    SelectionSort(A,n);
    cout<<"\nAfter Selection sorting the elements are: "<<endl;
    for(i=0;i<n;i++)
    printf("%d ",A[i]);
    printf("\n");
    //Insersion sort technique is used for Floating type array
   // float B[100];
    cout<<"Enter the how many float elements to be sort using Selection
sorting:"<<endl;
    cin>>n;
    cout<<"Elements of floating array are: "<<endl;
    for(i=0;i<n;i++){
       cin>>B[i];
    }
    cout<<"Before Selection sorting the elements are: "<<endl;
    for(i=0;i<n;i++){
       cout<<B[i]<<" ";
    }
    SelectionSort(B,n);
```

```
    cout<<"\nAfter Selection sorting the elements are: "<<endl;
    for(i=0;i<n;i++)
    printf("%f ",B[i]);
    printf("\n");
    getch();
    return 0;
}
```

Input and Output Section:

```
Enter the how many integer elements to be sort using Bubble sorting:
5
Elements of integer array are:
10 23 09 11 15
Before Bubble sorting the elements are:
10 23 9 11 15
After Bubble sorting the elements are:
9 10 11 15 23
Enter the how many float elements to be sort using Bubble sorting:
5
Elements of floating array are:
9.1 2.3 4.5 1.1 2.9
Before Bubble sorting the elements are:
9.1 2.3 4.5 1.1 2.9
After Bubble sorting the elements are:
1.100000 2.300000 2.900000 4.500000 9.100000
Enter the how many integer elements to be sort using Insersion sorting:
6
Elements of integer array are:
19 24 10 11 14
23
Before Insersion sorting the elements are:
19 24 10 11 14 23
After Insersion sorting the elements are:
10 11 14 19 23 24
Enter the how many float elements to be sort using Insersion sorting:
3
Elements of floating array are:
2.3 1.2 .9
Before Insersion sorting the elements are:
2.3 1.2 0.9
After Insersion sorting the elements are:
0.900000 1.200000 2.300000
Enter the how many integer elements to be sort using Selection sorting:
```

```
10
Elements of integer array are:
10 20 50 30 21 35 44 9 99 102
Before Selection sorting the elements are:
10 20 50 30 21 35 44 9 99 102
After Selection sorting the elements are:
9 10 20 21 30 35 44 50 99 102
Enter the how many float elements to be sort using Selection sorting:
5
Elements of floating array are:
1.1 .9 .2 .99 1.234
Before Selection sorting the elements are:
1.1 0.9 0.2 0.99 1.234
After Selection sorting the elements are:
0.200000 0.900000 0.990000 1.100000 1.234000
```

3. Implement Linked List include functions for insertion, deletion and search of a number, reverse the list and concatenate two linked lists.

Insertion Operation using linked list:

Program:

```
    /* linked List Insertion */
#include <stdio.h>
#include <stdlib.h>
struct Node
{
 int data;
 struct Node *next;
}*first=NULL;

void create(int A[],int n)
{
 int i;
 struct Node *t,*last;
 first=(struct Node *)malloc(sizeof(struct Node));
 first->data=A[0];
 first->next=NULL;
 last=first;
```

```
 for(i=1;i<n;i++)
 {
   t=(struct Node*)malloc(sizeof(struct Node));
   t->data=A[i];
   t->next=NULL;
   last->next=t;
   last=t;
 }
}
int count(struct Node *p)
{
 int l=0;
 while(p)
 {
   l++;
   p=p->next;
 }
 return l;
}
void Display(struct Node *p)
{
 while(p!=NULL)
 {
   printf("%d ",p->data);
   p=p->next;
 }
}
void Insert(struct Node *p,int index,int x)
{
 struct Node *t;
 int i;

 if(index < 0 || index > count(p))
   return;
 t=(struct Node *)malloc(sizeof(struct Node));
 t->data=x;
 if(index == 0)
 {
   t->next=first;
   first=t;
 }
 else
 {
```

```
    for(i=0;i<index-1;i++)
    p=p->next;
    t->next=p->next;
    p->next=t;
 }
}
int main()
{

 //int A[]={10,20,30,40,50};
 //create(A,5);

//Insert Node
 printf("Node Insert: \n");
 Insert(first,0,5);
 Display(first);
 printf("\nNode Insert: \n");
 Insert(first,1,10);
 Display(first);
 //First Node Insert
 printf("\nFirst Node Insert: \n");
 Insert(first,0,15);
 Display(first);
 //Last Node Insert
 printf("\nLast Node Insert: \n");
 Insert(first,3,20);
 Display(first);
 //Any position Node Insert
 printf("\nGiven position Node Insert: \n");
 Insert(first,2,39);
 Display(first);
 return 0;
}
```

Input and Output Section:

```
Node Insert:
5
Node Insert:
5 10
First Node Insert:
15 5 10
Last Node Insert:
15 5 10 20
```

Given position Node Insert:
15 5 39 10 20

Deletion Operation using linked list

Program:

```
/* Linked List Delete element */
#include <stdio.h>
#include <stdlib.h>
struct Node
{
 int data;
 struct Node *next;
}*first=NULL;
void create(int A[],int n)
{
 int i;
 struct Node *t,*last;
 first=(struct Node *)malloc(sizeof(struct Node));
 first->data=A[0];
 first->next=NULL;
 last=first;
 for(i=1;i<n;i++)
 {
    t=(struct Node*)malloc(sizeof(struct Node));
    t->data=A[i];
    t->next=NULL;
    last->next=t;
    last=t;
 }
}
void Display(struct Node *p)
{
 while(p!=NULL)
 {
    printf("%d ",p->data);
    p=p->next;
 }
}
int count(struct Node *p)
{
 int l=0;
 while(p)
```

```
 {
   l++;
   p=p->next;
 }
 return l;
}
int Delete(struct Node *p,int index)
{
 struct Node *q=NULL;
 int x=-1,i;
 if(index < 1 || index > count(p))
   return -1;
 if(index==1)
 {
   q=first;
   x=first->data;
   first=first->next;
   free(q);
   return x;
 }
 else
 {
   for(i=0;i<index-1;i++)
   {
   q=p;
   p=p->next;
   }
   q->next=p->next;
   x=p->data;
   free(p);
   return x;
 }
}
int main()
{
 int i;
 int A[]={10,20,30,40,50};
 create(A,5);
 printf("Lined List element are: \n");
 Display(first);
 printf("\nDelete element %d\n",Delete(first,2));
 Display(first);
 printf("\nDelete element %d\n",Delete(first,1));
```

```
 Display(first);
 printf("\nDelete element %d\n",Delete(first,0));
 Display(first);
    return 0;
}
```

Input and Output Section:

Lined List element are:
10 20 30 40 50
Delete element 20
10 30 40 50
Delete element 10
30 40 50
Delete element -1
30 40 50

Search of a number using linked list

Program:

```
/*Searching of a number using Lined List */
#include <stdio.h>
#include <stdlib.h>
struct Node
{
 int data;
 struct Node *next;
}*first=NULL;
void create(int A[],int n)
{
 int i;
 struct Node *t,*last;
 first=(struct Node *)malloc(sizeof(struct Node));
 first->data=A[0];
 first->next=NULL;
 last=first;
 for(i=1;i<n;i++)
 {
   t=(struct Node*)malloc(sizeof(struct Node));
   t->data=A[i];
   t->next=NULL;
   last->next=t;
   last=t;
 }
}
```

```
struct Node * LSearch(struct Node *p,int key)
{
 while(p!=NULL)
 {
    if(key==p->data){
          return p;
    }
    else{
       p=p->next;
    }
 }
   return NULL;
}
struct Node * RSearch(struct Node *p,int key)
{
 if(p==NULL)
   return NULL;
 if(key==p->data)
   return p;
 return RSearch(p->next,key);

}
int main()
{
 struct Node *temp;
 int A[]={3,5,7,10,25,8,32,2},i;
 printf("Linked list elements are: \n");
 for(i=0;i<8;i++){
    printf(" %d ",A[i]);
 }
 //Recursive LinearSearch
 create(A,8);

 temp=RSearch(first,8);
 if(temp)
   printf("\nKey is Found* %d \n",temp->data);
else
   printf("Key is not Found: \n");
//Iterative LinearSearch
temp=LSearch(first,27);
if(temp)
   printf("\nKey is Found* %d \n",temp->data);
else
```

```
    printf("Key is not found: ");

 return 0;
}
```

Input and Output Section:

```
Linked list elements are:
 3  5  7  10  25  8  32  2
Key is Found* 8
Key is not found:
```

Reverse a linked list:

Program:

```
/* Reverse a Linked List */
#include <stdio.h>
#include <stdlib.h>
struct Node
{
 int data;
 struct Node *next;
}*first=NULL,*second=NULL,*third=NULL;
void Display(struct Node *p)
{
 while(p!=NULL)
 {
 printf("%d ",p->data);
 p=p->next;
 }
}
void create(int A[],int n)
{
 int i;
 struct Node *t,*last;
 first=(struct Node *)malloc(sizeof(struct Node));
 first->data=A[0];
 first->next=NULL;
 last=first;

 for(i=1;i<n;i++)
 {
 t=(struct Node*)malloc(sizeof(struct Node));
 t->data=A[i];
```

```
 t->next=NULL;
 last->next=t;
 last=t;
 }
}
int count(struct Node *p)
{
 int l=0;
 while(p)
 {
   l++;
   p=p->next;
 }
 return l;
}
void Reverse1(struct Node *p)
{
 int *A,i=0;
 struct Node *q=p;

 A=(int *)malloc(sizeof(int)*count(p));

 while(q!=NULL)
 {
 A[i]=q->data;
 q=q->next;
 i++;
 }
 q=p;
 i--;
 while(q!=NULL)
 {
 q->data=A[i];
 q=q->next;
 i--;
 }
}
void Reverse2(struct Node *p)
{
 struct Node *q=NULL,*r=NULL;

 while(p!=NULL)
 {
```

```
 r=q;
 q=p;
 p=p->next;
 q->next=r;
 }
 first=q;
}
void Reverse3(struct Node *q,struct Node *p)
{
 if(p)
 {
 Reverse3(p,p->next);
 p->next=q;
 }
 else
 first=q;
}

int main()
{

 int A[]={10,20,40,50,60};
 create(A,5);
 printf("Linked list elements are: \n");
 Display(first);

 Reverse3(NULL,first);
 printf("\nReverse Linked list elements are: \n");
 Display(first);

 return 0;
}
```

Input and Output Section:

Linked list elements are:
10 20 40 50 60
Reverse Linked list elements are:
60 50 40 20 10

Concatenate of two linked list:

Program:

```
/*Concatenate two Linked List*/
```

```
#include <stdio.h>
#include <stdlib.h>
struct Node
{
 int data;
 struct Node *next;
}*first=NULL,*second=NULL,*third=NULL;
void Display(struct Node *p)
{
 while(p!=NULL)
 {
 printf("%d ",p->data);
 p=p->next;
 }
}
void create(int A[],int n)
{
 int i;
 struct Node *t,*last;
 first=(struct Node *)malloc(sizeof(struct Node));
 first->data=A[0];
 first->next=NULL;
 last=first;

 for(i=1;i<n;i++)
 {
 t=(struct Node*)malloc(sizeof(struct Node));
 t->data=A[i];
 t->next=NULL;
 last->next=t;
 last=t;
 }
}
void create2(int A[],int n)
{
 int i;
 struct Node *t,*last;
 second=(struct Node *)malloc(sizeof(struct Node));
 second->data=A[0];
 second->next=NULL;
 last=second;

 for(i=1;i<n;i++)
```

```
 {
 t=(struct Node*)malloc(sizeof(struct Node));
 t->data=A[i];
 t->next=NULL;
 last->next=t;
 last=t;
 }
}
/*void Merge(struct Node *p,struct Node *q)
{
 struct Node *last;
 if(p->data < q->data)
 {
 third=last=p;
 p=p->next;
 third->next=NULL;
 }
 else
 {
 third=last=q;
 q=q->next;
 third->next=NULL;
 }
 while(p && q)
 {
 if(p->data < q->data)
 {
 last->next=p;
 last=p;
 p=p->next;
 last->next=NULL;

 }
 else
 {
 last->next=q;
 last=q;
 q=q->next;
 last->next=NULL;

 }
 }
 if(p)last->next=p;
```

```
 if(q)last->next=q;

}
*/
void Concat(struct Node *p,struct Node *q){
   third=p;
   while(p->next!=NULL){
      p=p->next;
   }
   p->next=q;

}
int main()
{

 int A[]={10,20,40,50,60};
 int B[]={15,18,25,30,55};
 create(A,5);
 create2(B,5);


 //Merge(frist,second);
 //Display(third);
 printf("First Linked List \n");
 Display(first);
 printf("\n");
 printf("Second Linked List \n");
 Display(second);
 printf("\n");
 Concat(first,second);
 printf("Concatenate two Linked List: \n");
 Display(third);
 printf("\n\n");
 return 0;
}
```

Input and Output Section:

First Linked List
10 20 40 50 60
Second Linked List
15 18 25 30 55
Concatenate two Linked List:
10 20 40 50 60 15 18 25 30 55

4. Implement Circular Linked List include functions for insertion and deletion.

Circular Linked List for Insertion Operation:

Program:

```
/*Circular Linked List*/
#include <stdio.h>
#include <stdlib.h>
#include<conio.h>
struct Node
{
 int data;
 struct Node *next;
}*Head;
void create(int A[],int n)
{
 int i;
 struct Node *t,*last;
 Head=(struct Node*)malloc(sizeof(struct Node));
 Head->data=A[0];
 Head->next=Head;
 last=Head;

 for(i=1;i<n;i++)
 {
   t=(struct Node*)malloc(sizeof(struct Node));
   t->data=A[i];
   t->next=last->next;
   last->next=t;
   last=t;
 }
}
void Display(struct Node *h)
{
 do
 {
   printf("%d ",h->data);
   h=h->next;
 }while(h!=Head);
   printf("\n");
}
```

```
/*void RDisplay(struct Node *h)
{
 static int flag=0;
 if(h!=Head || flag==0)
 {
 flag=1;
 printf("%d ",h->data);
 RDisplay(h->next);
 }
 flag=0;
}
*/
int Length(struct Node *p)
{
   int len=0;
 do
 {
   len++;
   p=p->next;

 }while(p!=Head);
   return len;
}
void Insert(struct Node *p,int index, int x)
{
 struct Node *t;
 int i;
 if(index<0 || index > Length(p))
 return;

 if(index==0)
 {
   t=(struct Node *)malloc(sizeof(struct Node));
   t->data=x;
   if(Head==NULL)
   {
      Head=t;
      Head->next=Head;
   }
 else
 {
   while(p->next!=Head)p=p->next;
   p->next=t;
```

```
    t->next=Head;
    Head=t;
  }
  }
  else
  {
    for(i=0;i<index-1;i++)p=p->next;
    t=(struct Node *)malloc(sizeof(struct Node));
    t->data=x;
    t->next=p->next;
    p->next=t;
  }
}

int main()
{
 int A[]={2,3,4,5,6};
 create(A,5);
 printf("Linked List are: \n");
 Display(Head);

//Insert Node
 printf("\nNode Insert: \n");
 Insert(Head,2,10);
 Display(Head);
 //First Node Insert
 printf("\nFirst Node Insert: \n");
 Insert(Head,0,15);
 Display(Head);
 //Last Node Insert
 printf("\nLast Node Insert: \n");
 Insert(Head,7,20);
 Display(Head);
 //Any position Node Insert
 printf("\nGiven position Node Insert: \n");
 Insert(Head,2,39);
 Display(Head);
getch();
return 0;
}
```

Input and Output Section:

Linked List are:

2 3 4 5 6

Node Insert:
2 3 10 4 5 6

First Node Insert:
15 2 3 10 4 5 6

Last Node Insert:
15 2 3 10 4 5 6 20

Given position Node Insert:
15 2 39 3 10 4 5 6 20

Circular Linked List for Deletion Operation:

Program:

```
/*Circular Linked List Deletion*/
#include <stdio.h>
#include <stdlib.h>
#include<conio.h>
struct Node
{
 int data;
 struct Node *next;
}*Head;
void create(int A[],int n)
{
 int i;
 struct Node *t,*last;
 Head=(struct Node*)malloc(sizeof(struct Node));
 Head->data=A[0];
 Head->next=Head;
 last=Head;
 for(i=1;i<n;i++)
 {
    t=(struct Node*)malloc(sizeof(struct Node));
    t->data=A[i];
    t->next=last->next;
    last->next=t;
    last=t;
 }
}
```

```
void Display(struct Node *h)
{
 do
 {
   printf("%d ",h->data);
   h=h->next;
 }while(h!=Head);
   printf("\n");
}
int Length(struct Node *p)
{
   int len=0;
 do
 {
   len++;
   p=p->next;

 }while(p!=Head);
   return len;
}

int Delete(struct Node *p,int index)
{
   struct Node *q;
   int i,x;

 if(index <0 || index >Length(Head))
   return -1;
 if(index==1)
 {
   while(p->next!=Head)p=p->next;
   x=Head->data;
 if(Head==p)
 {
   free(Head);
   Head=NULL;
 }
 else
 {
   p->next=Head->next;
   free(Head);
   Head=p->next;
   }
```

```
 }
 else
 {
   for(i=0;i<index-2;i++)
   p=p->next;
   q=p->next;
   p->next=q->next;
   x=q->data;
   free(q);
 }
 return x;
}
int main()
{
 int A[]={2,3,4,5,6,7,8,9,10};
 create(A,9);
 printf("Linked List are: \n");
 Display(Head);

 //First Node Delete
 printf("\nFirst Node Delete: \n");
 Delete(Head,1);
 Display(Head);

 //Last Node Delete
 printf("\nLast Node Delete: \n");
 Delete(Head,8);
 Display(Head);

 //Any position Node Insert
 printf("\nGiven position Node Delete: \n");
 Delete(Head,5);
 Display(Head);
 getch();
return 0;
}
```

Input and Output Section:

```
Linked List are:
2 3 4 5 6 7 8 9 10

First Node Delete:
3 4 5 6 7 8 9 10
```

Last Node Delete:
3 4 5 6 7 8 9

Given position Node Delete:
3 4 5 6 8 9

5. Perform Stack operations using Linked List implementation.

Program:

```
/*Stack using Linked List*/
#include <stdio.h>
#include <stdlib.h>
struct Node
{
 int data;
 struct Node *next;
}*top=NULL;

void push(int x)
{
 struct Node *t;
 t=(struct Node*)malloc(sizeof(struct Node));
 if(t==NULL)
    printf("stack is full\n");
 else
 {
    t->data=x;
    t->next=top;
    top=t;
 }
}

int pop()
{
 struct Node *t;
 int x=-1;
 if(top==NULL)
    printf("Stack is Empty\n");
 else
 {
    t=top;
    top=top->next;
```

```
    x=t->data;
    free(t);
 }
 return x;
}

void Display()
{
 struct Node *p;
 p=top;
 while(p!=NULL)
 {
    printf("%d ",p->data);
    p=p->next;
 }
 printf("\n");
}
int main()
{
// push the elements
printf("Push the elements are: \n");
//last elements top of the stack
 push(10);
 push(20);
 push(30);
 push(40);
 push(50);
 Display();

 printf("pop element %d \n",pop());
 printf("pop element %d %d ",pop(),pop()); //right to left operation
 return 0;
}
```

Input and Output Section:

Push the elements are:
50 40 30 20 10
pop element 50
pop element 30 40

6. Perform Stack operations using Array implementation.

Program:

```
/* Stack using Array */
#include <stdio.h>
#include <stdlib.h>
struct Stack
{
 int size;
 int top;
 int *S;
};
void create(struct Stack *st)
{
 printf("Enter Size ");
 scanf("%d",&st->size);
 st->top=-1;
 st->S=(int *)malloc(st->size*sizeof(int));
}
void Display(struct Stack st)
{
 int i;
 for(i=st.top;i>=0;i--)
    printf("%d ",st.S[i]);
 printf("\n");

}
void push(struct Stack *st,int x)
{
 if(st->top==st->size-1)
    printf("Stack overflow\n");
 else
 {
    st->top++;
    st->S[st->top]=x;
 }
}
int pop(struct Stack *st)
{
    int x=-1;
    if(st->top==-1)
        printf("Stack Underflow\n");
    else
    {
        x=st->S[st->top--];
    }
```

```
 return x;
}

int peek(struct Stack st,int index)
{
 int x=-1;
 if(st.top-index+1<0)
    printf("Invalid Index \n");
    x=st.S[st.top-index+1];
 return x;
}
int isEmpty(struct Stack st)
{
 if(st.top==-1)
    return 1;
 return 0;
}
int isFull(struct Stack st)
{
    return st.top==st.size-1;
}
int stackTop(struct Stack st)
{
    if(!isEmpty(st))
         return st.S[st.top];
 return -1;
}
int main()
{
 struct Stack st;
 create(&st);
 //push the elements into the Stack
 printf("Stack elements are: \n");
 push(&st,10);
 push(&st,20);
 push(&st,30);
 push(&st,40);
 push(&st,50);
 push(&st,60);
 //Stack overflow when Enter the size 5
 Display(st);
 //pop the elements from a Stack
 printf("pop element: %d \n",pop(&st));
```

```
 printf("After the pop operation Stack elements are: \n");
 Display(st);
 //Stack Underflow when more then 6 elements pop out
 //printf("pop element: %d %d %d %d %d
    %d\n",pop(&st),pop(&st),pop(&st),pop(&st),pop(&st),pop(&st));

 //Peek the element into the Stack
 printf("peek element: %d \n",peek(st,1));
 printf("After the peek operation Stack elements are: \n");
 Display(st);
 return 0;
}
```

Input and Output Section:

```
Enter Size 6
Stack elements are:
60 50 40 30 20 10
pop element: 60
After the pop operation Stack elements are:
50 40 30 20 10
peek element: 50
After the peek operation Stack elements are:
50 40 30 20 10

Enter Size 5
Stack elements are:
Stack overflow
50 40 30 20 10
pop element: 50
After the pop operation Stack elements are:
40 30 20 10
peek element: 40
After the peek operation Stack elements are:
40 30 20 10

Enter Size 6
Stack elements are:
60 50 40 30 20 10
pop element: 60
After the pop operation Stack elements are:
50 40 30 20 10
Stack Underflow
pop element: -1 10 20 30 40 50
```

Invalid Index
peek element: 0
After the peek operation Stack elements are:

7. Perform Queues operations using Circular Array implementation.

Program:

```
/* Queue Operation Using Circular Array Implementation*/
#include <stdio.h>
#include <stdlib.h>
struct Queue
{
 int size;
 int front;
 int rear;
 int *Q;
};
void create(struct Queue *q,int size)
{
 q->size=size;
 q->front=q->rear=0;
 q->Q=(int *)malloc(q->size*sizeof(int));
}
void enqueue(struct Queue *q,int x)
{
 if((q->rear+1)%q->size==q->front)
 printf("Queue is Full\n");
 else
 {
 q->rear=(q->rear+1)%q->size;
 q->Q[q->rear]=x;
 }
}
int dequeue(struct Queue *q)
{
 int x=-1;

 if(q->front==q->rear)
 printf("Queue is Empty\n");
 else
 {
 q->front=(q->front+1)%q->size;
 x=q->Q[q->front];
```

```
 }
 return x;
}
void Display(struct Queue q)
{
 int i=q.front+1;

 do
 {

 printf("%d ",q.Q[i]);
 i=(i+1)%q.size;
 }while(i!=(q.rear+1)%q.size);

 printf("\n");
}
int main()
{
 struct Queue q;
 create(&q,6);
 printf("\nQueue elements are: \n");
 //enqueue Operation
 enqueue(&q,10);
 enqueue(&q,20);
 enqueue(&q,30);
 enqueue(&q,40);
 enqueue(&q,50);
 //enqueue(&q,60);
 Display(q);
 //dequeue Operation
 printf("dequeue element: %d \n",dequeue(&q));
 printf("After dequeue Queue elements are: \n");
 Display(q);
 return 0;
}
```

Input and Output Section:

Queue elements are:
10 20 30 40 50
dequeue element: 10
After dequeue Queue elements are:
20 30 40 50

8. WAP to scan a polynomial using linked list and add two polynomials.

Program:

```
//Polynomial addition using linked list
# include <stdio.h>
# include <stdlib.h>
struct node
{
    float coef;
    int expo;
    struct node *link;
};

 int display(struct node *ptr)
{
    if(ptr==NULL)
    {
            printf("Empty\n");
            return 0;
    }
    while(ptr!=NULL)
    {
            printf("(%.1fx^%d) + ", ptr->coef,ptr->expo);
            ptr=ptr->link;
    }
    printf("\b\b \n"); // \b\b to erase the last + sign
}
struct node *insert(struct node *start,float co,int ex)
{
    struct node *ptr,*tmp;
    tmp= (struct node*)malloc(sizeof(struct node));
    tmp->coef=co;
    tmp->expo=ex;

    //list empty or exp greater than first one
    if(start==NULL || ex>start->expo)
    {
            tmp->link=start;
            start=tmp;
    }
    else
    {
            ptr=start;
```

```
            while(ptr->link!=NULL && ptr->link->expo>ex)
                ptr=ptr->link;
            tmp->link=ptr->link;
            ptr->link=tmp;
            if(ptr->link==NULL)  //item to be added in the end
                tmp->link=NULL;
    }
    return start;
}
struct node *enter(struct node *start)
{
    int i,n,ex;
    float co;
    printf("How many terms you want to enter : ");
    scanf("%d",&n);
    printf("Enter each term with coeff and exp\n");
    for(i=1;i<=n;i++)
    {
            scanf("%f %d",&co,&ex);
            start=insert(start,co,ex);
    }
    return start;
}
struct node *poly_add(struct node *p1,struct node *p2)
{
    struct node *p3_start,*p3,*tmp;
    p3_start=NULL;
    if(p1==NULL && p2==NULL)
            return p3_start;

    while(p1!=NULL && p2!=NULL )
    {
            tmp= (struct node*)malloc(sizeof(struct node));
            if(p3_start==NULL)
            {
                p3_start=tmp;
                p3=p3_start;
            }
            else
            {
                p3->link=tmp;
                p3=p3->link;
            }
```

```
        if(p1->expo > p2->expo)
        {
                tmp->coef=p1->coef;
                tmp->expo=p1->expo;
                p1=p1->link;
        }
        else
                if(p2->expo > p1->expo)
                {
                        tmp->coef=p2->coef;
                        tmp->expo=p2->expo;
                        p2=p2->link;
                }
                else
                        if(p1->expo == p2->expo)
                        {
                                tmp->coef=p1->coef + p2->coef;
                                tmp->expo=p1->expo;
                                p1=p1->link;
                                p2=p2->link;
                        }
}
while(p1!=NULL)
{
        tmp= (struct node*)malloc(sizeof(struct node));
        tmp->coef=p1->coef;
        tmp->expo=p1->expo;
        if (p3_start==NULL) /*poly 2 is empty*/
        {
                p3_start=tmp;
                p3=p3_start;
        }
        else
        {
                p3->link=tmp;
                p3=p3->link;
        }
        p1=p1->link;
}
while(p2!=NULL)
{
        tmp= (struct node*)malloc(sizeof(struct node));
        tmp->coef=p2->coef;
```

```
            tmp->expo=p2->expo;
            if (p3_start==NULL) /*poly 1 is empty*/
            {
                    p3_start=tmp;
                    p3=p3_start;
            }
            else
            {
                    p3->link=tmp;
                    p3=p3->link;
            }
            p2=p2->link;
}
    p3->link=NULL;
    return p3_start;
}
int main( )
{
    struct node *p1_start,*p2_start,*p3_start;
    p1_start=NULL;
    p2_start=NULL;
    p3_start=NULL;
    printf("Polynomial 1 :\n");
    p1_start=enter(p1_start);
    printf("Polynomial 2 :\n");
    p2_start=enter(p2_start);
    p3_start=poly_add(p1_start,p2_start);
    printf("Polynomial 1 is :  ");
    display(p1_start);
    printf("Polynomial 2 is :  ");
    display(p2_start);
    printf("Added polynomial is :  ");
    display(p3_start);
    return 0;
}
```

Input and Output Section:

```
Polynomial 1 :
How many terms you want to enter : 3
Enter each term with coeff and exp
1.2 5
2.5 4
4 3
```

```
Polynomial 2 :
How many terms you want to enter : 3
Enter each term with coeff and exp
2 6
1 2
1 0
Polynomial 1 is :  (1.2x^5) + (2.5x^4) + (4.0x^3)
Polynomial 2 is :  (2.0x^6) + (1.0x^2) + (1.0x^0)
Added polynomial is :  (2.0x^6) + (1.2x^5) + (2.5x^4) + (4.0x^3) + (1.0x^2)
+ (1.0x^0)
```

9. WAP to calculate factorial of a given no. (i) using recursion, (ii) using iteration.

Program:

```
#include <stdio.h>
#include<conio.h>
//Iterative function definition
long ifact(int n){
 long fact=1,i;
 for(i=1;i<=n;i++){
    fact=fact*i;
 }
 return fact;
}
//Recursion function definition
long rfact(int n){
   //base condition
   if(n<=1){
      return n;
   }
   // Recrsive Procedure
   else{
      return n*rfact(n-1);
   }
}
int main()
{
   int n;
   printf("Enter the number \n");
   scanf("%d",&n);
   //iterative function call
   printf("Iteration Method: %d Factorial is %ld",n,ifact(n));
```

```
    //recursion function call
    printf("\nRecursion Method: %d Factorial is %ld",n,rfact(n));
    getch();
    return 0;
}
```

Input and Output Section:

```
Enter the number
5
Iteration Method: 5 Factorial is 120
Recursion Method: 5 Factorial is 120
Enter the number
9
Iteration Method: 9 Factorial is 362880
Recursion Method: 9 Factorial is 362880
```

10. WAP to display Fibonacci series (i)using recursion, (ii) using iteration.

Program:

```
#include <stdio.h>
#include<conio.h>
//Iterative function definition
void ifib(int n){
    int a=0,b=1,c,i;
    if(n<1){
        printf("Fibonacci series : %d ",a);
    }
    else if(n==1){
        printf("Fibonacci series : %d %d ",a,b);
                }
        else{
            printf("Fibonacci series are: %d %d",a,b);
            for(i=2;i<=n;i++){
                c=a+b;
                a=b;
                b=c;

            printf(" %d",c);
            }
        }
    }
//Recursion function definition
```

```
int rfib(int n){
   int a=0,b=1;
//base condition
   if(n<=1){
      return n;
   }
//Recursive Procedure
   else{
      return rfib(n-2)+rfib(n-1);
   }
}
int main()
{
   int n,result;
   printf("Enter the number \n");
   scanf("%d",&n);
   //iterative function call
   ifib(n);
   //recursion function call
   result=rfib(n);
   printf("\nLast value of Fibonacci series %d",result);
   getch();
   return 0;
}
```

Input and Output Section:

```
Enter the number
13
Fibonacci series are: 0 1 1 2 3 5 8 13 21 34 55 89 144 233
Last value of Fibonacci series 233

Enter the number
10
Fibonacci series are: 0 1 1 2 3 5 8 13 21 34 55
Last value of Fibonacci series 55
```

11. WAP to calculate GCD of 2 number (i) with recursion (ii) without recursion.

Program:

```
#include <stdio.h>
#include<conio.h>
//Iterative function definition
```

```
int igcd(int n,int m){
   while(m!=n){
      if(m>n){
         m=m-n;
      }
      else{
         n=n-m;
      }
         }
return m;
   }
//Recursion function definition
int rgcd(int n,int m){
   //base condition
   if(n==m){
      return n;
   }
   // Recrsive Procedure
   if(m>n){
      return rgcd(m-n,n);
   }
      rgcd(m,n-m);
}
int main()
{
   int a,b;
   printf("Enter the two number \n");
   scanf("%d%d",&a,&b);
   //iterative function call
   printf("Iterative Method %d and %d GCD is %d ",a,b,igcd(a,b));
   //recursion function call
   printf("\nRecursion Method %d and %d GCD is %d",a,b,rgcd(a,b));
   getch();
   return 0;
}
```

Input and Output Section:

```
Enter the two number
13 117
Iterative Method 13 and 117 GCD is 13
Recursion Method 13 and 117 GCD is 13
Enter the two number
93 131
```

Iterative Method 93 and 131 GCD is 1
Recursion Method 93 and 131 GCD is 1

12. WAP to create a Binary Search Tree and include following operations in tree: (a) Insertion (Recursive and Iterative Implementation) (b) Deletion.

(a) Binary Search Tree Insertion Operation (Recursive and Iterative Implementation):

Program:

```
#include<stdio.h>
#include<stdlib.h>
#include<conio.h>
struct Node{
   struct Node *lchild;
   int data;
   struct Node *rchild;
}*root=NULL;
void Insert(int key)
{
   struct Node *t=root;
   struct Node *r,*p;
   if(root==NULL){
      p=(struct Node *)malloc(sizeof(struct Node));
      p->data=key;
      p->lchild=p->rchild=NULL;
      root=p;
      return ;
   }
   while(t!=NULL){
      r=t;
      if(key<t->data)
         t=t->lchild;
      else if(key>t->data)
         t=t->rchild;
      else
         return;
   }
      p=(struct Node *)malloc(sizeof(struct Node));
      p->data=key;
      p->lchild=p->rchild=NULL;
```

```
        if(key<r->data) r->lchild=p;
        else r->rchild=p;
}
    void Inorder(struct Node *p){
        if(p){
            Inorder(p->lchild);
            printf("%d ",p->data);
            Inorder(p->rchild);
        }
    }
struct Node * Search(int key){
    struct Node *t=root;
    while(t!=NULL){
        if(key==t->data)
            return t;
        else if(key<t->data)
            t=t->lchild;
        else
            t=t->rchild;
    }
    return NULL;
}

struct Node *RInsert(struct Node *p,int key){
    struct Node *t=NULL;
    if(p==NULL){
        t=(struct Node *)malloc(sizeof(struct Node));
        t->data=key;
        t->lchild=t->rchild=NULL;
        return t;
    }
        if(key<p->data)
            p->lchild=RInsert(p->lchild,key);
        else if(key>p->data)
            p->rchild=RInsert(p->rchild,key);

        return p;
}

int main(){
    struct Node *temp;
    printf("Iterative BST: \n");
    Insert(10);
```

```
    Insert(5);
    Insert(20);
    Insert(8);
    Insert(30);
    Inorder(root);
    printf("\n");

     temp=Search(30);
    if(temp!=NULL){
       printf("Element %d is Found \n",temp->data);
    }
    else
       printf("Element is not found \n");

    printf("Recursive BST: \n");
    root=RInsert(root,10);
    RInsert(root,5);
    RInsert(root,20);
    RInsert(root,8);
    RInsert(root,30);
    Inorder(root);
    printf("\n");
    temp=Search(20);
    if(temp!=NULL){
       printf("Element %d is Found \n",temp->data);
    }
    else
       printf("Element is not found \n");
    getch();
    return 0;
}
```

Input and Output Section:

Iterative BST:
5 8 10 20 30
Element 30 is Found
Recursive BST:
5 8 10 20 30
Element 20 is Found

(b) Binary Search Tree Deletion Operation (Recursive and Iterative Implementation):

Program:

```
#include<stdio.h>
#include<stdlib.h>
#include<conio.h>
struct Node{
   struct Node *lchild;
   int data;
   struct Node *rchild;
}*root=NULL;
void Insert(int key)
{
   struct Node *t=root;
   struct Node *r,*p;
   if(root==NULL){
      p=(struct Node *)malloc(sizeof(struct Node));
      p->data=key;
      p->lchild=p->rchild=NULL;
      root=p;
      return ;
   }
   while(t!=NULL){
      r=t;
      if(key<t->data)
         t=t->lchild;
      else if(key>t->data)
         t=t->rchild;
      else
         return;
   }
      p=(struct Node *)malloc(sizeof(struct Node));
      p->data=key;
      p->lchild=p->rchild=NULL;
      if(key<r->data) r->lchild=p;
      else r->rchild=p;
}
   void Inorder(struct Node *p){
      if(p){
         Inorder(p->lchild);
         printf("%d ",p->data);
         Inorder(p->rchild);
      }
   }
```

```
/*struct Node * Search(int key){
   struct Node *t=root;
   while(t!=NULL){
      if(key==t->data)
         return t;
      else if(key<t->data)
         t=t->lchild;
      else
         t=t->rchild;
   }
   return NULL;
}
*/
struct Node *RInsert(struct Node *p,int key){
   struct Node *t=NULL;
   if(p==NULL){
      t=(struct Node *)malloc(sizeof(struct Node));
      t->data=key;
      t->lchild=t->rchild=NULL;
      return t;
   }
      if(key<p->data)
         p->lchild=RInsert(p->lchild,key);
      else if(key>p->data)
         p->rchild=RInsert(p->rchild,key);

      return p;
}
int Height(struct Node *p){
   int x,y;
   if(p==NULL) return 0;
   x=Height(p->lchild);
   y=Height(p->rchild);
   return x>y?x+1:y+1;
}
struct Node *InSucc(struct Node *p){
   while(p && p->lchild!=NULL)
      p=p->lchild;
   return p;
}
struct Node *InPre(struct Node *p){
   while(p && p->rchild!=NULL)
      p=p->rchild;
```

```
    return p;
}
//BST Delete from a Element
struct Node *Delete(struct Node *p,int key){
    struct Node *q;
    if(p==NULL)
        return NULL;
    if(p->lchild==NULL && p->rchild==NULL){
        if(p==root)
            root=NULL;
        free(p);
            return NULL;
    }
    if(key<p->data)
        p->lchild=Delete(p->lchild,key);
    else if(key>p->data)
        p->rchild=Delete(p->rchild,key);
    else
        {
            if(Height(p->lchild)>Height(p->rchild)){
                q=InPre(p->lchild);
                p->data=q->data;
                p->lchild=Delete(p->lchild,q->data);
            }
            else{
                q=InSucc(p->rchild);
                p->data=q->data;
                p->rchild=Delete(p->rchild,q->data);
            }
        }
        return p;
}

int main(){

    printf("Iterative BST: \n");
    Insert(10);
    Insert(5);
    Insert(20);
    Insert(8);
    Insert(30);
    Inorder(root);
    printf("\nAfter Iterative BST Delete Element:  ");
```

```
    Delete(root,5);
    Inorder(root);
    printf("\n");


    printf("Recursive BST: \n");
    root=RInsert(root,10);
    RInsert(root,5);
    RInsert(root,20);
    RInsert(root,8);
    RInsert(root,30);
    Inorder(root);
    Delete(root,20);
    printf("\nAfter Recursive BST Delete Element:  ");
    Inorder(root);
    printf("\n");
    getch();
    return 0;
}
```

Input and Output Section:

Iterative BST:
5 8 10 20 30
After Iterative BST Delete Element: 8 10 20 30
Recursive BST:
5 8 10 20 30
After Recursive BST Delete Element: 5 8 10 30

13. WAP to create Binary Tree and display its pre-order, post-order and in-order traversals Recursively.

Program:

```
#include <stdio.h>
#include <stdlib.h>
#include "Queue.h"
#include<conio.h>
struct Node *root=NULL;
void Treecreate()
{
 struct Node *p,*t;
 int x;
 struct Queue q;
```

```
 create(&q,100);

 printf("Enter root value ");
 scanf("%d",&x);
 root=(struct Node *)malloc(sizeof(struct Node));
 root->data=x;
 root->lchild=root->rchild=NULL;
 enqueue(&q,root);

 while(!isEmpty(q))
 {
 p=dequeue(&q);
 printf("enter left child of %d ",p->data);
 scanf("%d",&x);
 if(x!=-1)
 {
 t=(struct Node *)malloc(sizeof(struct Node));
 t->data=x;
 t->lchild=t->rchild=NULL;
 p->lchild=t;
 enqueue(&q,t);
 }
 printf("enter right child of %d ",p->data);
 scanf("%d",&x);
 if(x!=-1)
 {
 t=(struct Node *)malloc(sizeof(struct
Node));
 t->data=x;
 t->lchild=t->rchild=NULL;
 p->rchild=t;
 enqueue(&q,t);
 }
 }
}
void Preorder(struct Node *p)
{
 if(p)
 {
 printf("%d ",p->data);
 Preorder(p->lchild);
 Preorder(p->rchild);
 }
```

```
}
void Inorder(struct Node *p)
{
 if(p)
 {
 Inorder(p->lchild);
 printf("%d ",p->data);
 Inorder(p->rchild);
 }
}
void Postorder(struct Node *p)
{
 if(p)
 {
 Postorder(p->lchild);
 Postorder(p->rchild);
 printf("%d ",p->data);
 }
}
int main()
{
 Treecreate();
 printf(" \nIn order ");
 Inorder(root);
 printf(" \nPre order ");
 Preorder(root);
 printf("\nPost Order ");
 Postorder(root);
 getch();
 return 0;
}
```

Queue Header File

```
#include<stdio.h>
#include<stdlib.h>
struct Node
{
 struct Node *lchild;
 int data;
 struct Node *rchild;
};
struct Queue
{
```

```
 int size;
 int front;
 int rear;
 struct Node **Q;
};
void create(struct Queue *q,int size)
{
 q->size=size;
 q->front=q->rear=0;
 q->Q=(struct Node **)malloc(q->size*sizeof(struct
Node *));
}
void enqueue(struct Queue *q,struct Node *x)
{
 if((q->rear+1)%q->size==q->front)
 printf("Queue is Full");
 else
 {
 q->rear=(q->rear+1)%q->size;
 q->Q[q->rear]=x;
 }
}
struct Node * dequeue(struct Queue *q)
{
 struct Node* x=NULL;

 if(q->front==q->rear)
 printf("Queue is Empty\n");
 else
 {
 q->front=(q->front+1)%q->size;
 x=q->Q[q->front];
 }
 return x;
}
int isEmpty(struct Queue q)
{
 return q.front==q.rear;
}
```

Input and Output Section:

Enter root value 10

```
enter left child of 10 20
enter right child of 10 30
enter left child of 20 40
enter right child of 20 50
enter left child of 30 60
enter right child of 30 70
enter left child of 40 80
enter right child of 40 90
enter left child of 50 -1
enter right child of 50 -1
enter left child of 60 -1
enter right child of 60 -1
enter left child of 70 -1
enter right child of 70 -1
enter left child of 80 -1
enter right child of 80 -1
enter left child of 90 -1
enter right child of 90 -1

In order 80 40 90 20 50 10 60 30 70
Pre order 10 20 40 80 90 50 30 60 70
Post Order 80 90 40 50 20 60 70 30 10
```

14. WAP to create Binary Tree and display its pre-order, post-order and in-order traversals Iteratively.

Program:

```
#include <stdio.h>
#include <stdlib.h>
#include "Stack.h"
#include "Queue.h"
#include<conio.h>
struct Node *root=NULL;
void Treecreate()
{
 struct Node *p,*t;
 int x;
 struct Queue q;
 create(&q,100);

 printf("Enter root value ");
 scanf("%d",&x);
 root=(struct Node *)malloc(sizeof(struct Node));
```

```
root->data=x;
root->lchild=root->rchild=NULL;
enqueue(&q,root);

while(!isEmpty(q))
{
p=dequeue(&q);
printf("enter left child of %d ",p->data);
scanf("%d",&x);
if(x!=-1)
{
t=(struct Node *)malloc(sizeof(struct Node));
t->data=x;
t->lchild=t->rchild=NULL;
p->lchild=t;
enqueue(&q,t);
}
printf("enter right child of %d ",p->data);
scanf("%d",&x);
if(x!=-1)
{
t=(struct Node *)malloc(sizeof(struct
Node));
t->data=x;
t->lchild=t->rchild=NULL;
p->rchild=t;
enqueue(&q,t);
}
}
}
void IPreorder(struct Node *p){
        struct Stack stk;
        Stackcreate(&stk,100);
        while(p || !isEmpty(stk))
        {
                if(p){
                        printf("%d ",p->data);
                        push(&stk,p);
                        p=p->lchild;
                }
                else{
                        p=pop(&stk);
                        p=p->rchild;
```

```
                }
        }
}
void IInorder(struct Node *p){
        struct Stack stk;
        Stackcreate(&stk,100);
        while(p || !isEmpty(stk))
        {
                if(p){

                        push(&stk,p);
                        p=p->lchild;
                }
                else{
                        p=pop(&stk);
                        printf("%d ",p->data);
                        p=p->rchild;
                }
        }
}

int main()
{
 Treecreate();
 printf(" \nIn order ");
 IInorder(root);
 printf(" \nPre order ");
 IPreorder(root);

 getch();
 return 0;
}
```

Stack Header File

```
#include <stdio.h>
#include <stdlib.h>
//#include "Queue.h"
struct Stack
{
 int size;
 int top;
 struct Node **S;
};
```

```
void Stackcreate(struct Stack *st,int size)
{
 st->size=size;
 st->top=-1;
 st->S=(struct Node **)malloc(st->size*sizeof(struct Node *));
}

void push(struct Stack *st,struct Node *x)
{
 if(st->top==st->size-1)
 printf("Stack overflow\n");
 else
 {
 st->top++;
 st->S[st->top]=x;
 }

}
struct Node *pop(struct Stack *st)
{
 struct Node *x=NULL;
 if(st->top==-1)
 printf("Stack Underflow\n");
 else
 {
 x=st->S[st->top--];
 }
 return x;
}

int isEmpty(struct Stack st)
{
 if(st.top==-1)
          return 1;
 return 0;
}
int isFull(struct Stack st)
{
 return st.top==st.size-1;
}
```

Input and Output Section:

```
Enter root value 10
enter left child of 10 20
```

```
enter right child of 10 30
enter left child of 20 40
enter right child of 20 50
enter left child of 30 60
enter right child of 30 70
enter left child of 40 -1
enter right child of 40 -1
enter left child of 50 -1
enter right child of 50 -1
enter left child of 60 -1
enter right child of 60 -1
enter left child of 70 -1
enter right child of 70 -1

In order 40 20 50 10 60 30 70
Pre order 10 20 40 50 30 60 70
```

15. WAP to implement Diagonal Matrix using one-dimensional array.

Program:

```
#include<stdio.h>
#include<conio.h>
struct Matrix
{
 int A[10];
 int n;
};
void Set(struct Matrix *m,int i,int j,int x)
{
 if(i==j)
 m->A[i-1]=x;

}
int Get(struct Matrix m,int i,int j)
{
 if(i==j)
 return m.A[i-1];
 else
 return 0;
}
void Display(struct Matrix m)
{
 int i,j;
```

```
 for(i=0;i<m.n;i++)
 {
   for(j=0;j<m.n;j++)
   {
   if(i==j)
      printf("%d ",m.A[i]);
   else
      printf("0 ");
 }
   printf("\n");
 }
}
int main()
{
//clrscr();
 struct Matrix m;
 m.n=4;

 Set(&m,1,1,5);
 Set(&m,2,2,8);
 Set(&m,3,3,9);
 Set(&m,4,4,12);
// printf("%d \n",Get(m,3,3));
 Display(m);
 getch();
 return 0;
}
```

Input and Output section:

```
5 0 0 0
0 8 0 0
0 0 9 0
0 0 0 12
```

16. WAP to implement Lower Triangular Matrix using one-dimensional array.

Program:

```
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
struct Matrix
{
 int *A;
 int n;
};
void Set(struct Matrix *m,int i,int j,int x)
{
 if(i>=j)
 m->A[m->n*(j-1)+(j-2)*(j-1)/2+i-j]=x;
}
int Get(struct Matrix m,int i,int j)
{
 if(i>=j)
 return m.A[m.n*(j-1)+(j-2)*(j-1)/2+i-j];
 else
 return 0;
}
void Display(struct Matrix m)
{
 int i,j;
 for(i=1;i<=m.n;i++)
 {
 for(j=1;j<=m.n;j++)
 {
 if(i>=j)
 printf("%d  ",m.A[m.n*(j-1)+(j-2)*(j-1)/2+i-j]);
 else
 printf("0   ");
 }
 printf("\n");
 }
}
int main()
{
 struct Matrix m;
 int i,j,x;
//clrscr();
 printf("Enter Dimension");
 scanf("%d",&m.n);
```

```
 m.A=(int *)malloc(m.n*(m.n+1)/2*sizeof(int));
 printf("enter all elements");
 for(i=1;i<=m.n;i++)
 {
 for(j=1;j<=m.n;j++)
 {
 scanf("%d",&x);
 Set(&m,i,j,x);
 }
 }
 printf("\n\n");
 Display(m);

getch();
 return 0;
}
```

Input and Output Section:

```
Enter Dimension
4
enter all elements
10 20 30 40
11 22 33 44
12 24 36 48
13 26 39 52

Lower Triangular Matrix are:
10   0    0   0
11  22   0    0
12  24  36   0
13  26  39  52
```

17. WAP to implement Upper Triangular Matrix using one-dimensional array.

Program:

```
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
struct Matrix
{
 int *A;
 int n;
```

```
};
void Set(struct Matrix *m,int i,int j,int x)
{
 if(i>=j)
 m->A[m->n*(j-1)+(j-2)*(j-1)/2+i-j]=x;
}
int Get(struct Matrix m,int i,int j)
{
 if(i>=j)
 return m.A[m.n*(j-1)+(j-2)*(j-1)/2+i-j];
 else
 return 0;
}
void Display(struct Matrix m)
{
 int i,j;
 for(i=1;i<=m.n;i++)
 {
 for(j=1;j<=m.n;j++)
 {
 if(i<=j)
 printf("%d  ",m.A[m.n*(i-1)+(i-2)*(i-1)/2+j-i]);
 else
 printf("0   ");
 }
 printf("\n");
 }
}
int main()
{
 struct Matrix m;
 int i,j,x;
//clrscr();
 printf("Enter Dimension");
 scanf("%d",&m.n);
 m.A=(int *)malloc(m.n*(m.n+1)/2*sizeof(int));
 printf("enter all elements");
 for(i=1;i<=m.n;i++)
 {
 for(j=1;j<=m.n;j++)
 {
 scanf("%d",&x);
 Set(&m,i,j,x);
```

```
 }
 }
 printf("\n");
 printf("Upper Triangular Matrix are: \n");
 Display(m);

getch();
 return 0;
}
```

Input and Output Section:

```
10 20 33 44
12 11 23 45
12 34 56 78
13 23 45 23

Upper Triangular Matrix are:
10  12  12  13
0   11  34  23
0   0   56  45
0   0   0   23
```