ANNAMALAI UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

B. E. COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

SEMESTER – III

DSCP309. DATA STRUCTURES AND ALGORITHMS LAB

LABORATORY MANUAL

(JULY 2022 – NOVEMBER 2022)

LAB INCHARGE:

Dr. S. PASUPATHY, Associate Professor

DSCP309. DATA STRUCTURES AND ALGORITHMS LAB

LIST OF EXERCISES

(The Exercises are to be done in C++)

CYCLE – 1

1. Write a program to create a Stack and perform insertion and deletion operations on it.
2. Write a program to create a List and perform operations such as insert, delete, update and reverse.
3. Write a program to create a Queue and perform operations such as insertion and deletion.
4. Using iteration and recursion concepts, Write programs for finding the element in the array using the Binary Search method.
5. Write a program and simulate various graph traversing techniques.
6. Write a program to implement Binary Search Tree.
7. Write a program to simulate Bubble Sort algorithm.

CYCLE – II

8. Write a program to implement separate chaining to handle collisions in hashing.
9. Write a program to implement Heaps.
10. Implement Quick Sort algorithm to illustrate Divide and Conquer method.
11. Using Dynamic Programming method implement Dijkstra's shortest path algorithm.
12. Write a program to simulate the n-Queens problem using back tracking approach.
13. Implement the selection Sort algorithm to illustrate greedy approach.

ADDITIONAL EXERCISES (Using modern tools)

1. One Dimensional Array Manipulation Using Numpy Package
2. Two Dimensional Array Manipulation Using NUMPY Package

LAB INCHARGE:

Dr. S. PASUPATHY, Associate Professor

DSCP309. Data Structures ad Algorithms Lab

Ex. No.01	**STACK**
Date:	

Aim:

To write a C++ program to create a Stack and perform insertion and deletion operations on it.

Procedure:

Member variables in the class Stack

size, top as integer
StackData as array of integer of size 100

Member functions in the class Stack

Stack() {top=-1;}	- Constructor to set top as -1
void SetSize(intn)	- To set the size of stack
void Push(intx)	- To insert value x in to the stack
int Pop(void)	- To remove a value from the stack
void Display(void)	- To display all elements of the stack

Algorithm

Stack()
1. Initialize top=–1.

void SetSize(int n)
1. Set the size of the Stack as n

void Push(int x)
1. Check whether the top is less than the size of the stack.
2. If true (there is space in the stack), then increment the top by one and place the new element in the position pointed to by top.
3. Otherwise, display "Stack overflow".

int Pop(void)
1. Check whether the top is greater than –1.
2. If true (there is an element) then, store the element present at the location pointed to by top in x and decrement the value of the pointer by one and return the value of x.
3. Otherwise, display "Stack underflow".

void Display(void)
1. Display the elements present in the locations pointed by top to location zero.
2. Otherwise, display "The Stack is empty".

int main()
1. Display menu to perform the operations on the Stack.
2. Get user choice and perform the corresponding operation.

Source Code:

```
//Stack Operations
#include<iostream.h>
// #include<conio.h>
class Stack
```

```
{
        int StackData[100], size, top;
        public:
                Stack()
                {
                        top=-1;
                }
                void SetSize(int n)
                {
                        size=n;
                }
                void Push(int x);
                int Pop(void);
                void Display(void);
};
void Stack::Push(int x)
{
        if(top>=size-1)
        {
                cout<<"\n\t\t Stack over flow...";
                // getch();
        }
        else
        {
                top++;
                StackData[top]=x;
                cout<<"\n\t\t"<<x<<" is pushed \n\n\n";
        }
}
int Stack::Pop(void)
{
        int x;
        if(top<=-1)
        {
                cout<<"\n\t\t Stack under flow";
                return -9999;
        }
        else
        {
                x=StackData[top];
                top--;
                return x;
        }
}
void Stack::Display(void)
{
        if(top>=0)
        {
```

```cpp
                cout<<"\n The elements in stack are: ";
                cout<<"\n~~~~~~~~~~~~~~~~~~~~~~~~~~~";
                for(int i=top;i>=0;i--)
                cout<<"\n\n DATA "<<i+1<<"="<<StackData[i];
                cout<<"\n\n\n\n Press any key to continue...";
        }
        else
        {
                cout<<"\n The Stack is empty.";
        }
}
int main()
{
        Stack S;
        // clrscr();
        int option, n;
        cout<<"\n Enter the size of stack [MAX=100] : ";
        cin>>n;
        S.SetSize(n); do
        {
                // clrscr();
                cout<<"\n\t\t Stack Operation";
                cout<<"\n\t\t ~~~~~~~~~~~~~~~~";
                cout<<"\n\t 1.PUSH\n\t2.POP\n\t3.DISPLAY\n\t4.EXIT";
                cout<<"\n\n Enter your option : ";
                cin>>option;
                int x, topvalue;
                switch(option)
                {
                        case 1:
                                cout<<"\n Enter a value to be pushed : ";
                                cin>>x;
                                S.Push(x);
                                S.Display();
                                break;
                        case 2:
                                topvalue=S.Pop();
                                if (topvalue!=-9999)
                                cout<<"\n\t\t The popped element is "<<topvalue;
                                S.Display();
                                break;
                        case 3:
                                S.Display();
                                break;
                        case 4:
                                cout<<"\n\n\t\t You are on EXIT...";
                                break;
                        default:
```

```
                    cout<<"\n\n\t Enter only1,2,3,4.";
                }
            // getch();
        }
    while(option!=4); return 0; }
```

Sample Input/Output:

Enter the size of stack [MAX=10] : 5

Stack Operation
~~~~~~~~~~~~~~
   1. PUSH
   2. POP
   3. DISPLAY
   4. EXIT
Enter your option : 1
Enter a value to be pushed : 5
5 is Pushed

The elements in stack are:
~~~~~~~~~~~~~~~~~
DATA1 =5
 Press any key to continue...

Stack Operation
~~~~~~~~~~~~~
   1. PUSH
   2. POP
   3. DISPLAY
   4. EXIT

Enter your option : 1
Enter a value to be pushed : 4
4 is Pushed

 The elements in stack are:
~~~~~~~~~~~~~~~~~~
 DATA2 =4
 DATA1 =5
Press any key to continue...

 Stack Operation
~~~~~~~~~~~~~
   1. PUSH
   2. POP
   3. DISPLAY
   4. EXIT
Enter your option : 1
Enter a value to be pushed : 3
3 is Pushed

The elements in stack are:
~~~~~~~~~~~~~~~~~
DATA 3 =3

DATA2 =4
DATA1 =5

Press any key to continue...

Stack Operation
~~~~~~~~~~~~~
1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 1
Enter a value to be pushed: 22
22 is Pushed

The elements in stack are:
~~~~~~~~~~~~~~~~
DATA4=22
DATA 3 =3
DATA2 =4
DATA1 =5

Press any key to continue...

Stack Operation
~~~~~~~~~~~~~
1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 1
Enter a value to be pushed: 11
11 is Pushed

The elements in stack are:
~~~~~~~~~~~~~~~~~
DATA5=11
DATA4=22
DATA 3 =3
DATA2 =4
DATA1 =5

Press any key to continue...

Stack Operation
~~~~~~~~~~~~~
1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 1
Stack over flow...

Press any key to continue...

Stack Operation

~~~~~~~~~~~~
1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 2
The popped element is 11.

The elements in stack are:
~~~~~~~~~~~~~~~~~

DATA4=22
DATA 3 =3
DATA2 =4
DATA1 =5

Press any key to continue...

Stack Operation
~~~~~~~~~~~~
1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 2
The popped element is 22.

The elements in stack are:
~~~~~~~~~~~~~~~~~

DATA 3 =3
DATA2 =4
DATA1 =5

Press any key to continue...

Stack Operation
~~~~~~~~~~~~
1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 2
The popped element is3.

The elements in stack are:
~~~~~~~~~~~~~~~~~

DATA2 =4
DATA1 =5

Press any key to continue...

Stack Operation
~~~~~~~~~~~~
1. PUSH
2. POP
3. DISPLAY

4. EXIT

Enter your option : 2

The popped element is4.

The elements in stack are:
~~~~~~~~~~~~~~

DATA1 =5

Press any key to continue...

Stack Operation
~~~~~~~~~~~

1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 2

The popped element is 5.

The Stack is empty.

Stack Operation
~~~~~~~~~~~~

1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 2

Stack under flow The Stack is empty.

Stack Operation
~~~~~~~~~~~~

1. PUSH
2. POP
3. DISPLAY
4. EXIT

Enter your option : 4

You are on EXIT...

Result:

Thus, a C++ program was written and executed to create a Stack data structure and perform the operations on stack.

Ex. No.02	
Date:	**LIST**

Aim:

   To write a C++ program to create a List and perform operations such as insert, delete, update and reverse.

Procedure:

Create user defined data type called node using structure in C++ with the following members
 data as integer
 link as a pointer to hold the address of the next node

Member variables in the class LinkedList

 Head as pointer to the node

Member functions in the LinkedList

LinkedList()	- Constructor to initialize Head as NULL
~LinkedList(){delete Head;}	- Destructor to release the memory of Head void
Append(int x);	- To add a node at the end of the linked list void
Add After(intloc,intx);	- To add a node after the specific location in the linked list
void AddAtBegin(intx);	- To add a node at the beginning of the linked list
void Display();	- To display all nodes of linked list
void Count();	- To count number of nodes in the linked list
void Delete(intx);	- To delete a node in the linked list
void Reverse();	- To reverse the linked list

Algorithm

LinkedList()
1. Initialize Head as NULL.

~LinkedList()
1. Release the memory allocated to Head.

void Append(int x)
1. Create a node temp and get the data in the data field of the temp node and next-address field of temp to hold NULL.
2. Make the next-address field of the last node to hold the address of the temp node.

void AddAfter(int loc,int x)
1. Create a node temp and get the data in the data field of the temp node and next-address field of temp to hold NULL.
2. After traversing N nodes in the list i.e., specified by loc, make the Nth node next-address field to hold the address of the temp node and then make the next-address field of the temp node to hold the address of the $(N+1)^{th}$ node.

void AddAtBegin(int x)
1. Create a node temp and get the data in the data field of the temp node and next-address field of temp to hold NULL.

Make the temp node as front node by making the next-address field of the temp node to hold the address of the front node of the list. [If there is no element already present in the list then, the list would have only this one element in the data field and NULL in the address field.]

void Display()

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1. Traverse the list from the first node to the last node by displaying the contents of its data field.

void Count()

1. Count the nodes by traversing the node one by one from the first node till the address field of the node contains NULL.

void Delete(int x)

1. Locate the node having the data x in its data field.
2. If the node to be deleted is present at the first location, then make the next (second) node as the first node by making the first node's next-address field to NULL and free the memory location of the deleted node.
3. If the node to be deleted is present as intermediate node (having previous node and next node in the list) then, make the previous node's next-address field to hold the address of the next node and free the memory location of the deleted node.
4. If the node to be deleted is present at the last in the list, then make the previous node address to hold the NULL value and free the memory location of the deleted node.
5. If the list consists of only one node then, make the list as Null and free the memory location of the deleted node.

void Reverse()

1. Set the node pointed to by the Head node as current node. Set prev, tmp nodes as NULL.
2. Traverse the list from the current node to the last node in the list (last node has NULL in the address field) and do the following:
    (i)   Save the current node's address field in temp.
    (ii)   Save the prev node in the current node's address field.
    (iii)   Set current node as prev node.
    (iv)   Set temp node as current node.
3. Set the node pointed to be previous node as Head node.

int main()

1. Display menu to perform linked list operations.
2. Get user choice and perform corresponding operation.

Source Code:

```
//Single Linked List
#include<iostream.h>
// #include<conio.h>
typedef struct node
{
        int data;
        struct node *link;
};
class LinkedList
{
        node *Head;
        public:
                LinkedList(){Head=NULL; }
                ~LinkedList(){delete Head;}
                void Append(int x);
                void AddAfter(int loc,int x);
```

```
                void AddAtBegin(int x);
                void Display();
                void Count();
                void Delete(int x);
                void Reverse();
};
void LinkedList::Append(int num)
{
        node *temp,*r; temp=Head;
        if(Head==NULL)
        {
                temp=new node;
                temp->data=num;
                temp->link=NULL;
                Head=temp;
        }
        else
        {
                while(temp->link!=NULL)
                temp=temp->link;
                r=new node;
                r->data=num;
                r->link=NULL;
                temp->link=r;
        }
}
void LinkedList::AddAfter(int loc,int num)
{
        node *temp,*r;
        int i;
        temp=Head;
        if(temp==NULL)
        {
                cout<<"\n\n\t\t There are less than "<<loc<<" elements in list.";
                return;
        }
        for(i=0;i<loc-1;i++)
        {
                if(temp==NULL)
                {
                        cout<<"\n\n\t\t There are less than "<<loc<<" elements in list.";
                        return;
                }
                temp=temp->link;
        }
        r=new node;
        r->data=num;
        r->link=temp->link;
```

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```cpp
      temp->link=r;

}
void LinkedList::AddAtBegin(int num)
{
      node *temp;
      temp = new node;
      temp->data=num;
      temp->link=Head;
      Head=temp;
}
void LinkedList::Display()
{
      cout<<"\n\n\n";
      node *temp=Head;
      while(temp!=NULL)
      {
              cout<<temp->data<<" --> ";
              temp=temp->link;
      }
      cout<<"NULL";
      // getch();
}
void LinkedList::Count()
{
      int c=0;
      node *temp=Head;
      while(temp!=NULL)
      {
              temp=temp->link;
              c++;
      }
      cout<<"\n\n\n\t\tCount = "<<c;
}
void LinkedList::Delete(int num)
{
      node *old,*temp;
      temp=Head;
      while(temp!=NULL)
      {
              if(temp->data==num)
              {
                      if(temp==Head)
                      {
                              Head=temp->link;
                              delete temp;
                              return;
                      }
```

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```
                    else
                    {
                            old->link=temp->link;
                            delete temp;
                            return;
                    }
            }
            else
            {
                    old=temp;
                    temp=temp->link;
            }
        }
        cout<<"\n\n\n\t\tThe data not found.";
}

void LinkedList::Reverse() {
    node *temp = NULL;
    node *prev = NULL;
    node *current = Head;
    while(current != NULL) {
        temp = current->link;
        current->link = prev;
        prev = current;
        current = temp;
    }
    Head = prev;
}

int main()
{
        LinkedList L; int choice,x,loc;
        do
        {
                // clrscr();
                cout<<"\n\t\t\t Singly Linked List";
                cout<<"\n\t\t\t~~~~~~~~~~~~~~~~~~~";
                cout<<"\n\t1. CREATE A NODE";
                cout<<"\n\t2.ADD AT THE BEGINING";
                cout<<"\n\t3. ADD AT END";
                cout<<"\n\t4. ADD AFTER A SPECIFIC LOCATION";
                cout<<"\n\t5. DISPLAY ";
                cout<<"\n\t6. COUNT NO OF NODES";
                cout<<"\n\t7. DELETE A SPECIFIED NODE";
                cout<<"\n\t8. REVERSE THE LIST";
                cout<<"\n\t9. EXIT";
                cout<<"\n\n\n Enter your choice : ";
                cin>>choice;
```

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```
switch(choice)
{
        case 1 :
                cout<<"\n Enter a value : ";
                cin>>x;
                L.Append(x);
                L.Display();
                break;
        case 2 :
                cout<<"\n Enter a value : ";
                cin>>x;
                L.AddAtBegin(x);
                L.Display();
                break;
        case 3 :
                cout<<"\n Enter a value : ";
                cin>>x;
                L.Append(x);
                L.Display();
                break;
        case 4 :
                cout<<"\n Enter the location : ";
                cin>>loc;
                cout<<"\n Enter a value : ";
                cin>>x;
                L.AddAfter(loc,x);
                L.Display();
                break;
        case 5 :
                L.Display();
                break;
        case 6 :
                L.Count();
                L.Display();
                break;
        case 7 :
                cout<<"\n Enter a value to delete : ";
                cin>>x;
                L.Delete(x);
                L.Display();
                break;
        case 8:
                cout<< "\n The list before reversal is: \n";
                L.Display();
                L.Reverse();
                cout<<"\n The reversed list is: \n";
                L.Display();
                break;
```

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```
                case 9 :
                        cout<<"\n\n\n\t\t You are on Exit . . . ";
                        // getch();
                        break;
            }
    }
    while(choice!=9);
    return 0;
}
```

Sample Input/Output:

Single Linked List

~~~~~~~~~~~~~

1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD AT END
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT

Enter your choice: 1

Enter a value : 1

1--> NULL

Single Linked List

~~~~~~~~~~~~~

1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD AT END
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT

Enter your choice: 2

Enter a value : 11

11-->1 -->NULL

Single Linked List

~~~~~~~~~~~~~

1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD AT END
4. ADD AFTER A SPECIFICLOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT

Enter your choice : 3

Enter a value : 33

11-->1 -->33--> NULL

Single Linked List

~~~~~~~~~~~~~

1. CREATE A NODE
2. ADD AT THE BEGINING

3. ADD AT END
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT
Enter your choice: 4
Enter thelocation: 2
Enter a value : 23
11-->1 -->23-->33--> NULL

Single Linked List
~~~~~~~~~~~~
1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD AT END
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT
Enter your choice : 5
11--> 1-->23-->33--> NULL

Single Linked List
~~~~~~~~~~~~
1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD ATEND
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT
Enter your choice : 6
Count = 4
11-->1 -->23-->33--> NULL

Single Linked List
~~~~~~~~~~~~
1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD ATEND
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE

8. REVERSE THE LIST
9. EXIT
Enter your choice : 7
Enter a value to delete: 23
11--> 1-->33--> NULL

Single Linked List
~~~~~~~~~~~~
1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD AT END
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT
Enter your choice : 8
The list before reversal is:
11--> 1-->33--> NULL
The reversed list is:
33--> 1-->11--> NULL

Singly Linked List
~~~~~~~~~~~~~
1. CREATE A NODE
2. ADD AT THE BEGINING
3. ADD AT END
4. ADD AFTER A SPECIFIC LOCATION
5. DISPLAY
6. COUNT NO OF NODES
7. DELETE A SPECIFIED NODE
8. REVERSE THE LIST
9. EXIT
Enter your choice : 9
You are on Exit . . .

Result:
Thus, a C++ program was written and executed to create a list and perform operations on the list.

DSCP309. Data Structures ad Algorithms Lab

Ex. No.03	**QUEUE**
Date:	

Aim:

To write a C++ program to create a queue and perform operations on the queue.

Procedure:

Member variables in the class Queue

size, front, rear as integer

QueueData as array of integer of size 100

Member functions in the class Queue

Queue()	- Constructor to set front and rear as 0
void SetSize(intn)	- To set the size of queue
void Enque(int);	- To insert value x in to queue
int Deque(void);	- To remove a value from queue
void View(void);	- To display all elements of queue

Algorithm

Queue()

1. Initialize the front and rear to 0.

void SetSize(int n)

1. Set the size of the Queue as n.

void Enque(int x)

1. Check whether there is any space for new element to be added.
2. If there is any space then, place the new element in the position pointed by rear and increment the rear by one.
3. Otherwise, display "Queue is overflow".

int Deque(void)

1. Check whether there is any element present in the queue.
2. If there is an element then, store the element present at the location pointed by front in x and increment the front by one and return the value of x.
3. Otherwise, display "Queue is underflow".

void Display(void)

1. If there is element, then Display the elements present in the locations pointed by front to rear.
2. Otherwise, display "Queue is empty".

int main()

1. Display menu to perform queue operations.
2. Get user choice and perform corresponding operation.

Source Code:

```
//Queue Operation
#include<iostream.h>
// #include<conio.h>
class Queue
{
    int QueueData[100],size,front,rear;
```

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```
        public:
                Queue()
                {
                        front=0;
                        rear=0;
                }
                void SetSize(int n)
                {
                        size=n;
                }
                void Enque(int);
                int Deque(void);
                void View(void);
};
void Queue::Enque(int x)
{
        if((rear-front+1)>size)
        {
                cout<<"\n\t\t Queue over flow...";
        }
        else
        {
                QueueData[rear]=x;
                cout<<"\n\t\t"<<x<<" is added.\n";
                rear++;
        }
}
int Queue::Deque(void)
{
        int x;
        if(front>=rear)
        {
                cout<<"\n\t\t Queue  under flow...";
                return -9999;
        }
        else
        {
                x=QueueData[front];
                front++;
                return x;
        }
}
void Queue::View()
{
        int i=front,j=rear;
        if(i>=j)
```

```
                {
                        cout<<"\n\t\t Queue is empty...";
                }
                else
                {
                        cout<<"\n\n\t Data in Queue:";
                        for(;i<=j-1;i++)
                        cout<<" "<<QueueData[i] << ", ";
                }
        }
        int main()
        {
                // clrscr();
                int n;
                cout<<"\n Enter the size of Queue[MAX=100] : ";
                cin>>n;
                Queue Q;
                Q.SetSize(n);
                int choice;
                do
                {
                        // clrscr();
                        cout<<"\n\t\t Queue Operation";
                        cout<<"\n\t\t ~~~~~~~~~~~~~~~~~"; cout<<"\n\n\t
                        1.INSERT\n\t2.DELETE\n\t3.VIEW\n\t4.EXIT";
                        cout<<"\n\n Enter your choice : ";
                        cin>>choice;
                        int x;
                        switch(choice)
                        {
                                case 1:
                                        cout<<"\n Enter a value : ";
                                        cin>>x;
                                        Q.Enque(x);
                                        Q.View(); break;
                                case 2:
                                        x=Q.Deque();
                                        if (x!=-9999)
                                        cout<<"\n\n\t"<<x<<" is deleted.\n\n";
                                        Q.View();
                                        break;
                                case 3:
                                        Q.View();
                                        break;
                                case 4:
                                        cout<<"\n\n\t\t Exit...";
                                        break;
                        }
```

```
        // getch();
    }
    while(choice!=4);
    return 0;
}
```

Sample Input/Output:

Enter The size of Queue [MAX=100] : 3

Queue Operation
~~~~~~~~~~~~
      1. INSERT
      2. DELETE
      3. VIEW
      4. EXIT
Enter your choice: 1
Enter a value: 11
11 is added.
Data in Queue : 11

Queue Operation
~~~~~~~~~~~~
      1. INSERT
      2. DELETE
      3. VIEW
      4. EXIT
Enter your choice: 1
Enter a value: 22
22 is added.
Data in Queue : 11 22

Queue Operation
~~~~~~~~~~~~
      1. INSERT
      2. DELETE
      3. VIEW
      4. EXIT
Enter your choice: 1
Enter a value : 33
33 is added.
Data in Queue : 11 22 33

Queue Operation
~~~~~~~~~~~~
      1. INSERT
      2. DELETE
      3. VIEW
      4. EXIT
Enter your choice : 1
Queue over flow...
Data in Queue : 11 22 33

Queue Operation
~~~~~~~~~~~~
      1. INSERT
      2. DELETE
      3. VIEW
      4. EXIT

Enter your choice : 3
Data in Queue : 11 22 33

  Queue Operation
  ~~~~~~~~~~~~~
        1. INSERT
        2. DELETE
        3. VIEW
        4. EXIT
  Enter your choice: 2
  11 is deleted.
  Data in Queue : 22 33

  Queue Operation
  ~~~~~~~~~~~~~
        1. INSERT
        2. DELETE
        3. VIEW
        4. EXIT
Enter your choice: 2
22 is deleted.
Data in Queue : 33

  Queue Operation
  ~~~~~~~~~~~~~
        1. INSERT
        2. DELETE
        3. VIEW
        4. EXIT
Enter your choice: 2
33 is deleted.
Queue is empty...

  Queue Operation
  ~~~~~~~~~~~~~
        1. INSERT
        2. DELETE
        3. VIEW
        4. EXIT
Enter your choice: 2
Queue under flow... Queue is empty…

  Queue Operation
  ~~~~~~~~~~~~~
        1. INSERT
        2. DELETE
        3. VIEW
        4. EXIT
  Enter your choice : 4

  Exit...

Result:
        Thus, a C++ program was written and executed to create a queue and perform operations
on queue.

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Ex. No.04 (A)	**BINARY SEARCH (Iteration)**
Date:	

Aim:

To write a C++ program with iterative loop to search an element from the given list using binary search technique.

Procedure:

Member variables in the class Binary

n and key as integer

a as array of integer of size100

Member functions in the class Binary

void GetData(void)	- To get the input from user
void Sort(void)	- To sort the input in ascending order
void Display(void)	- To display all elements of the list
void BinarySearch(void)	-To search the key in the given array a using binary search technique

Algorithm

void GetData(void)

1. Get the list of numbers.
2. Get the Key value to be searched.

void Sort(void)

1. for i=0 to n-1 do step2
2. for j=i+1 to n do step3
3. if(a[i]>a[j]) exchange a[i] and a[j]

void Display(void)

1. Display elements of the list one by one.

void BinarySearch(void)

1. Assign:

high= total number of elements in the list-1. low=0.

2. Until low <= high repeat the following steps,
   a. mid= (high +low)/2.
   b. Check the key value with the value present at the middle index position of the sorted list.
   c. If present, display its position in the list and stop the process.
   d. Else if key value < the value present in the middle position, then
         high=mid+1;
   e. Else if key value > the value present in the middle position, then
         low=mid+1;
3. Display "The key value is not present in the list".

int main()

1. Create an object B of class Binary.
2. Call member function GetData() of object B.
3. Call member function Sort() of object B.
4. Call member function Display() of object B.
5. Call member function BinarySearch() of object B.

Source Code:

```cpp
// Binary Search
#include <iostream.h>
#include <conio.h>
class Binary
{
        int a[100],n,key;
        public:
                void GetData(void);
                void Sort(void);
                void Display(void);
                void BinarySearch(void);
};
void Binary::GetData(void)
{
        cout<<"\nEnter the size of the list to be searched : ";
         cin>>n;
        cout<<"\nEnter the elements of the list :";
         for(int i=0;i<n;i++)
        {
                cin>>a[i];
        }
        cout<<"Enter the key value to be searched in the above list : ";
        cin>>key;
}
void Binary::Sort(void)
{
        for(int i=0;i<n-1;i++)
        for(int j=i+1;j<n;j++)
        {
                if(a[i]>a[j])
                {
                        int temp=a[i];
                        a[i]=a[j];
                        a[j]=temp;
                }
        }
}
void Binary::Display(void)
{
        for(int i=0;i<n;i++)
        cout<<" Element"<< i+1<<"is"<< a[i]<<endl;
}
void Binary::BinarySearch(void)
{
        int high,low,mid;
        high=n-1;
        low=0;
```

```cpp
        while (low<=high)
        {
                mid=(low+high)/2;
                if(a[mid]==key)
                {
                        cout<<"\n The key value"<< key <<"is present at location "<<mid+1;
                        return;
                }
        else if (key<a[mid])
        {
                high=mid-1;
        }
         else
        {
                low=mid+1;
        }
    }
    cout<<"\n The key value "<< key<<" is not present in the above list";
}
int main()
{
        Binary B;
        // clrscr();
        B.GetData();
        B.Sort();
        cout<<"\n The Sorted List \n";
        cout<<"          \n";
        B.Display();
        B.BinarySearch();
        // getch();
        return 0;
}
```

Sample Input/Output:

Enter the size of the list to be searched: 11
Enter the elements of the list.: -12 2 3 1 -15 3 52 4 4 66 -11
Enter the key value to be searched in the above list: 3
The Sorted List

 Element 1 is -15.
 Element 2 is -12.
 Element 3 is -11.
 Element 4 is 1.
 Element 5 is 2.
 Element 6 is 3.
 Element 7 is 4.
 Element 8 is 4.
 Element 9 is 5.
 Element 10 is 23.
 Element 11 is 66.
 The key value 3 is present at location 6.

Result:

        Thus, a C++ program to search a key element from the given list by binary search technique was written, executed and output was verified.

Ex. No.04 (B)	**BINARY SEARCH (Recursion)**
Date:	

Aim:

      To write a C++ program with recursion to search an element from the given list using binary search technique.

Procedure:

Member variables in the class Binary

      n and key as integer

      a as array of integer of size100

Member functions in the class Binary

int GetData(void)	- To get the input from user and return the number of elements in the list
void Sort(void)	- To sort the input in ascending order
void Display(void)	- To display all elements of the list
void RecursiveBsearch(int, int)	-To search the key in the given array a using recursive binary search

Algorithm

int GetData(void)

1. Get the list of numbers.
2. Get the Key value to be searched.
3. Return the number of elements in the list.

void Sort(void)

1. for i=0 to n-1 do step 2
2. for j=i+1 to n do step 3
3. if(a[i]>a[j]) exchange a[i] and a[j]

void Display(void)

1. Display elements of the list one by one.

int RecursiveBsearch(int start, int end)

1. If start > end, then return -1, since element is not found.

2. Else do the following:

    (i)   Find the position of middle element as mid= (start +end)/2

    (ii)   If middle element is equal to the key, then return the position of middle element.

    (iii)   Else if key is lesser than middle element, then search only the lower (left) half of the list by calling the function recursively as RecursiveBsearch(start, mid-1)

    (iv)   Else if key is greater than middle element, then search only the upper (right) half of the list by calling the function recursively as RecursiveBsearch(mid+1, end)

int main()

1. Create an object B of class Binary.
2. Call member function GetData() of object B.
3. Call member function Sort() of object B.
4. Call member function Display() of object B.

5. Call member function RecursiveBsearch(0,N-1) of object B.

SOURCE CODE:

```
#include <iostream.h>

#include <conio.h>

class Binary

{

int a[100],n,key;

public:

int GetData(void);

void Sort(void);

void Display(void);

int RecursiveBsearch(int, int);

};

int Binary::GetData(void)

{

cout<<"\nEnter the size of the list to be searched : ";

cin>>n;

cout<<"\n Enter the elements of the list : ";

 for(int i=0;i<n;i++)

{

cin>>a[i];

}

cout<<"Enter the key value to be searched in the above list :  ";

cin>>key;

return(n);

}

void Binary::Sort(void)
```

```
{
for(int i=0;i<n-1;i++)
for(int j=i+1;j<n;j++)
{
if(a[i]>a[j])
{
int temp=a[i];
a[i]=a[j];
a[j]=temp;
}
}
}
void Binary::Display(void)
{
for(int i=0;i<n;i++)
cout<<" Element "<< i+1<<"is "<< a[i]<<"\n";
}
int Binary::RecursiveBsearch(int start, int end) {
 if(start>end) return -1;
    int mid = (start+end)/2;
  if( a[mid] == key ) return mid;
  else if( key < a[mid] )
    RecursiveBsearch(start, mid-1);
  else
    RecursiveBsearch(mid+1, end);
}
int main()
```

```
{

Binary B;

int index = -1, N;

// clrscr();

N=B.GetData();

B.Sort();

cout<<"\n The Sorted List \n";

cout<<"\n";

B.Display();

index=B.RecursiveBsearch(0,N-1);

if (index>=0)

    cout<<"\n The key value is present at location "<<index+1;

else

    cout<<"\n The key value is not present in the list";

// getch();

return 0;

}
```

Sample Input/Output:

Enter the size of the list to be searched: 11
Enter the elements of the list.: -12 2 3 1 -15 3 52 4 4 66 -11
Enter the key value to be searched in the above list: 3
The Sorted List

 Element 1 is -15.
 Element 2 is -12.
 Element 3 is -11.
 Element 4 is 1.
 Element 5 is 2.
 Element 6 is 3.
 Element 7 is 4.
 Element 8 is 4.
 Element 9 is 5.
 Element 10 is 23.
 Element 11 is 66.
 The key value is present at location 6.

Ex. No.05 (a)	**Graph Traversal (Depth First Search)**
Date:	

Aim:

      To write a program to traverse a graph using Depth First Search (DFS) algorithm.

Procedure:

Member variables in the class Graph

      n and s as integer

      a as two dimensional array of integer of size[10][10]

Member functions in the class Graph

      void getdata()   - To get the input from user

      void dfs_traverse()   - To traverse a graph from one node to another

                                      node in depth first order.

Algorithm

void getdata()

      1.   Get the number of vertices in the graph.

      2.   Get the adjacency matrix of the graph.

      3.   Get the starting vertex for traversal.

void dfs_traverse()

      1. Push starting vertex into a stack and make it visited.

      2. Pop a vertex from stack.

      3. Find all adjacent vertices of popped vertex in the reverse order in such a way

         that it is not already visited.

      4. Push them into stack and make them visited.

      5. Repeat steps 2 to 4 until the stack is empty.

int main()

      1. Call the getdata( ) function to get input from user.

      2. Call the dfs_traverse( ) function to do the traversal operation.

Source Code:

```
//Depth First Search
#include<iostream.h>
#include<conio.h>
class Graph
{
     int a[10][10],n,s;
     public:
     void getdata();
     void dfs_traverse();
};
void Graph::getdata()
{
     cout<<"\n Enter the number of vertices in the graph: ";
     cin>>n;
     cout<<"\n Enter the adjacency matrix of graph: "<<endl;
```

```cpp
        for(int i=0;i<n;i++)


        for(int j=0;j<n;j++)
        cin>>a[i][j];
        cout<<"\n Enter the vertex from which you want to traverse: ";
        cin>>s;
}
void Graph::dfs_traverse()
{
        int *visited=new int[n];
        int stack[10],top=-1,i;
        for(int j=0;j<n;j++)
        visited[j]=0;
        cout<<"\n The Depth First Search Traversal : "<<endl;
        i=stack[++top]=s;
        visited[s]=1;
        while(top>=0)
        {
                i=stack[top];
                cout<<stack[top--]<<endl;
                for(int j=n-1;j>=0;j--)
                if(a[i][j]!=0&&visited[j]!=1)
                {
                        stack[++top]=j;
                        visited[j]=1;
                }
        }
}
int main()
{
        Graph DFS;
        // clrscr();
        DFS.getdata();
        DFS.dfs_traverse();
        // getch();
        return 0;
}
```

Sample Input/ Output:

Enter the number of vertices in the graph: 6
Enter the adjacency matrix of graph:
0 1 1 0 00
1 0 0 1 10
1 0 0 0 10
0 1 0 0 11
0 1 1 1 01
0 0 0 1 10

Enter the vertex from which you want to traverse: 0
The Depth First Search Traversal:

0
1
3
5
4
2

Result:

Thus, a C++ program to traverse a graph using Depth First Search algorithm was written, executed and output was verified

Ex. No.05 (b)	**Graph Traversal (Breadth First Search)**
Date:	

Aim:

To write a C++ program to traverse a graph using Breadth First Search (BFS) algorithm.

Procedure:

Member variables in the class BGraph

n and start as integer

a as two dimensional array of integer of size[10][10]

Member functions in the class BGraph

voidgetdata()   - To get the input from user

voidbfs_traverse()   - To traverse a graph from one node to another
node in breadth first order.

Algorithm

void getdata()

1. Get the number of vertices in the graph.
2. Get the adjacency matrix of the graph.
3. Get the starting vertex for traversal.

void bfs_traverse()

1. Insert starting vertex into a queue and make it visited.
2. Remove a vertex from queue.
3. Find all adjacent vertices of removed vertex in such a way that it is not already visited.
4. Insert them into queue and make them visited.
5. Keep repeating steps 2 to 4 until the queue is empty.

int main()

1. Call the getdata( ) function to get input from user.
2. Call the bfs_ traverse( ) function to do the traversal operation.

Source Code:

```
//Breadth First Search
#include<iostream.h>
#include<conio.h>
class BGraph
{
      int a[10][10],n,start;
      public:
              void getdata();
              void bfs_traverse();
};
void BGraph::getdata()
{
      cout<<"\n Enter the number of vertices in the graph: ";
      cin>>n;
      cout<<"\n Enter the adjacency matrix of graph: "<<endl;
      for(int i=0;i<n;i++)
```

```cpp
        for(int j=0;j<n;j++)


        cin>>a[i][j];
        cout<<"\n Enter the vertex from which you want to traverse: ";
        cin>>start;
}
void BGraph::bfs_traverse()
{
        int *visited= new int[n];
        int queue[10],front=-1,rear=0,i;
        for(int j=0;j<n;j++)
        visited[j]=0;
        cout<<"\n Traversing the graph using breadth first search algorithm : "<<endl;
        queue[rear]=start;
        visited[start]=1;
        while(front!=rear)
        {
                cout<<queue[++front]<<endl;
                i=queue[front];
                for(int j=0;j<n;j++)
                if(a[i][j]!=0&&visited[j]!=1)
                {
                        queue[++rear]=j; visited[j]=1;
                }
        }
}
int main()
{
        BGraph bfs;
        bfs.getdata();
        bfs.bfs_traverse();
        // getch();
        return 0;
}
```

Sample Input/Output:

Enter the number of vertices in the graph: 5
Enter the adjacency matrix of graph:
0 1 1 00
1 0 0 10
1 0 0 11
0 1 1 00
0 0 1 10
Enter the vertex from which you want to traverse: 1
Traversing the graph using breadth first search algorithm:
1
0
3
2
4

Result:

Thus, a C++ program to traverse a graph using Breadth First Search algorithm was written, executed and output was verified.

Ex. No.06	**BINARY SEARCH TREE**
Date:	

Aim:

      To write a C++ program to create a binary search tree and perform in-order, pre-order and post-order traversals.

Procedure:

 Create user defined data type called node using structure in C++ with the following members:

      data as integer

      left as a pointer to hold the address of the left child

      right as a pointer to hold the address of the right child

Member variables in the class BinarySearchTree

      Root as pointer to the root node

Member functions in the BinarySearchTree

BinarySearchTree()	- Constructor to initialize Root as NULL
~BinarySearchTree()	- Destructor to release the memory of Root
BSTnode*GetRoot(void)	- To know the Root
voidSetRoot(BSTnode*root)	- To set the Root
BSTnode*CreateNode(void)	- To create a node
void Insert(BSTnode *root, BSTnode*New)	
	- To insert a new node in binary search tree
voidPreorder(BSTnode*temp)	- To traverse in preorder
voidInorder(BSTnode*temp)	- To traverse in inorder void
Postorder(BSTnode *temp)	- To traverse in preorder void
Display(BSTnode *temp,int row,int low,int high)	
	-To display the nodes in tree structure

Algorithm

BinarySearchTree()
1. Initialize Root as NULL

~BinarySearchTree()
1. Release the memory of Root

BSTnode *GetRoot(void)
1. Return the Root

void SetRoot(BSTnode *root)
1. Set the Root as root

STnode *CreateNode(void)
1. Create a node with default values and return it's address.

void Insert(BSTnode *root, BSTnode *New)
1. If the tree is empty or left-address field and right-address field is holding NULL values, then store the value in root node itself.
2. Compare the new with the root for its place until the leaf node is reached by traverse through left child or right child based on the root data.
3. If the new value is greater than the leaf node value then, place the data in a new node and make the right-address field of the leaf node to hold the address of the new node.

4. If the new value is lesser than the leaf node value then, place the data in a new node and make the left-address field of the leaf node to hold the address of the new node.

void Preorder(BSTnode *temp)
1. Display the present root node's value
2. Traverse the left sub-tree by taking the left node as new root node in Preorder.
3. Traverse the right sub-tree by taking the left node as new root node in Preorder.

void Inorder(BSTnode *temp)
1. Traverse the left sub-tree by taking the left node as new root node in Inorder.
2. Display the present root node's value.
3. Traverse the right sub-tree by taking the left node as new root node in Inorder.

void Postorder(BSTnode *temp)
1. Traverse the left sub-tree by taking the left node as new root node in Postorder.
2. Traverse the right sub-tree by taking the left node as new root node in Postorder.
3. Display the present root node's value.

void Display(BSTnode *temp,int row,int low,int high)
1. Find the place to print the data and print it to display like a binary search tree.

int main()
1. Display menu to perform binary search tree creation and it's traversals.
2. Get user choice and perform corresponding operation.

Source Code:

```cpp
//Binary Search Tree Traversal
#include<iostream.h>
#include<conio.h>
#include<stdlib.h>
typedef struct BSTnode
{
    int data;
    BSTnode *left,*right;
};
class BinarySearchTree
{
    BSTnode *Root; public:
    BinarySearchTree() {Root=NULL; }
    ~BinarySearchTree() {delete Root;}
    BSTnode *GetRoot(void) {return Root;}
    void SetRoot(BSTnode *root) {Root=root;}
    BSTnode *CreateNode(void);
    void Insert(BSTnode *root, BSTnode *New);
    void Preorder(BSTnode *temp);
    void Inorder(BSTnode *temp);
    void Postorder(BSTnode *temp);
    void Display(BSTnode *temp,int row,int low,int high);
};
/*Create node*/
BSTnode *BinarySearchTree::CreateNode()
{
```

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```
        BSTnode *temp;
        temp=new BSTnode;
        temp->left=NULL;
        temp->right=NULL;
        return temp;
}
/*Insert Function*/
void BinarySearchTree::Insert(BSTnode *root,BSTnode *New)
{
        if(New->data < root->data)
        {
                if(root->left==NULL) root->left=New;
                else
                Insert(root->left,New);
        }
        if(New->data >= root->data)
        {
                if(root->right==NULL) root->right=New;
                else
                Insert(root->right,New);
        }
}
/*Preorder Traversals*/
void BinarySearchTree::Preorder(BSTnode *temp)
{
        if(temp!=NULL)
        {
                cout<<"-> "<<temp->data<<" ";
                Preorder(temp->left);
                Preorder(temp->right);
        }
}
/*Inorder Traversals*/
void BinarySearchTree::Inorder(BSTnode *temp)
{
        if(temp!=NULL)
        {
                Inorder(temp->left);
                cout<<"-> "<<temp->data<<" ";
                Inorder(temp->right);
        }
}
/*Postorder Traversals*/
void BinarySearchTree::Postorder(BSTnode *temp)
{
        if(temp!=NULL)
        {
                Postorder(temp->left);
```

```cpp
                Postorder(temp->right);
                cout<<"-> "<<temp->data<<" ";
        }
}
/*display of binary search tree in tree format*/
void BinarySearchTree::Display(BSTnode *temp,int row,int low,int high)
{
        if(temp!=NULL)
        {
                Display(temp->left,row+2,low,(low+high)/2);
                gotoxy((low+high)/2,row);
                cout<<temp->data;
                Display(temp->right,row+2,(low+high)/2,high);
        }
}
int main()
{
        BinarySearchTree B; int ch;
        BSTnode *New=NULL,*root=NULL;
        while(1)
        {
                // clrscr();
                cout<<"\n\t\t\tBinary Search Tree";
                cout<<"\n\t\t\t ~~~~~~~~~~~~~~~~~~~";
                cout<<"\n1-Create";
                cout<<"\n2-Preorder";
                cout<<"\n3-Inorder";
                cout<<"\n4-Postorder";
                cout<<"\n5-Display";
                cout<<"\n6-Exit\n";
                cout<<"\nEnter your choice : ";
                cin>>ch;
                root=B.GetRoot();
                switch(ch)
                {
                        case 1:
                                cout<<"\nEnter elements1 by1:(0to stopentering)\n";
                                do
                                {
                                        New=B.CreateNode();
                                        cin>>New->data;
                                        if(New->data==0)
                                        break;
                                        if(root==NULL)
                                        root=New;
                                        else
                                        B.Insert(root,New);
                                }
```

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```
                        while(1);
                        B.SetRoot(root);
                        break;
                case 2:
                        if(root==NULL)
                        cout<<"\nNo element in Tree\n"; else
                        {
                                cout<<"\n~~~Preorder Traversal~~~\n\nThe Tree is:\n";
                                B.Preorder(root);
                        }
                        // getch();
                        break;
                case 3:
                        if(root==NULL)
                        cout<<"\nNo element in Tree\n";
                        else
                        {
                                cout<<"\n~~~Inorder Traversal~~~\n\nThe Tree is:\n";
                                B.Inorder(root);
                        }
                        // getch();
                        break;
                case 4:
                         if(root==NULL)
                        cout<<"\nNo element in Tree\n";
                        else
                        {
                                cout<<"\n~~~Postorder Traversal~~~\n\nThe Tree is:\n";
                                B.Postorder(root);
                        }
                        // getch();
                        break;
                case 5:
                        // clrscr();
                        B.Display(root,1,1,80);
                        // getch();
                        break;
                case 6:
                        cout<<"\n~~~Exit~~~\n";
                        // getch();
                        exit(0);
                default:
                        cout<<"\nEnter between 1 to5\n\n";
                        break;
                }
        }
        return 0;
}
```

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Sample Input/Output:

Binary Search Tree
~~~~~~~~~~~~~~
1-Create
2- Preorder
3- Inorder
4-Postorder
5-Display
6-Exit
Enter your choice: 1
Enter elements1 by1:(0to stopentering)
100
70
120
50
80
110
130
5
55
75
85
105
115
125
135
0
Binary Search Tree
~~~~~~~~~~~~~~
1-Create
2- Preorder
3-Inorder
4-Postorder
5-Display
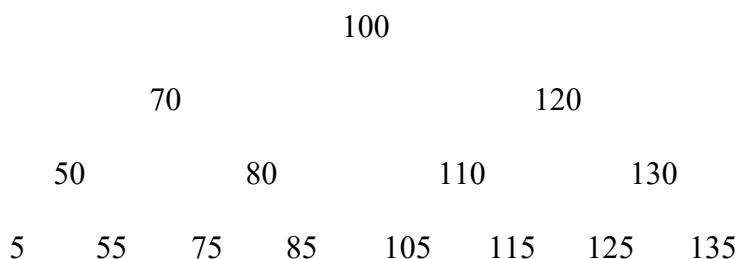6-Exit

Enter your choice : 2
~~~Preorder Traversal~~~
The Tree is:->100->70->50->5->55->80->75->85->120->110->105->115->130->125 ->135
Binary Search Tree
~~~~~~~~~~~~~~
1-Create
2- Preorder
3- Inorder
4-Postorder
5-Display
6-Exit

Enter your choice : 3
~~~Inorder Traversal~~~
The Tree is:->5->50->55->70->75->80->85->100->105->110->115->120->125->130->135

Binary Search Tree
~~~~~~~~~~~~~~
1-Create
2- Preorder
3- Inorder
4- Postorder
5- Display
6- Exit

Enter your choice :4
~~~Postorder Traversal~~~
The Tree is:->5->55->50->75->85->80->70->105->115->110->125->135->130->120 ->100

Binary Search Tree
~~~~~~~~~~~~~~
1-Create
2- Preorder
3- Inorder
4- Postorder
5- Display
6- Exit
Enter your choice : 5

```
                        100

                70                      120

         50           80          110          130

     5      55    75      85    105    115    125    135
```

Binary Search Tree
~~~~~~~~~~~~~~
1-Create
2- Preorder
3- Inorder
4- Postorder
5- Display
7- Exit

Enter your choice : 6
~~~Exit~~~

Result:

Thus, a C++ program to create the binary search tree and perform in-order, pre-order and post-order traversals was written, executed and output was verified

Ex. No.07	**BUBBLE SORT**
Date:	

Aim:

To write a C++ program to sort the given list of numbers using bubble sort technique.

Procedure:

Create the base class DataArray with the following member variables and functions.

Member variables in the base class DataArray

n as integer

a as array ofinteger of size100

Member functions in the base class DataArray

voidGetData(void)   - To get the input from user

voidDisplay(void)   - To display elements of the list

Algorithm

void GetData(void)

1. Get the list of numbers.

void Display(void)

1. Display all elements of the list one by one.

Create a derived class Bubble, derived from the base class DataArray with public access.

Member variable in the derived class Bubble is none.

Member functions in the derived class Bubble

void BubbleSort(void)   - To sort elements in ascending order

Algorithm

void BubbleSort(void)

1. Compare pairs of adjacent elements from the first location towards right for the entire list with the size of the list decreasing by one for each repetition.
2. For each comparison, if the first element is greater than the second element then interchange it's position.
3. Repeat the above steps 1 and 2 until no interchanges has happened during any comparison from left to right

int main()

1. Create an object B of classBubble.
2. Call member function GetData() of object B.
3. Call member function BubbleSort() of object B.
4. Call member function Display() of object B.

SourceCode:

```
// Bubble sorting
#include<iostream.h>
#include<conio.h>
class DataArray
{
        protected:
```

```cpp
        int a[100],n;
    public:
        void GetData(void);
        void Display(void);
};
void DataArray::GetData(void)
{
    cout<<"\n Enter the number of elements to be sorted : ";
    cin>>n;
    for(int i=0;i<n;i++)
    {
        cout<<" Enter element no."<<i+1<<" :";
        cin>>a[i];
    }
}
void DataArray::Display(void)
{
    for(int i=0;i<n;i++)
    cout<<" "<<a[i];
    cout<<endl;
}
class Bubble : public DataArray
{
    public:
        void BubbleSort(void);
};
void Bubble::BubbleSort(void)
{
    intflag=1,i,j,temp;
    for(i=0;i<n-1;i++)
    {
        for(j=0;j<n-i-1;j++)
        if(a[j]>a[j+1])
        {
            temp=a[j];
            a[j]=a[j+1];
            a[j+1]=temp;
            flag=0;
        }
        cout<<"\n Array after iteration "<<i<<": ";
        Display();
        if(flag)
        break;
        else
        flag=1;
    }
}
int main()
```

```
{
    Bubble B;
    clrscr();
    B.GetData();
    B.BubbleSort();
    cout<<"\n\t The Sorted Array";
    cout<<"\n\t ~~~~~~~~~~~~~~~~~\n";
    B.Display();
    getch();
    return 0;
}
```

Sample Input/output:
Enter the number of elements to be sorted: 10
Enter element no. 1: 19
Enter element no. 2: 77
Enter element no. 3: -60
Enter element no. 4: -12
Enter element no. 5: 7
Enter element no. 6: 41
Enter element no. 7: 2
Enter element no. 8: 1
Enter element no. 9: 99
Enter element no. 10: 0

Array after iteration 0:   19 -60 -12 7 41 2 1 77 0 99
Array after iteration 1: -60 -12 7 19 2 1 41 0 77 99
Array after iteration 2: -60 -12 7 2 1 19 0 41 77 99
Array after iteration 3:   -60 -12   2   1   7   0 19 41 77 99
Array after iteration 4:   -60 -12   1   2   0   7 19 41 77 99
Array after iteration 5:   -60 -12   1   0   2   7 19 41 77 99
Array after iteration 6:   -60 -12   0   1   2 7 19 41 77 99
Array after iteration 7: -60 -12   0   1   2 7 19 41 77 99

 The Sorted Array
 ~~~~~~~~~~~~~
-60 -12 0 1 2 7 19 41 77 99

Result:
    Thus, a C++ program to sort the given list by bubble sort technique was written, executed and output was verified.

Ex. No. 08	**SEPARATE CHAINING IN HASHING**
Date:	

Aim:

      To write a C++ program to implement separate chaining to handle collisions in hashing.

Procedure:

Classes

      HashNode

      HashMap

Data Members in class HashNode

      key, value as integers

      next as pointer to HashNode

Member Functions in class HashNode

      HashNode(int key, int value)   – to initialize the node

Data Members in class HashMap

      htable as pointer to HashNode

Member Functions in class HashMap

HashMap()   - to allocate memory and create new node in the Hash table

~HashMap()   - to delete the entries in the Hash table and deallocate memory

int HashFunc(int key)   - to compute the hash key

void Insert(int key, int value) - to insert an element at key

void Remove(int key)   - to remove Element at a key

int Search(int key)   - to search an element at key

main() function

1. For the class HashMap, create an object hash.
2. Display menu to accept choice from user.
3. Based on choice, invoke Insert or Remove or Search function for the object hash.

Algorithm:

A Hash Table in C/C++ is a data structure that maps keys to values. This uses a hash function to compute indexes for a key. Based on the Hash Table index, we can store the value at the appropriate location. If two different keys get the same index, we need to use other data structures (buckets) to account for these collisions. Open Hashing is a collision avoidance method which uses array of linked list to resolve the collision. It is also known as the separate chaining method (each linked list is considered as a chain). The algorithms to insert/remove/search are written based on separate chaining method to resolve collision.

Insert data into the hash table:

1. Declare an array of a linked list with the hash table size.
2. Initialize an array of a linked list to NULL.
3. Find hash key. (where, hash key = value / table size)
4. If htable[hash_val] == NULL, make htable[hash_val] point to the key node.
5. Otherwise (i.e., there is collision), Insert the key node at the end of the htable[hash_val].

Searching a value in the hash table:

1. Get the value.
2. Compute the hash key.
3. Search the value in the entire hash table. i.e. htable[hash_val].
4. If found, print the element found at key.
5. Otherwise, print "No element found at key"

Deleting/Removing an element from the hash table:

1. Get the value
2. Compute the key.
3. Using linked list deletion algorithm, delete the element from the htable[hash_val] (by using the Linked List Deletion Algorithm for deleting a node in the linked list)
4. If unable to delete, print "No element found at key"

Source Code:

```
/*   C++ Program to Implement Hash Tables chaining with Singly Linked Lists */

#include<iostream.h>
#include<cstdlib.h>
#include<string.h>
#include<cstdio.h>

using namespace std;
const int TABLE_SIZE = 128;

/*  HashNode Class Declaration  */
class HashNode
{
   public:
    .   int key;
        int value;
      HashNode* next;
       HashNode(int key, int value)
       {
           this->key = key;
           this->value = value;
           this->next = NULL;
       }
};

/*  HashMap Class Declaration  */
class HashMap
{
   private:
      HashNode** htable;
   public:
      HashMap()
```

```cpp
{
   htable = new HashNode*[TABLE_SIZE];
   for (int i = 0; i < TABLE_SIZE; i++)
      htable[i] = NULL;
}
~HashMap()
{
   for (int i = 0; i < TABLE_SIZE; ++i)
      {
      HashNode* entry = htable[i];
      while (entry != NULL)
         {
         HashNode* prev = entry;
         entry = entry->next;
         delete prev;
      }
   }
   delete[] htable;
}
/*
 * Hash Function
 */
int HashFunc(int key)
{
   return key % TABLE_SIZE;
}

/*        Insert Element at a key        */
void Insert(int key, int value)
{
   int hash_val = HashFunc(key);
   HashNode* prev = NULL;
   HashNode* entry = htable[hash_val];
   while (entry != NULL)
   {
      prev = entry;
      entry = entry->next;
   }
   if (entry == NULL)
   {
      entry = new HashNode(key, value);
      if (prev == NULL)
         {
         htable[hash_val] = entry;
      }
         else
         {
         prev->next = entry;
      }
   }
```

```cpp
        else
        {
          entry->value = value;
        }
    }

    /*       Remove Element at a key       */
    void Remove(int key)
    {
      int hash_val = HashFunc(key);
      HashNode* entry = htable[hash_val];
      HashNode* prev = NULL;
      if (entry == NULL || entry->key != key)
      {
              cout<<"No Element found at key "<<key<<endl;
        return;
      }
      while (entry->next != NULL)
        {
        prev = entry;
        entry = entry->next;
      }
      if (prev != NULL)
      {
        prev->next = entry->next;
      }
      delete entry;
      cout<<"Element Deleted"<<endl;
    }

    /*  Search Element at a key       */
    int Search(int key)
    {
      bool flag = false;
      int hash_val = HashFunc(key);
      HashNode* entry = htable[hash_val];
      while (entry != NULL)
        {
        if (entry->key == key)
          {
          cout<<entry->value<<" ";
          flag = true;
        }
        entry = entry->next;
      }
      if (!flag)
        return -1;
    }
};
```

```cpp
/*  Main Contains Menu  */
int main()
{
   HashMap hash;
   int key, value;
   int choice;
   while (1)
   {
      cout<<"\n----------------------"<<endl;
      cout<<"Operations on Hash Table"<<endl;
      cout<<"\n----------------------"<<endl;
      cout<<"1.Insert element into the table"<<endl;
      cout<<"2.Search element from the key"<<endl;
      cout<<"3.Delete element at a key"<<endl;
      cout<<"4.Exit"<<endl;
      cout<<"Enter your choice: ";
      cin>>choice;
      switch(choice)
      {
      case 1:
         cout<<"Enter element to be inserted: ";
         cin>>value;
         cout<<"Enter key at which element to be inserted: ";
         cin>>key;
         hash.Insert(key, value);
         break;
      case 2:
         cout<<"Enter key of the element to be searched: ";
         cin>>key;
         cout<<"Element at key "<<key<<" : ";
         if (hash.Search(key) == -1)
         {
             cout<<"No element found at key "<<key<<endl;
             continue;
         }
         break;
      case 3:
         cout<<"Enter key of the element to be deleted: ";
         cin>>key;
         hash.Remove(key);
         break;
      case 4:
         exit(1);
      default:
         cout<<"Enter correct option\n";
      }
   }
   return 0;
}
```

Sample Input/Output:

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 1
Enter element to be inserted: 12
Enter key at which element to be inserted: 1

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 1
Enter element to be inserted: 24
Enter key at which element to be inserted: 1

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 1
Enter element to be inserted: 36
Enter key at which element to be inserted: 1

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 1
Enter element to be inserted: 48
Enter key at which element to be inserted: 2

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 1
Enter element to be inserted: 60
Enter key at which element to be inserted: 2

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 2
Enter key of the element to be searched: 1
Element at key 1 : 12 24 36

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 2
Enter key of the element to be searched: 2
Element at key 2 : 48 60

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 3
Enter key of the element to be deleted: 4
No Element found at key 4

Operations on Hash Table

1.Insert element into the table

2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 2
Enter key of the element to be searched: 1
Element at key 1 : 12 24 36

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 3
Enter key of the element to be deleted: 1
Element Deleted

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 2
Enter key of the element to be searched: 5
Element at key 5 : No element found at key 5

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 2
Enter key of the element to be searched: 1
Element at key 1 : 12 24

Operations on Hash Table

1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 1

Enter element to be inserted: 36
Enter key at which element to be inserted: 1

\----------------------
Operations on Hash Table

\----------------------
1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 2
Enter key of the element to be searched: 1
Element at key 1 : 12 24 36
\----------------------
Operations on Hash Table

\----------------------
1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 2
Enter key of the element to be searched: 2
Element at key 2 : 48 60
\----------------------
Operations on Hash Table

\----------------------
1.Insert element into the table
2.Search element from the key
3.Delete element at a key
4.Exit
Enter your choice: 4

Program exited with code: 1
Press return to continue

Result:

　　　　Thus, a C++ program was written to implement separate chaining on hash tables with singly linked lists and executed to verify the output.

Ex. No.09	**HEAP**
Date:	

Aim:

To write a C++ program to implement a Heap and perform Heap Sort.

Procedure:

Variables used in the main() function:
 n   - number of elements in the array
arr[]   - array to hold the elements

Functions used:
void heapify(int arr[], int n, int i)   - to heapify a subtree rooted with node i which is an index in arr[], n is the size of heap

void heapSort(int arr[], int n)   – to do heap sort on the array elements

void printArray(int arr[], int n)   – to display the array elements

int main()   – to accept user input, invoke function to sort the heap, and display the sorted list of numbers.

Algorithm:

void heapify(int arr[], int n, int i)
1. Initialize largest as root
2. Set left = 2*i + 1, right = 2*i + 2
3. If left child is larger than root, then set largest = l
4. If right child is larger than largest so far, then set largest = r
5. If largest is not root, then
      i.   Interchange arr[i] and arr[largest]
      ii.   Recursively call heapify() function to heapify the affected sub-tree

void heapSort(int arr[], int n)
1. Build heap by calling the function heapify() to rearrange array elements.
2. Display the heap created.
3. One by one extract an element from heap by doing the following:
      i)   Move current root to end
      ii) call max heapify on the reduced heap

void printArray(int arr[], int n)
      Display the array elements stored in arr[].

int main()
1. Accept the number of elements and array elements from the user.
2. Invoke function heapSort(arr, n) to create and sort the heap elements.
3. Display the sorted list.

Source Code:

```cpp
// C++ program for implementation of Heap Sort
#include <iostream.h>
 using namespace std;

// To heapify a subtree rooted with node i which is an index in arr[]. n is size of heap
void heapify(int arr[], int n, int i)
{
    int largest = i; // Initialize largest as root
    int l = 2*i + 1; // left = 2*i + 1
    int r = 2*i + 2; // right = 2*i + 2

    // If left child is larger than root
    if (l < n && arr[l] > arr[largest])
        largest = l;

    // If right child is larger than largest so far
    if (r < n && arr[r] > arr[largest])
        largest = r;

    // If largest is not root
    if (largest != i)
    {
        swap(arr[i], arr[largest]);

        // Recursively heapify the affected sub-tree
        heapify(arr, n, largest);
    }
}

// main function to do heap sort
void heapSort(int arr[], int n)
{
    // Build heap (rearrange array)
    for (int i = n / 2 - 1; i >= 0; i--)
        heapify(arr, n, i);

        // Display the heap
        cout << "The heap is : \n";
    for (int i = 0; i < n; ++i)
        cout << arr[i] << " ";
    cout << "\n";

    // One by one extract an element from heap
    for (int i=n-1; i>0; i--)
    {
        // Move current root to end
        swap(arr[0], arr[i]);
```

```
        // call max heapify on the reduced heap
        heapify(arr, i, 0);
    }
}


/* function to print array of size n */
void printArray(int arr[], int n)
{
    for (int i=0; i<n; ++i)
        cout << arr[i] << " ";
    cout << "\n";
}
 // Driver program
int main()
{
    int n, i, arr[100];

        cout << "\n Enter the number of elements in the list: ";
        cin >> n;
        for (i=0; i<n; i++)
        {
        cout << "\n Enter the element no. " << i+1 << ": ";
        cin >> arr[i];
        }
    heapSort(arr, n);
      cout << "\n Sorted array is \n";
    printArray(arr, n);
    return(0);
}
```

Sample Input/Output:
Enter the number of elements in the list: 6
Enter the element no. 1: 12
Enter the element no. 2: 11
Enter the element no. 3: 13
Enter the element no. 4: 5
Enter the element no. 5: 6
Enter the element no. 6: 7

The Heap is:
13 11 12 5 6 7

Sorted array is
5 6 7 11 12 13

Result:

        Thus, a C++ program was written to implement heap and perform heap sort on a list of numbers and executed to verify the output.

Ex. No.10	**QUICK SORT**
Date:	

Aim:

      To write a C++ program to sort the given list by quick sort technique using divide and conquer method.

Procedure:

Create the base class DataArray with the following member variables and functions.

Member variables in the base class DataArray
      n as integer
      a as array of integer of size100

Member functions in the base class DataArray
      int Getn(void)   - To return value of n
      void GetData(void)   - To get the input from user
      void Display(void)   - To display elements of th elist

Algorithm:

void GetData(void)
    1. Get the list of numbers.

void Display(void)
    1. Display all elements of the list one by one.

Create a derived class Quick, derived from the base class DataArray with public access.
Member variable in the derived class Quick is none.

Member functions in the derived class Quick

      void QuickSort(int low, int high)   - To divide the list into two part
                                          based on pivot element
      void QuickDisplay(int l, int h)   - To Display elements from l to h

Algorithm

void QuickSort(int low, int high)
    1. Set the first element in the list as pivot element.
    2. Assume two pointers left and right moving from either end of the list towards each other
    3. Move left pointer until finding the element larger than the pivot element's value.
    4. Move the right pointer until finding the element not larger than the pivot element value.
    5. Swap the contents of the location pointed by these two pointers.
    6. Repeat the steps 3, 4 and 5 until the pointers crossed each other.
    7. Swap the contents of the location pointed by pivot pointer and right pointer.
    8. Repeat the above steps from 1 to 8 by considering two new lists, partitioned by the pivot pointer until further partitioning is not possible.

void QuickDisplay(int l, int h)

    1. Display elements from l to h in the list one by one.

int main()
1. Create an object Q of class Quick.
2. Call member function GetData() of object Q.
3. Call member function QuickSort() of object Q.
4. Call member function Display() of object Q.

SourceCode:

```
// Quick sorting
#include<iostream.h>
#include<conio.h>
Class DataArray
{
        protected:
                int a[100],n;
        public:
                int Getn(void)
                {
                        return n;
                }
                void GetData(void);
                void Display(void);
};
void DataArray::GetData(void)
{
        cout<<"\n Enter the number of elements to be sorted : ";
        cin>>n;
        for(int i=0;i<n;i++)
        {
                cout<<" Enter element no. "<<i+1<<" : ";
                cin>>a[i];
        }
}
void DataArray::Display(void)
{
        for(int i=0;i<n;i++)
        cout<<" "<<a[i];
        cout<<endl;
}
class Quick : public DataArray
{
        public:
                void QuickSort(int low, int high);
                void QuickDisplay(int l, int h);
};
void Quick::QuickSort(int low, int high)
{
        int left= low+1;
```

```cpp
        int right =high;
        int temp= 0;
        int pivot = a[low]; /* first element as pivot element */
        if ( low > high ) return;
        /* partition */
        do
        {
                while(a[left] < pivot && left <high)left++;          /* find element above ... */
                while(a[right] >= pivot && right >low)right--;        /* find element below ... */
                if(left<right)
                {
                        temp = a[left];
                        a[left] = a[right];
                        a[right] = temp;
                }
                else break;
        }
        while(1);
        temp = a[low];
        a[low] = a[right];
        a[right] = temp;
        cout<<"Left:";
        QuickDisplay(low,right-1);
        cout<<"Pivot : ["<<pivot<<"] ";
        cout<<"Right:";
        QuickDisplay(right+1,high);
        cout<<endl;
        /* recursive */
        QuickSort(low,right-1);
        QuickSort(right+1,high);
}
void Quick::QuickDisplay(int l,int h)
{
        cout<<" {";
        for(int i=l;i<=h;i++)
        cout<<""<<a[i];
        cout<<" } ";
}
int main()
{
        Quick Q;
        clrscr();
        Q.GetData();
        cout<<"Original: ";
        Q.QuickDisplay(0,Q.Getn()-1);
        cout<<endl;
        Q.QuickSort(0,Q.Getn()-1);
        cout<<"\n\t The Sorted Array";
        cout<<"\n\t ~~~~~~~~~~~~~~~~~\n";
        Q.Display();
```

```
        getch();
        return 0;
}
```

Sample Input/Output:

Enter the number of elements to be sorted : 7
Enter element no. 1 : 30
Enter element no. 2 : 10
Enter element no. 3: 20
Enter element no. 4: 15
Enter element no. 5: 45
Enter element no. 6: 40
Enter element no. 7: 50
Original : { 30 10 20 15 45 40 50}
Left: { 15 10 20} Pivot: [30] Right : { 45 40 50}
Left: { 10} Pivot : [15] Right: { 20}
Left: {} Pivot: [10] Right : {}
Left: {} Pivot: [20] Right : {}
Left : { 40 } Pivot : [45] Right : { 50 }
Left : { } Pivot : [40] Right : {}
Left : { } Pivot : [50] Right : {}

        The Sorted Array
        ~~~~~~~~~~~~
10 15 20 30 40 45 50

Result:
        Thus, a C++ program to sort the given list by quick sort technique using divide and conquer method was written, executed and output was verified.

Ex. No.11	DIJKSTRA'S SHORTEST PATH ALGORITHM

Date:	

Aim:

To write a C++ program to implement Dijkstra's shortest path algorithm.

Procedure:

Variables used:

N   - as integer to store Number of vertices in the graph
graph[10][10] - as integer to store the adjacency matrix representation of graph
dist[10]   - as integer, the output array, dist[i] will hold the shortest distance from src to i
visited[10]   - as Boolean, it will be true if vertex i is included in shortest path tree or shortest distance from src to i is finalized
parent[10]   - as integer to store parent information used to display the shortest path

Functions used:

void createGraph()   - to accept the user input for number of nodes, edge and weight values to create the adjacency matrix representation of the graph.

int minDistance()   - to find the vertex with minimum distance value, from the set of vertices not yet included in shortest path tree.

void printPath(int j)   - to print the shortest path.

void dijkstra()   - to implement Dijkstra's single source shortest path algorithm.

int main()   - to invoke functions createGraph() and Dijkstra()

Algorithm:

Dijkstra's Single Source Shortest Path to calculate the shortest path is as follows:

1. Create a set visited[] (shortest path tree set) that keeps track of vertices included in shortest path tree, i.e., whose minimum distance from source is calculated and finalized. Initially, this set is empty.
2. Assign a distance value to all vertices in the input graph. Initialize all distance values as INFINITE. Assign distance value as 0 for the source vertex so that it is picked first.
3. While visited doesn't include all vertices
   a) Pick a vertex u which is not there in visited[] and has minimum distance value.
   b) Include u to visited[].
   c) Update distance value of all adjacent vertices of u. To update the distance values, iterate through all adjacent vertices. For every adjacent vertex v, if sum of distance value of u (from source) and weight of edge u-v, is less than the distance value of v, then update the distance value of v.

Source Code:

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

int N;
int graph[10][10];
int dist[10];
bool visited[10];
int parent[10];

// Function to create the adjacency matrix representation of the graph based on user inputs
void createGraph()
{
  int i,j,max,u,v,w;
  cout<<"Enter the number of nodes : ";
  cin>>N;
  for(i=0;i<=N;i++)
   for(j=0;j<=N;j++)
    graph[i][j]=0;
  max=N*(N+1);
  for(i=0;i<max;i++)
  {
   cout<<"Enter Edge and Weight : ";
   cin>>u>>v>>w;
   if(u==-1)   break;
   else
   {
     graph[u][v]=w;
     graph[v][u]=w;
   }
  }
}

/* Function to find the vertex with minimum distance value, from the set of vertices not yet
included in shortest path tree */
int minDistance()
{
  int min = 10000, minDist;
  for (int v = 0; v < N; v++)

    if (visited[v] == false && dist[v] <= min)
    {
      min = dist[v];
      minDist = v;
    }
  return minDist;
}

// to print the shortest path
void printPath(int j)
```

```
{
  if (parent[j]==-1)
    return;
  printPath(parent[j]);

  cout<<j<<" ";
}


// Function that implements Dijkstra's single source shortest path algorithm
void dijkstra()

{
  int src;
  cout<<"Enter the Source Node : ";
  cin>>src;


// Initialize all distances as INFINITE, parent as -1 and visited as false
  for (int i = 0; i < N; i++)
  {
    parent[0] = -1;
    dist[i] = 10000;
    visited[i] = false;
  }


// Distance of source vertex from itself is always 0
  dist[src] = 0;
// Find shortest path for all vertices
  for (int count = 0; count < N-1; count++)
  {
/* Pick the minimum distance vertex from the set of vertices not yet processed. u is always
equal to src in the first iteration. */
    int u = minDistance();
  // Mark the picked vertex as processed
    visited[u] = true;
// Update dist value of the adjacent vertices of the picked vertex.
    for (int v = 0; v < N; v++)
/* Update dist[v] only if is not in sptSet, there is an edge from u to v, and total weight of path
from src to  v through u is smaller than current value of dist[v]   */
      if (!visited[v] && graph[u][v] &&
        dist[u] + graph[u][v] < dist[v])
      {
        parent[v] = u;
        dist[v] = dist[u] + graph[u][v];
      }
  }


// print the constructed distance array
  cout<<"Src->Dest \t Distance \t Path"<<endl;
  for (int i = 1; i < N; i++)
  {
    cout<<src<<"->"<<i<<"\t "<<dist[i]<<"\t "<<src<<" ";
```

```
        printPath(i);
        cout<<endl;
    }
}
int main()

{
    createGraph();
    dijkstra();
    return 0;
}
```

Sample Input/Output:

Enter the number of nodes : 5
Enter Edge and Weight : 0 1 3
Enter Edge and Weight : 1 2 4
Enter Edge and Weight : 1 3 2
Enter Edge and Weight : 0 3 7
Enter Edge and Weight : 2 3 5
Enter Edge and Weight : 3 4 4
Enter Edge and Weight : 2 4 6
Enter Edge and Weight : -1 -1 -1
Enter the Source Node : 0

Src->Dest	Distance	Path
0->1	3	0 1
0->2	7	0 1 2
0->3	5	0 1 3
0->4	9	0 1 3 4

Result:

       Thus a C++ program was written to implement Dijkstra's algorithm to find the single source shortest path and executed to verify the output.

Ex. No.12	**N-QUEENS PROBLEM**
Date:	

Aim:

To write a C++ program to solve N-queens problem using Back tracking Method.

Procedure:

Create user defined data typed called bool using enum in C++.

Member variables in the class N-queen:

Board as pointer to pointer to hold 2D array

Member functions in the N-queen:

NQueen(int size)   - Constructor to create and initialize 2D array board

~NQueen   - Destructor to release the memory of board

void printsolution (void)   - To print the solution

bool Issafe(int row, int col)   - To check is the safety of the queen

bool SolveNQueen(int col)   - To solve N-queens placement

Algorithm:

NQueen(int size)

1. Create board as 2D array initialize values of 2D array board as zero.

~NQueen ()

1. Release the memory of board.

 void printSolution()

1. Print solution board

 bool Issafe(int row, int col)

1. Check the left side of row if found a queen return false.
2. Check upper diagonal on left side if found a queen return false.
3. Check lower diagonal on left side if found a queen return false
4. Return true.

bool SolveNQueen(int col)

1. Base case: if all queens are placed then return true.

2. Consider this column and try placing this queen in all rows one by one.
3. Check if queen can be placed on board[i][col]
4. If safe then place this queen in board[i][col]
5. Recur to place rest of the queens
6. If placing queen in board[i][col] doesn't lead to a solution, then remove queen from board[i][col]
7. If queen cannot be placed in any row in this column col then return false

int main()

1. Use solve NQueen() to solve the problem after getting size of the board.
2. If solve NQueen() reurns false then queens cannot be placed, otherwise print placement of queens in the form of Qs and Os.

Source code:

```
  //program to solve N-queen problem using backtracking

#include <iostream.h>
#include<conio.h>

class NQueen
{
int **board,N;
public:
        NQueen(int size);
        ~NQueen(){delete board; }
        void printSolution(void);
        bool IsSafe(int row,int col);
        bool SolveNQueen(int col);

};

NQueen::NQueen(int size)
{
//2D array creation
int i, j;
N=Size;
board=new int*[N];
for (i=0;i<N;i++)
board[i]=new int[N];
//2D array initialization
for (i=0;i<N;i++)
for (j=0;j<N;j++)
board[i][j]=0;
}

//A function to print solution
void NQueen::printSolution()
{
for (int i=0;i<N;i++)
```

```
{
for (int j=0;j<N;j++)
if(board[i][j]==1) cout<<"Q"<<j+1<<" ";
else  cout<<" "<<board[i][j]<<" ";
cout<<"\n";
}
}
```

```
    /* A function to check if a Queen can be placed on board[row][col]. Note that this function
is called when "col" queens are already placed in columns from 0 to col -1 so we need to
check only left side for attacking queens*/
bool NQueen::IsSafe(int row,int col)
{
int i.j;
/* check this row on left side */
for(i=0;i<col;i++)
if(board[row][i]) return false;
/* check upper diagonal on left side */
for(i=row, j=col; i>=0 && j>=0; i--,j--)
if(board[i][j])  return false;
/* check lower diagonal on left side*/
for (i=row, j=col; j>=0 && i<N; i++, j--)
if (board[i][j]) return false;
return true;
}
```

```
// A recursive function to solve N-Queens problem
bool NQueen::SolveNQueen(int col)
{
// base case: if all queens are placed then return true
if(col>=N) return true;
//consider this column and try placing this queen in all rows one by one
for(int i=0; i<N; i++)
{
// check if queen can be placed on board[i][col]
if(IsSafe(i, col))
{
//place this queen in board[i][col]
board[i][col]=1;
//recur to place rest of the queens
if(SolveNQueen(col+1)) return true;

/*if placing queen in board[i][col] doesn't lead to a solution, then remove queen from
board[i][col]*/
board[i][col] = 0; // BACKTRACK
}
}
//if queen cannot be place in any row in this column col then return false
return false;
}
```

/* This function solves the N-queens problem using Backtracking. It mainly uses solveNQueen() to solve the problem. It returns false if queens cannot be placed, otherwise return true and prints placements of queens in the form of Is. Please not that there may be more than one solutions, this function prints one of the feasible solutions*/

```
int main()
{
int size;
clrscr();
cout<<"\n enter the size of the board:";
cin>>size;

NQueen Q(size);
If (Q.SolveNQueen(0)==false){
cout<<"\n solution does not exist";
}
else{
cout<<"\n queens can be placed as shown below \n";
Q.printSolution();
}
getch();
return 0;
}
```

Sample Input/Output:

Enter the size of the board:8

Queens can be placed as shown below

Q1 0 0 0 0 0 0   0

0   0 0 0 0 0 Q7 0

0   0 0 0 0 Q5 0 0

0   0 0 0 0 0 0 Q8

0   Q2 0 0 0 0 0 0

0   0 0 Q4 0 0 0 0

0   0 0 0 0 Q6 0 0

0   0 Q3 0 0 0 0 0

Result:

       Thus, a C++ program to solve N-Queens problem using backtracking method was written, executed and output was verified.

Ex. No.13	**SELECTION SORT**
Date:	

Aim:
>   To write a C++ program to sort the given list of elements by selection sort technique.

Procedure:
Create the base class DataArray with the following member variables and functions.

Member variables in the base class DataArray
>   n as integer
>   a as array of integer of size 100

Member functions in the base class DataArray
>   void GetData(void)   - To get the input from user
>   void Display(void)   - To display elements of the list

Algorithm:
void GetData(void)
1.   Get the list of numbers.

void Display(void)
1.   Display all elements of the list one by one.

Create a derived class Selection, derived from the base class DataArray with public access.

Member variable in the derived class Selection is none.

Member functions in the derived class Selection

void SelectionSort(void)   - To sort elements in ascending order

Algorithm
void SelectionSort(void)
1.   Find the largest number and place it in last position in the list.
2.   Consider rest of the elements only as new list and repeat the step 1 until there is only one element in the list.

int main()
1.   Create an object S of class Selection.
2.   Call member function GetData() of object S.
3.   Call member function SelectionSort() of object S.
4.   Call member function Display() of object S.

Source Code:
```
// Selection sorting
#include<iostream.h>
#include<conio.h>
class DataArray
```

```cpp
{
        protected:
                int a[100], n;
        public:
                void GetData(void);
                void Display(void);
};
void DataArray::GetData(void)
{
        cout<<"\n Enter the number of elements to be sorted : ";
        cin>>n;
        for(int i=0;i<n;i++)
        {
                cout<<" Enter element no."<<i+1<<" :";
                cin>>a[i];
        }
}
void DataArray::Display(void)
{
        for(int i=0;i<n;i++)
        cout<<" "<<a[i];
        cout<<endl;
}
class Selection : public DataArray
{
        public:
                void SelectionSort(void);
};
void Selection::SelectionSort(void)
{
        int large,index,i,j;
        for(i=n-1;i>0;i--)
        {
                large=a[0];
                index=0;
                for(j=1;j<=i;j++)
                {
                        if(a[j]>large)
                        {
                                large=a[j];
                                index=j;
                        }
                }
                a[index]=a[i];
                a[i]=large;
                cout<<"\n Array after iteration "<<n-i<<": ";
                Display();
        }
}
int main()
```

```
{
        Selection S;
        clrscr();
        S.GetData();
        S.SelectionSort();
        cout<<"\n\t The Sorted Array";
        cout<<"\n\t ~~~~~~~~~~~~~~~~\n";
        S.Display();
        getch();
        return 0;
}
```

Sample Input/output:

Enter the number of elements to be sorted : 10

Enter element no. 1 : 19

Enter element no. 2 : 77

Enter element no. 3 : -60

Enter element no. 4:-12

Enter element no. 5 : 7

Enter element no. 6: 41

Enter element no. 7:2

Enter element no. 8: 1

Enter element no. 9:99

Enter element no. 10:0

Array after iteration 1: 19 77 -60 -12 7 41 2 1 0 99

Array after iteration 2:   19 0 -60 -12 7 41 2 1 77 99

Array after iteration 3:   19 0 -60 -12 7 1 2 41 77 99

Array after iteration 4:   2   0 -60 -12 7   1 19 41 77 99

Array after iteration 5:   2   0 -60 -12 1   7 19 41 77 99

Array after iteration 6:   1   0 -60 -12 2   7 19 41 77 99

Array after iteration 7: -12   0 -60 1 2 7 19 41 77 99

Array after iteration 8: -12 -60 0 1 2 7 19 41 77 99

Array after iteration 9: -60 -12 0 1 2 7 19 41 77 99

        The Sorted Array
        ~~~~~~~~~~~~~~
   -60 -12 0 1 2 7 19 41 77 99

Result:

        Thus, a C++ program to sort the given list of numbers by selection sort technique was written, executed and output was verified.

ADDITIONAL EXERCISES

Ex. No. 1	**One Dimensional Array Manipulation Using Numpy Package**
Date:	

Aim:

    (a) To write a program to perform basic operations on a single array using Numpy package.

Procedure

Various arithmetic operations like addition, subtraction, multiplication, squaring each element, doubling each element and printing the transpose of the array are done to do element-wise operation on an existing array to create a new array.

Source Code :

```python
import numpy as np

a =np.array([1, 2, 5, 3])

# add 1 to every element

print("Adding 1 to every element:", a+1)

# subtract 3 from each element

print("Subtracting 3 from each element:", a-3)

# multiply each element by 10

print("Multiplying each element by 10:", a*10)

# square each element

print("Squaring each element:", a**2)

# modify existing array

a *=2

print("Doubled each element of original array:", a)

# transpose of array

a =np.array([[1, 2, 3], [3, 4, 5], [9, 6, 0]])

print("\nOriginal array:\n", a)

print("Transpose of array:\n", a.T)
```

Output :

Adding 1 to every element: [2 3 6 4]

Subtracting 3 from each element: [-2 -1 2 0]

Multiplying each element by 10: [10 20 50 30]

Squaring each element: [1 4 25 9]

Doubled each element of original array: [2 4 10 6]

Original array:

 [[1 2 3]

 [3 4 5]

 [9 6 0]]
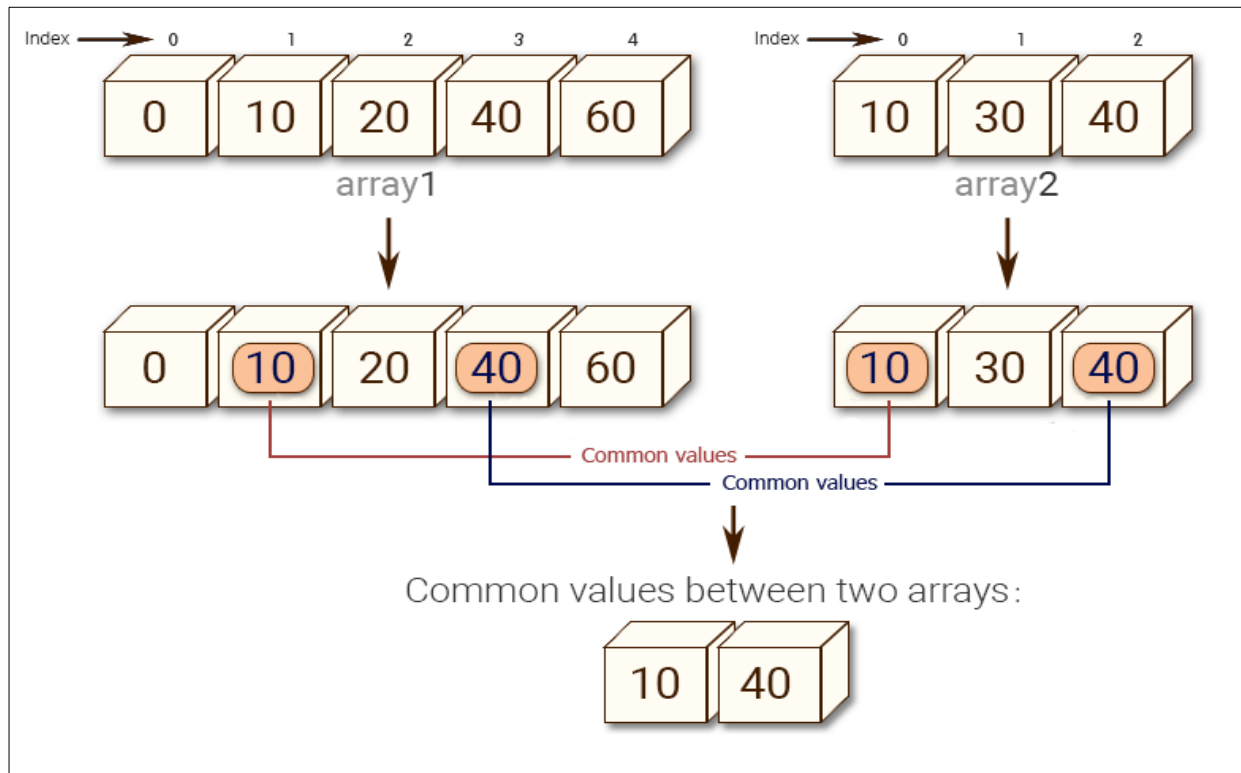
Transpose of array:

 [[1 3 9]

 [2 4 6]

 [3 5 0]]

Aim:

(b) To find common values between two arrays.

Procedure :

The common values between two given arrays are selected and printed using np.intersect1d command.

Pictorial Presentation:

Source Code:

```
import numpy as np
array1 = np.array([0, 10, 20, 40, 60])
print("Array1: ",array1)
array2 = [10, 30, 40]
print("Array2: ",array2)
print("Common values between two arrays:")
print(np.intersect1d(array1, array2))
```

Sample Input/output:

Array1: [0,10,20,40,60]

Array2:[10,30,40]

Common Values between two arrays : [10,40]

Result:

Thus, a Python program to perform One Dimensional Array Manipulation using Numpy Package has been successfully written and outputs have been verified.

| Ex. No. 2	**Two Dimensional Array Manipulation Using NUMPY PACKAGE**
Date:	

Aim:

    (a) To write a program to extract 3rd and 4th elements of the 1st and 2nd rows from a given Two Dimensional array using Numpy package.

Procedure:

Specified elements for example, third and fourth elements of the first and second rows are selected and printed from the two dimensional array using arra_data command.

Pictorial Presentation:
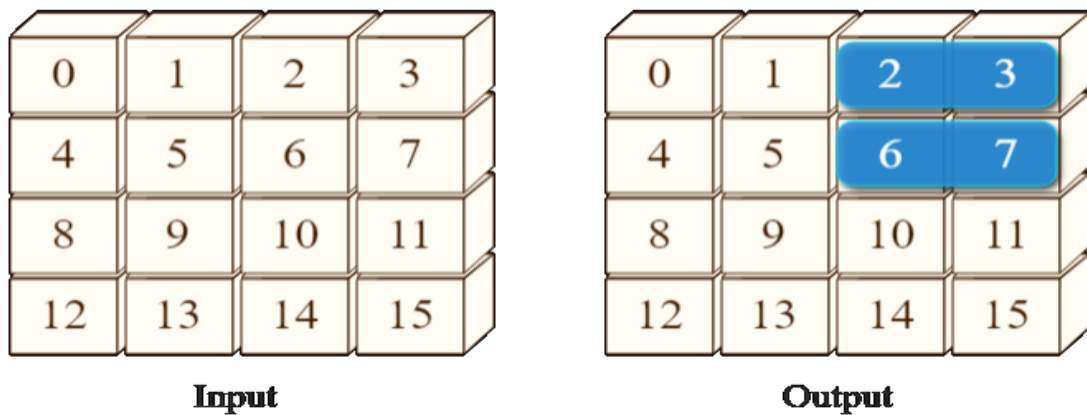
Input   Output

Source Code:
```
import numpy as np
arra_data = np.arange(0,16).reshape((4, 4))
print("Original array:")
print(arra_data)
print("\n Extracted data: Third and fourth elements of the first and second rows ")
print(arra_data[0:2, 2:4])
```
Sample Input/Output:

Original array:

[[0 1 2 3]

 [4 5 6 7]

 [8 9 10 11]

 [12 13 14 15]]

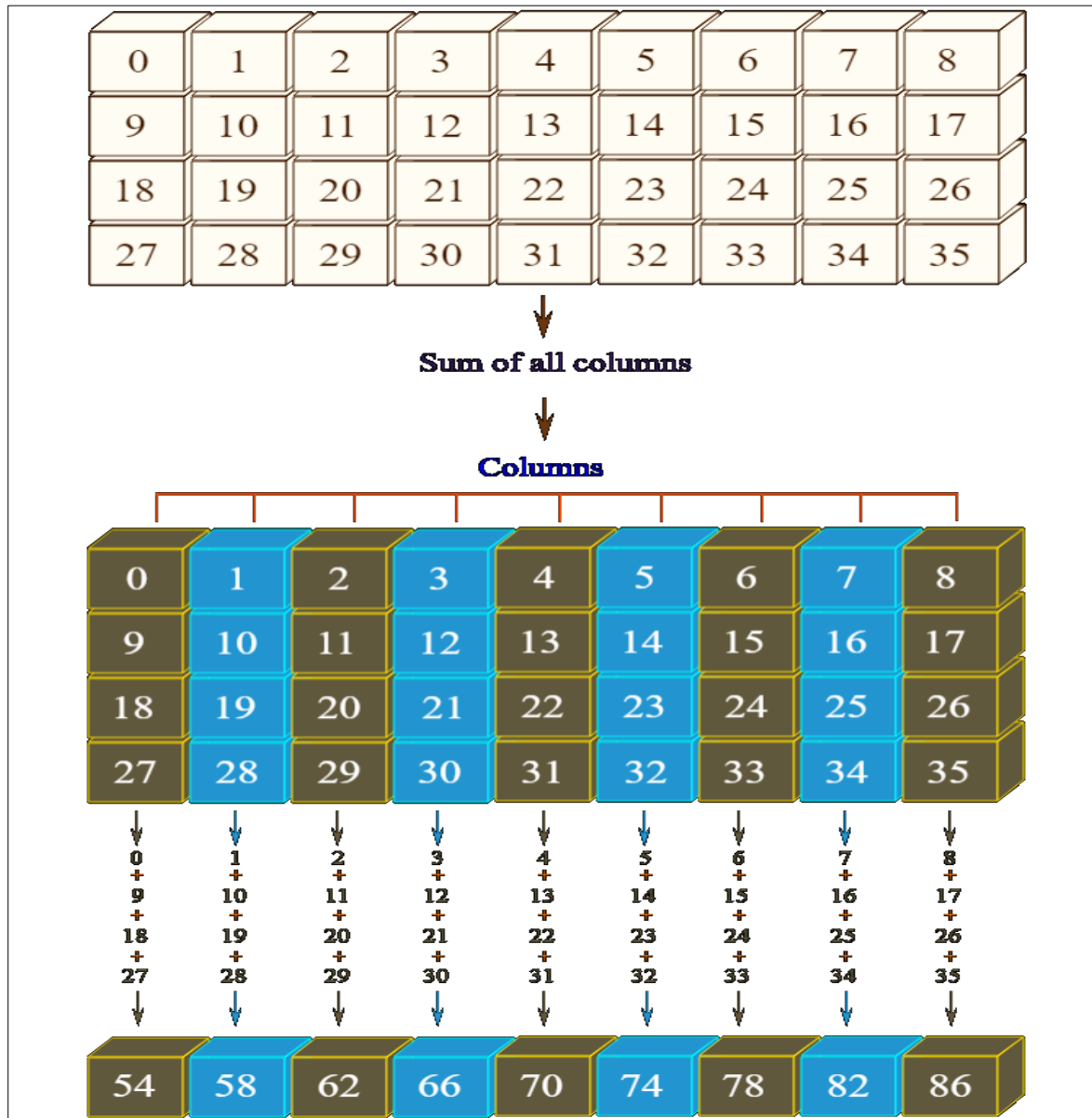Extracted data: Third and fourth elements of the first and second rows

[[2 3]

 [6 7]]

Aim:
    (b) To calculate the sum of all columns of a 2D array.

Procedure:
The sum of all columns of a 2D array are calculated and printed using arr1.sum command.

Pictorial Presentation:

Source Code:
```
import numpy as np
num = np.arange(36)
arr1 = np.reshape(num, [4, 9])
print("Original array:")
print(arr1)
result  = arr1.sum(axis=0)
print("\nSum of all columns:")
```

print(result)
Sample Input/output:

Original array:
[[0 1 2 3 4 5 6 7 8]
[9 10 11 12 13 14 15 16 17]
[18 19 20 21 22 23 24 25 26]
[27 28 29 30 31 32 33 34 35]]

Sum of all columns:
[54 58 62 66 70 74 78 82 86]

Result:

Thus, a Python program to perform Two Dimensional Array Manipulation using Numpy Package has been successfully written and outputs have been verified.