VISVESVARAYATECHNOLOGICALUNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU) BENGALURU-
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **“DATA STRUCTURES”** carried out by Harsha B (1BM23CS107) , who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2024- 25. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST)** work prescribed for the said degree.

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BMSCE, Bengaluru	BMSCE, Bengaluru

Index Sheet

Course outcomes:

CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations of different data structures.

Lab program 1:

Write a program to simulate the working of stack using an array with the following: a) Push

b) Pop

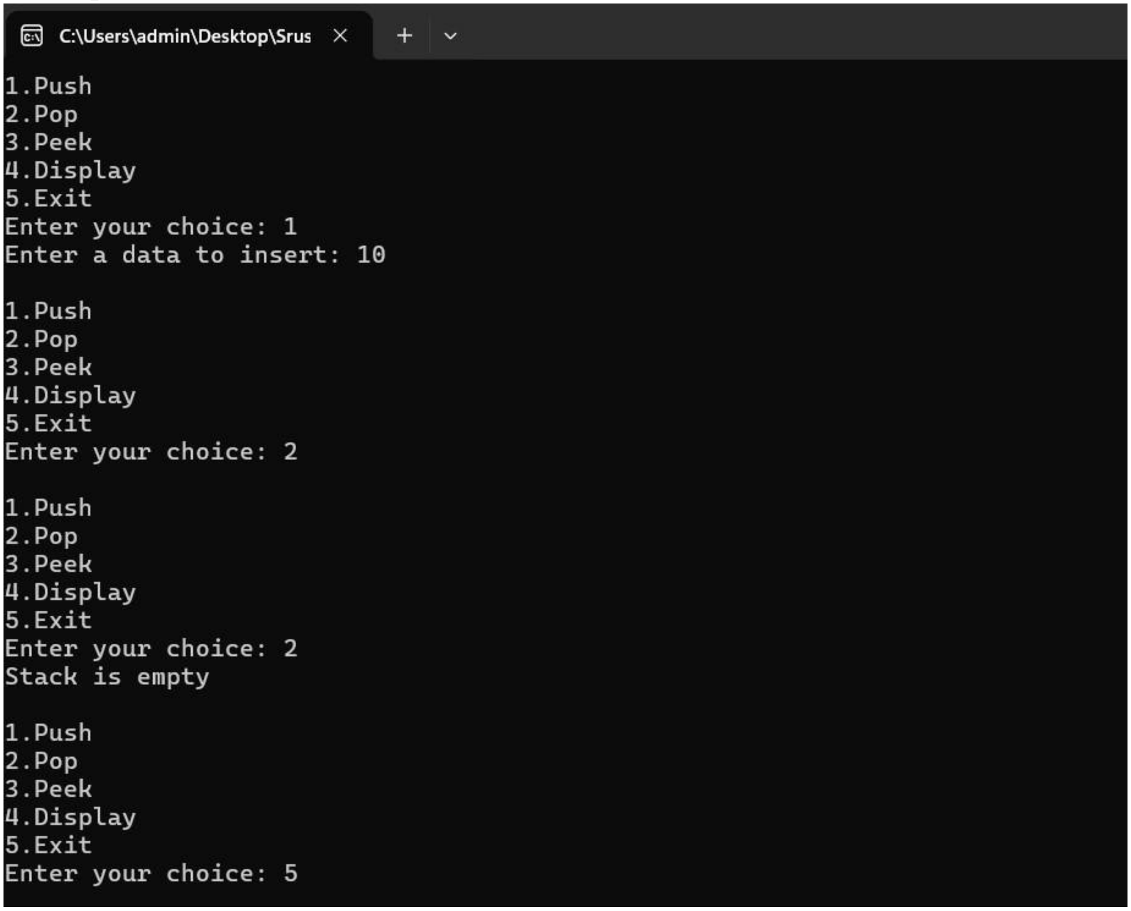
c) Display

The program should print appropriate messages for stack overflow, stack underflow.

```
#include<stdio.h>
#include<stdlib.h
> #define max 4
int stack[max];
int top=-1;

void push(int x){
   if(top==max-1){ printf("Stack
      is full\n");
   }
   else{
      top++;
      stack[top]=x;
   }

void       pop(){       if(top==-1){
printf("Stack is empty\n");
   }
   else{  top--
      ;
   }
}

void peek(){ if(top!=-1){
   printf("%d",stack[top]);
   }
}

void    display(){    if(top==-1){
   printf("Stack is empty\n");
   }
   else{ for(int i=top;i>=0;i--){
      printf("%d\n",stack[i]);
      }
   }
}

void   main(){   int
   choice,data;
   while(1){
   printf("\n1.Pus
   h         \n2.Pop
   \n3.Peek
```

```
          \n4.Display
          \n5.Exit\n");
            printf("Enter your choice: ");
            scanf("%d",&choice);
            switch(choice){
              case 1:printf("Enter a data to insert:
                  "); scanf("%d",&data); push(data);
                  break;
              case 2:pop(); break;
              case 3:peek(); break;
              case 4:display(); break;
              case 5:exit(0);
                  break;
              default:printf("Invalid choice.");
            }
          }
        }
```

Output:



```
1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 1
Enter a data to insert: 10

1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 2

1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 2
Stack is empty

1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 5
```

Lab program 2a:

WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide)

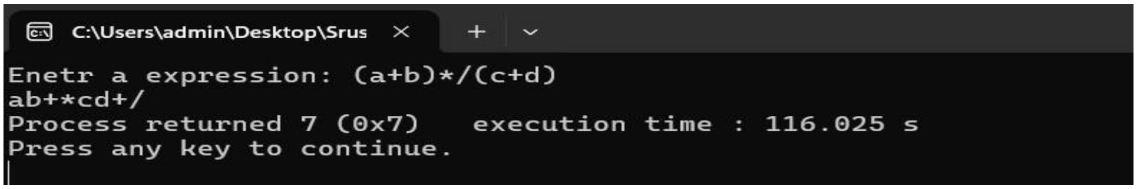
```
#include<stdio.h>
```

```
#include<string.h>
#define  max  30  char
s1[max];//postfix char
s2[max];//infix       int
t1=-1,t2=-1;

int precedence(char x){
   if(x=='*'   ||   x=='/'){
   return 2;
   }
   else if(x=='+' || x=='-'){ return
      1;
   }

   else if(x=='^'){ return
      3;
   }
   return 0;
}

void push1(char x){
   if(t1==max-1){
      printf("Stack is full\n");
      return;
   }
   else{ t1++;
      s1[t1]=x
      ;
   }
}

void push2(char x){
   if(t2==max-1){
      printf("Stack is full\n");
      return;
   }
   else{
      t2++;
      s2[t2]=x;
   }
}
```

```
char pop1(){ if(t1==-1){
   printf("Stack is empty\n");
      return '\0';
   }
   return s1[t1--];
}

char      pop2(){      if(t2==-1){
   printf("Stack   is   empty\n");
   return '\0';
   }
   return s2[t2--];
}

char peek2(){ if(t2!=-
   1){

      return s2[t2];
   }
   return '\0';
}

void main(){ char
   str[max];
   printf("Enetr a expression: ");
   scanf("%s",str);

   for(int i=0;i<strlen(str);i++){ char
      ch=str[i];

      if(ch=='('){
         push2(ch);
      }
      else if(ch==')'){
         while(peek2()!='('){
         push1(pop2());
         }
         pop2();
      }
      else  if(ch=='+'||  ch=='-'||  ch=='*'   ||   ch=='/'   ||   ch=='^'){
         while(t2>-1 && precedence(peek2())>=precedence(ch)){
         push1(pop2());
         }
         push2(ch);
      }
```

```
        else if(ch>='a' && ch<='z'){ push1(ch);
        }
    }

    while(t2>-1){
        push1(pop2());
    }
    for(int                    i=0;i<=t1;i++){
        printf("%c",s1[i]);
    }
```

Output:



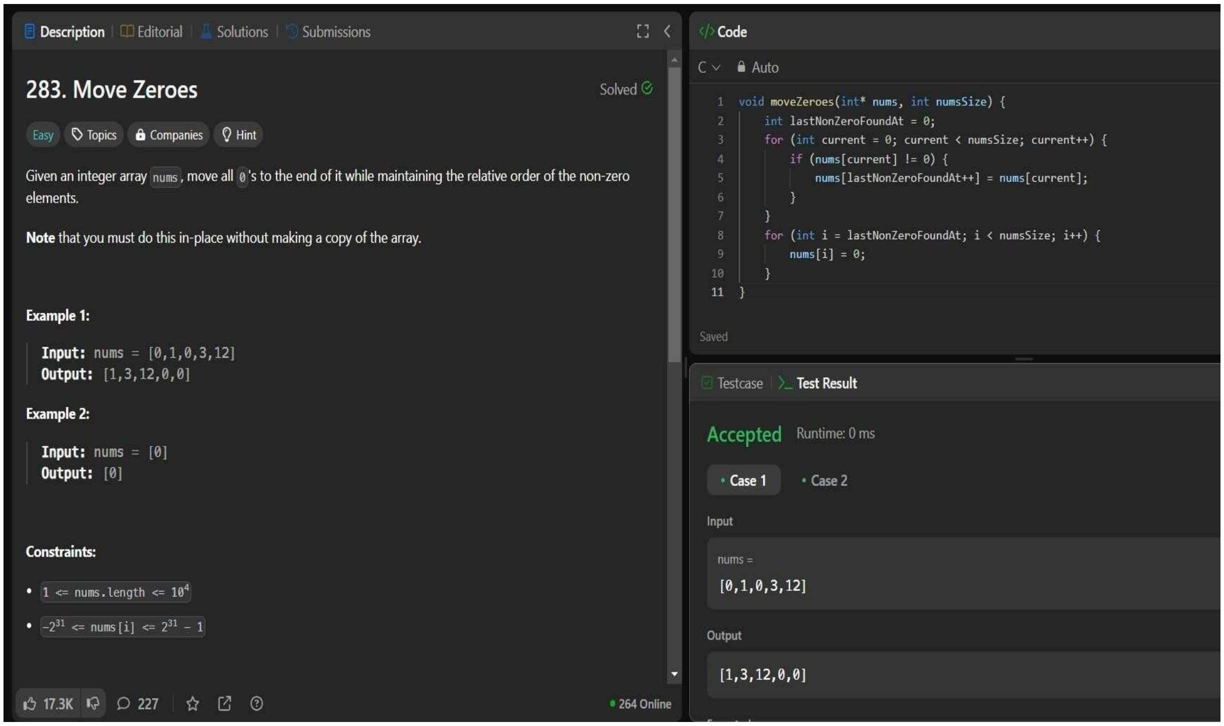
```
Enetr a expression: (a+b)*/(c+d)
ab++cd+/
Process returned 7 (0x7)   execution time : 116.025 s
Press any key to continue.
```

Lab program 2b:

Demonstration of account creation on LeetCode platform Program - Leetcode platform.

```
void moveZeroes(int* nums, int
numsSize) { int lastNonZeroFoundAt = 0; for (int current = 0; current <
numsSize; current++) { if (nums[current] != 0) {
nums[lastNonZeroFoundAt++] = nums[current];
                }
        }
        for (int i = lastNonZeroFoundAt; i < numsSize; i++) {
                nums[i] = 0;
        }
}
```

Output:



283. Move Zeroes

Given an integer array `nums`, move all `0`'s to the end of it while maintaining the relative order of the non-zero elements.

Note that you must do this in-place without making a copy of the array.

Example 1:

```
Input: nums = [0,1,0,3,12]
Output: [1,3,12,0,0]
```

Example 2:

```
Input: nums = [0]
Output: [0]
```

Constraints:

- `1 <= nums.length <=` 10^4
- -2^{31} `<= nums[i] <=` $2^{31} - 1$

```
void moveZeroes(int* nums, int numsSize) {
    int lastNonZeroFoundAt = 0;
    for (int current = 0; current < numsSize; current++) {
        if (nums[current] != 0) {
            nums[lastNonZeroFoundAt++] = nums[current];
        }
    }
    for (int i = lastNonZeroFoundAt; i < numsSize; i++) {
        nums[i] = 0;
    }
}
```

Accepted Runtime: 0 ms

Input

```
nums =
[0,1,0,3,12]
```

Output

```
[1,3,12,0,0]
```

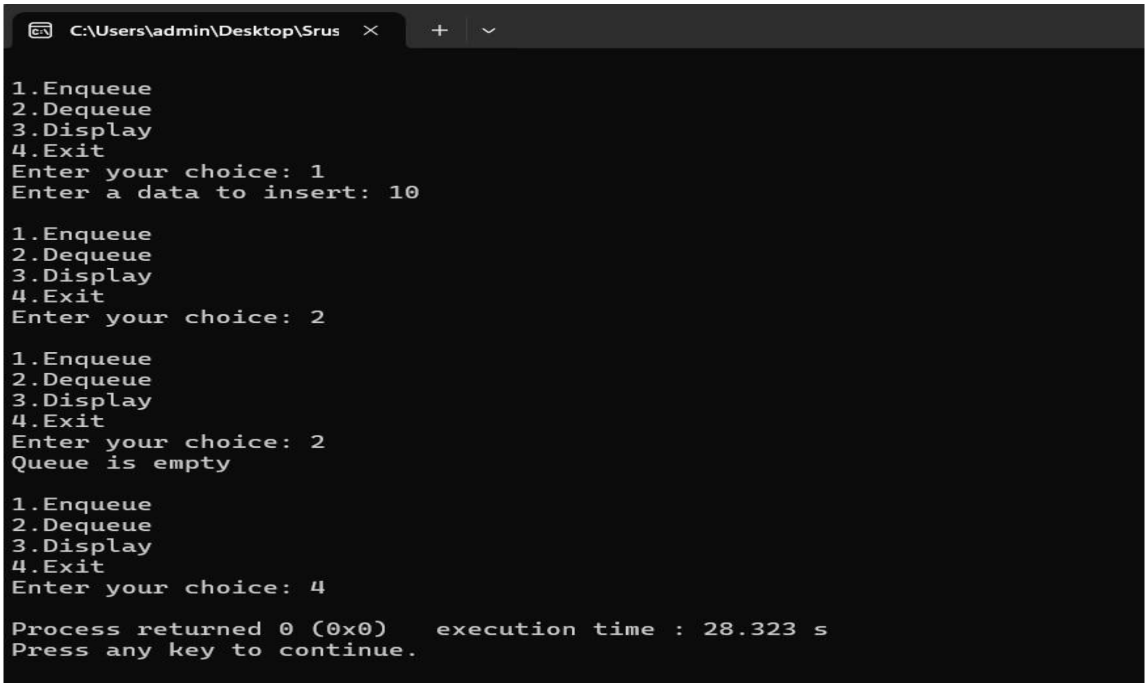
Lab program 3a:

WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display The program should print appropriate messages for queue empty and queue overflow conditions.

```
#include<stdio.h>
#include<stdlib.h>
#define    n    4    int
queue[n];            int
front=-1,rear=-1;

void        enqueue(int        x){
   if(rear==n-1){
   printf("Queue is full\n");
   }
   else if(rear==-1 && front==-1){ rear=front=0;
      queue[rear]=x;
   } else{
   rear++;
      queue[rear]=x;
   }
}

void dequeue(){ if(rear==-1 &&
   front==-1){  printf("Queue  is
   empty\n");
   }
   else if(front==rear){ front=rear=-1;
   }
   else{
      front++;
   }
}

void display(){  if(rear==-1  &&
   front==-1){  printf("Queue  is
   empty\n");
   } else{ for(int
   i=front;i<=rear;i++){
   printf("%d\n",queue[i]);
      }
   } }
```

```
void main(){ int choice,data; while(1){ printf("\n1.Enqueue
  \n2.Dequeue \n3.Display \n4.Exit\n"); printf("Enter your
  choice: "); scanf("%d",&choice); switch(choice){ case
  1:printf("Enter a data to insert: "); scanf("%d",&data);
  enqueue(data); break;
        case 2:dequeue(); break;
        case 3:display(); break;
        case 4:exit(0); break;
        default:printf("Invalid choice.");
    }
  }
}
```

Output:



```
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 1
Enter a data to insert: 10

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 2

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 2
Queue is empty

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 4

Process returned 0 (0x0)   execution time : 28.323 s
Press any key to continue.
```

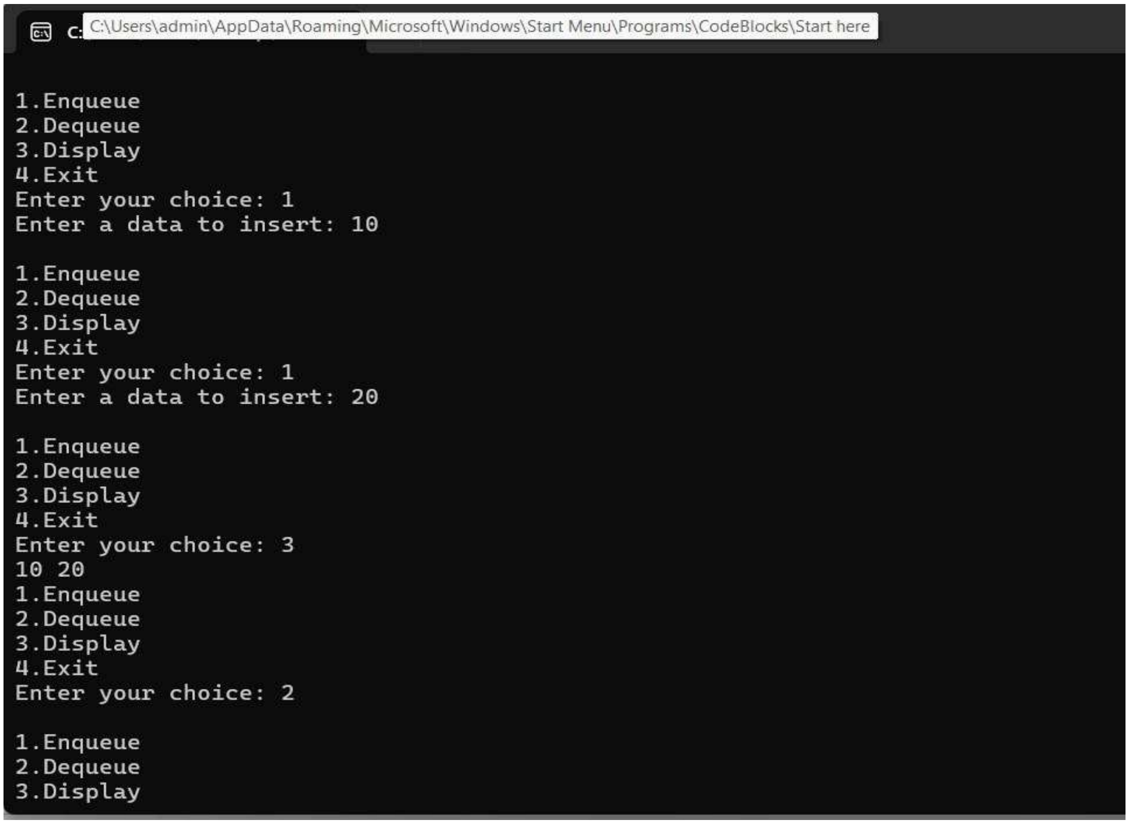
Lab program 3b:

WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The program should print appropriate messages for queue empty and queue overflow conditions

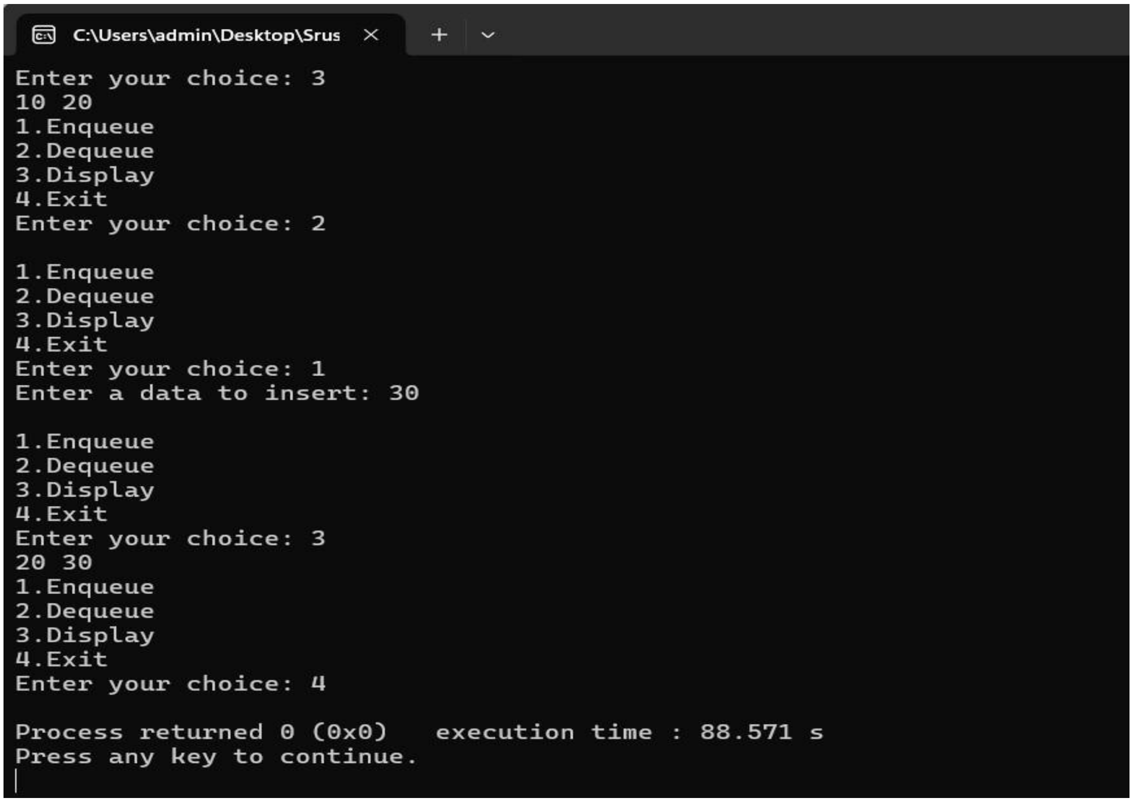
```
#include<stdio.h>
#include<stdlib.h>
#  define  n  4  int
q[n];
int rear=-1, front=-1;

void        enqueue(int        x){
   if(front==(rear+1)%n){
   printf("Queue is full\n");
   }
   else if(front==-1 && rear==-1){
      front=rear=0;
      q[rear]=x;
   }
   else{
      rear=(rear+1)%n;
      q[rear]=x;
   }
}

void dequeue(){ if(front==-1 &&
   rear==-1){    printf("Queue    is
   Empty\n");
   }
   else if(rear==front){ front=rear=-1;
   }
   else {
      front=(front+1)%n;
   }
}

void  display(){  if(front==-1  &&
   rear==-1){    printf("Queue    is
   empty\n");
   }
   else{                           for(int
      i=front;i!=rear;i++){
      printf("%d ",q[i]);
      }
      printf("%d",q[rear]);
   }
}

void   main(){   int   choice,data;   while(1){   printf("\n1.Enqueue
   \n2.Dequeue \n3.Display \n4.Exit\n");
```

```
        printf("Enter your choice: ");
        scanf("%d",&choice);
        switch(choice){
          case 1:printf("Enter a data to insert: ");
                scanf("%d",&data);
                enqueue(data);
                break;
          case 2:dequeue();
                break;
          case 3:display();
                break;
          case 4:exit(0);
               break;
          default:printf("Invalid choice.");
        }
    }
}
```

Output:


C:\Users\admin\AppData\Roaming\Microsoft\Windows\Start Menu\Programs\CodeBlocks\Start here

```
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 1
Enter a data to insert: 10

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 1
Enter a data to insert: 20

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 3
10 20
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 2

1.Enqueue
2.Dequeue
3.Display
```



```
Enter your choice: 3
10 20
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 2

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 1
Enter a data to insert: 30

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 3
20 30
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice: 4

Process returned 0 (0x0)   execution time : 88.571 s
Press any key to continue.
```

Lab program 4a:

WAP to Implement Singly Linked List with following operations a) Createalinkedlist.

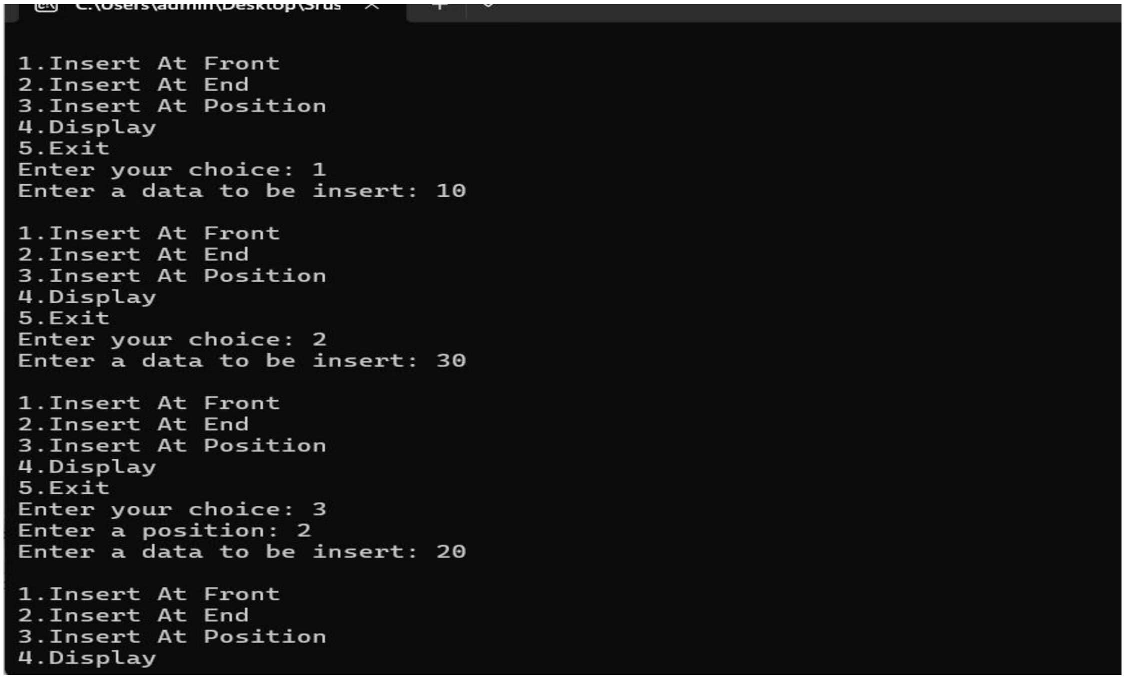
b) Insertion of a node at first position, at any position and at end of list.

Display the contents of the linked list.

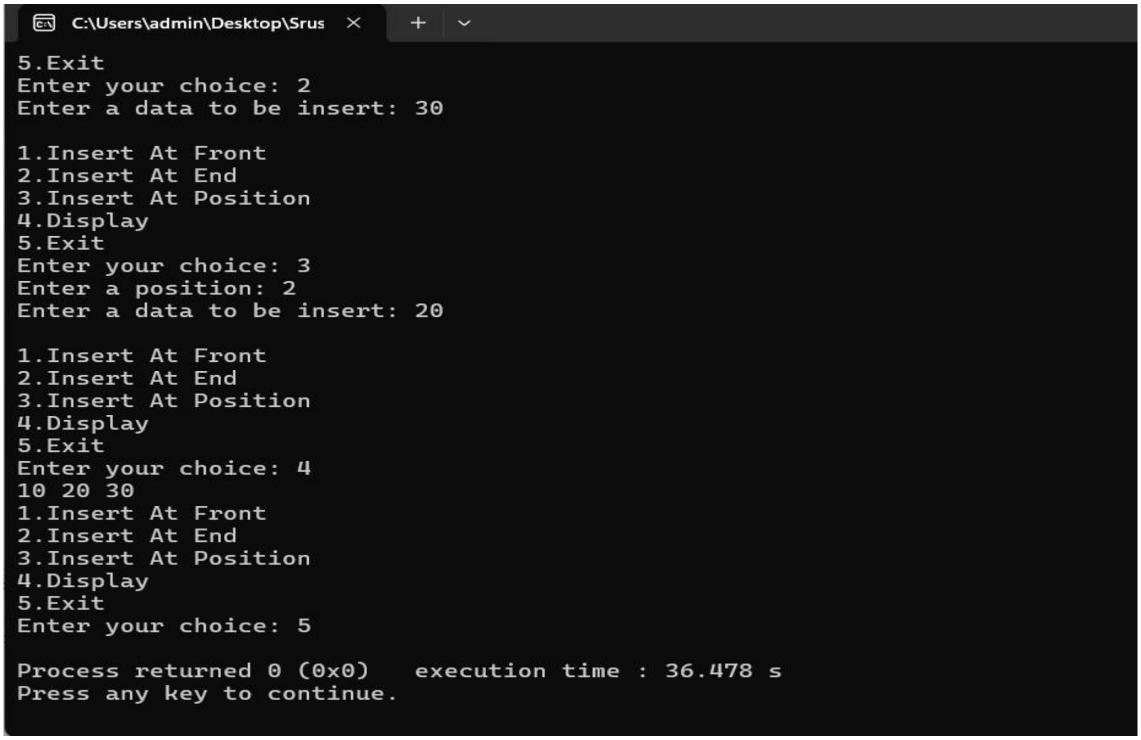
```
#include<stdio.h>
#include<stdlib.h>

struct    Node{    int
   data;  struct  Node
   *next;
};

struct Node *CreateNode(int data){ struct Node *newnode=(struct
   Node*)malloc(sizeof(struct Node)); newnode->data=data;
   newnode->next=NULL;
   return newnode;
}

void insertAtFirst(struct Node* *head,int data){
   struct Node* newnode=CreateNode(data);
```

```
        newnode->next=*head;
        *head=newnode;
}

void insertAtEnd(struct Node* *head,int data){
    struct   Node*   newnode=CreateNode(data);
    if(*head==NULL){ *head=newnode;
        return;
    }
    struct Node *temp=*head; while(temp-
    >next!=NULL){ temp=temp->next;
    }
    temp->next=newnode;
}

void insertAtPos(struct Node* *head,int data,int pos){
    struct        Node*        newnode=CreateNode(data);
    if(pos==1){                            newnode->next=*head;
    *head=newnode;
        return;
    }
    struct Node *temp=*head;
    for(int i=1;i<pos-1 && temp!=NULL;i++){ temp=temp-
        >next;
    }
    if(temp==NULL){
        printf("Position out of range.\n");
        free(newnode);
        return;
    }
    newnode->next=temp->next;
    temp->next=newnode;
}

void display(struct Node *head){
    struct    Node    *temp=head;
    while(temp!=NULL){
    printf("%d      ",temp->data);
    temp=temp->next;
    }
}

void   main(){   struct   Node
    *head=NULL;   int   data,
    choice,pos; while(1){
        printf("\n1.Insert At Front \n2.Insert At End \n3.Insert At Position \n4.Display
        \n5.Exit"); printf("\nEnter your choice: "); scanf("%d",&choice); switch(choice){ case
        1:printf("Enter a data to be insert: "); scanf("%d",&data); insertAtFirst(&head,data);
        break;
          case 2:printf("Enter a data to be insert:
                "); scanf("%d",&data);
                insertAtEnd(&head,data); break;
          case 3:printf("Enter a position: "); scanf("%d",&pos);
                printf("Enter a data to be insert: ");
                scanf("%d",&data);
                insertAtPos(&head,data,pos);
                break;
          case 4:display(head); break;
          case 5:exit(0); break;
          default:printf("Invalid choice.");

        }
    }
}
```

Output:



```
1.Insert At Front
2.Insert At End
3.Insert At Position
4.Display
5.Exit
Enter your choice: 1
Enter a data to be insert: 10

1.Insert At Front
2.Insert At End
3.Insert At Position
4.Display
5.Exit
Enter your choice: 2
Enter a data to be insert: 30

1.Insert At Front
2.Insert At End
3.Insert At Position
4.Display
5.Exit
Enter your choice: 3
Enter a position: 2
Enter a data to be insert: 20

1.Insert At Front
2.Insert At End
3.Insert At Position
4.Display
```



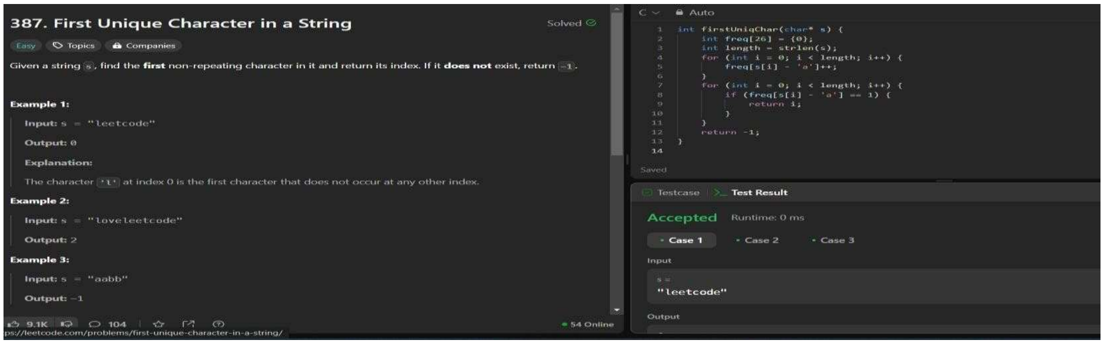
```
5.Exit
Enter your choice: 2
Enter a data to be insert: 30

1.Insert At Front
2.Insert At End
3.Insert At Position
4.Display
5.Exit
Enter your choice: 3
Enter a position: 2
Enter a data to be insert: 20

1.Insert At Front
2.Insert At End
3.Insert At Position
4.Display
5.Exit
Enter your choice: 4
10 20 30
1.Insert At Front
2.Insert At End
3.Insert At Position
4.Display
5.Exit
Enter your choice: 5

Process returned 0 (0x0)   execution time : 36.478 s
Press any key to continue.
```

Lab program 4b:

Program - Leetcode platform

```
int firstUniqChar(char* s) { int
      freq[26] = {0}; int length =
      strlen(s); for (int i = 0; i <
      length; i++) { freq[s[i] -
      'a']++;
      }
      for (int i = 0; i < length; i++) {
            if (freq[s[i] - 'a'] == 1) {
            return i;
            }
      }
      return -1;
}
```

Output:



387. First Unique Character in a String

Given a string s, find the **first** non-repeating character in it and return its index. If it **does not** exist, return -1.

Example 1:

Input: s = "leetcode"

Output: 0

Explanation:

The character 'l' at index 0 is the first character that does not occur at any other index.

Example 2:

Input: s = "loveleetcode"

Output: 2

Example 3:

Input: s = "aabb"

Output: -1

```
int firstUniqChar(char* s) {
    int freq[26] = {0};
    int length = strlen(s);
    for (int i = 0; i < length; i++) {
        freq[s[i] - 'a']++;
    }
    for (int i = 0; i < length; i++) {
        if (freq[s[i] - 'a'] == 1) {
            return i;
        }
    }
    return -1;
}
```

Accepted Runtime: 0 ms

Input

s =

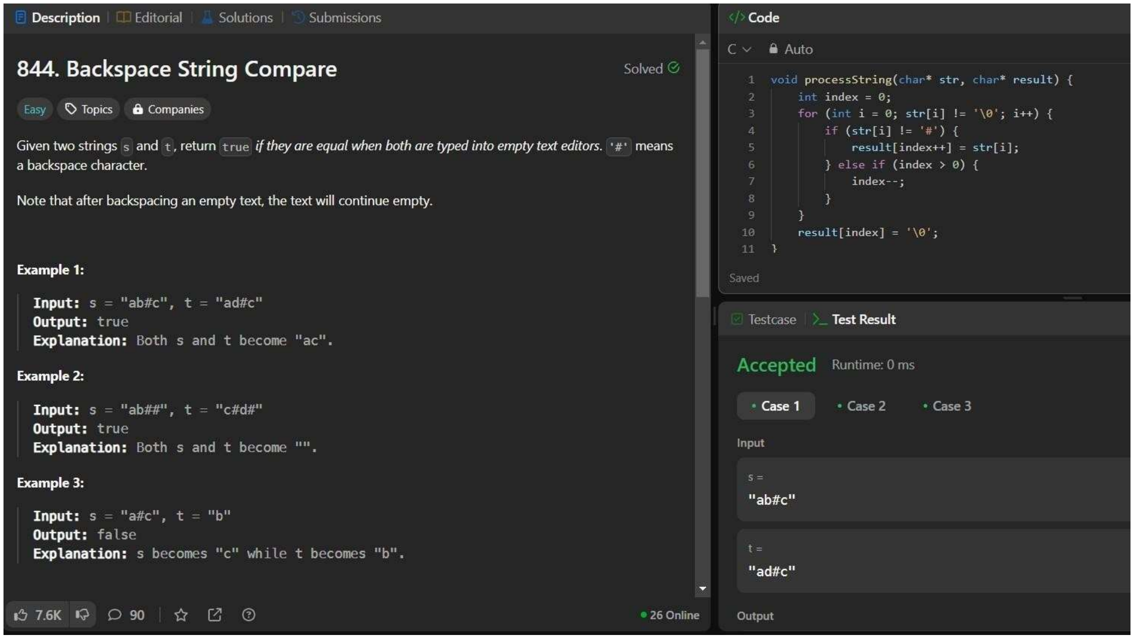
"leetcode"

Output

Program - Leetcode platform

```
void processString(char* str, char* result) { int
            index = 0;
             for (int i = 0; str[i] != '\0'; i++) { if
                        (str[i] != '#') { result[index++]
                        = str[i];
                        } else if (index >
                        0) { index--;
                        }
            }
            result[index] = '\0';
}
bool  backspaceCompare(char*  s,  char*  t)  {  char
            processedS[201];     char     processedT[201];
            processString(s,                     processedS);
            processString(t,       processedT);       return
            strcmp(processedS, processedT) == 0;
}
```

Output:



844. Backspace String Compare

Given two strings s and t, return true *if they are equal when both are typed into empty text editors.* '#' means a backspace character.

Note that after backspacing an empty text, the text will continue empty.

Example 1:

```
Input: s = "ab#c", t = "ad#c"
Output: true
Explanation: Both s and t become "ac".
```

Example 2:

```
Input: s = "ab##", t = "c#d#"
Output: true
Explanation: Both s and t become "".
```

Example 3:

```
Input: s = "a#c", t = "b"
Output: false
Explanation: s becomes "c" while t becomes "b".
```

```
void processString(char* str, char* result) {
    int index = 0;
    for (int i = 0; str[i] != '\0'; i++) {
        if (str[i] != '#') {
            result[index++] = str[i];
        } else if (index > 0) {
            index--;
        }
    }
    result[index] = '\0';
}
```

Accepted Runtime: 0 ms

Input

s =

"ab#c"

t =

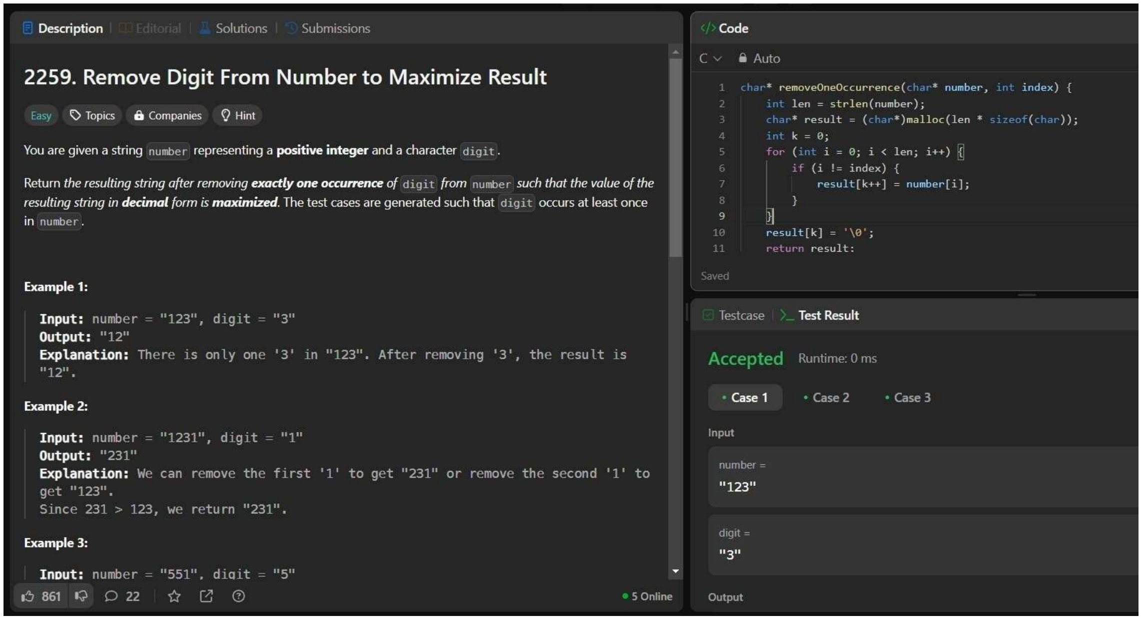
"ad#c"

Output

Program - Leetcode platform

```
char* removeOneOccurrence(char* number, int index) { int
    len = strlen(number);
    char* result = (char*)malloc(len * sizeof(char));
    int k = 0; for (int i = 0; i <
    len; i++) { if (i != index) {
        result[k++] = number[i];
        }
}
    result[k] = '\0'; return
    result;
}
char* removeDigit(char* number, char digit) { char*
    maxString = NULL;
    for (int i = 0; number[i] != '\0'; i++) { if
        (number[i] == digit) {
        char* newString = removeOneOccurrence(number, i); if (maxString
            == NULL || strcmp(newString, maxString) > 0) { if (maxString
            != NULL) { free(maxString);
                }
            maxString = newString;
            }
            else { free(newString);
            }
        }
    }
    return maxString;
}
```

Output:



2259. Remove Digit From Number to Maximize Result

You are given a string `number` representing a **positive integer** and a character `digit`.

Return *the resulting string after removing **exactly one occurrence** of* `digit` *from* `number` *such that the value of the resulting string in **decimal** form is **maximized***. The test cases are generated such that `digit` occurs at least once in `number`.

Example 1:

```
Input: number = "123", digit = "3"
Output: "12"
Explanation: There is only one '3' in "123". After removing '3', the result is
"12".
```

Example 2:

```
Input: number = "1231", digit = "1"
Output: "231"
Explanation: We can remove the first '1' to get "231" or remove the second '1' to
get "123".
Since 231 > 123, we return "231".
```

Example 3:

```
Input: number = "551", digit = "5"
```

```
char* removeOneOccurrence(char* number, int index) {
    int len = strlen(number);
    char* result = (char*)malloc(len * sizeof(char));
    int k = 0;
    for (int i = 0; i < len; i++) {
        if (i != index) {
            result[k++] = number[i];
        }
    }
    result[k] = '\0';
    return result:
```

Accepted Runtime: 0 ms

Input

number =
"123"

digit =
"3"

Output

Lab program 5a:

WAP to Implement Singly Linked List with following operations a) Create a linked list.

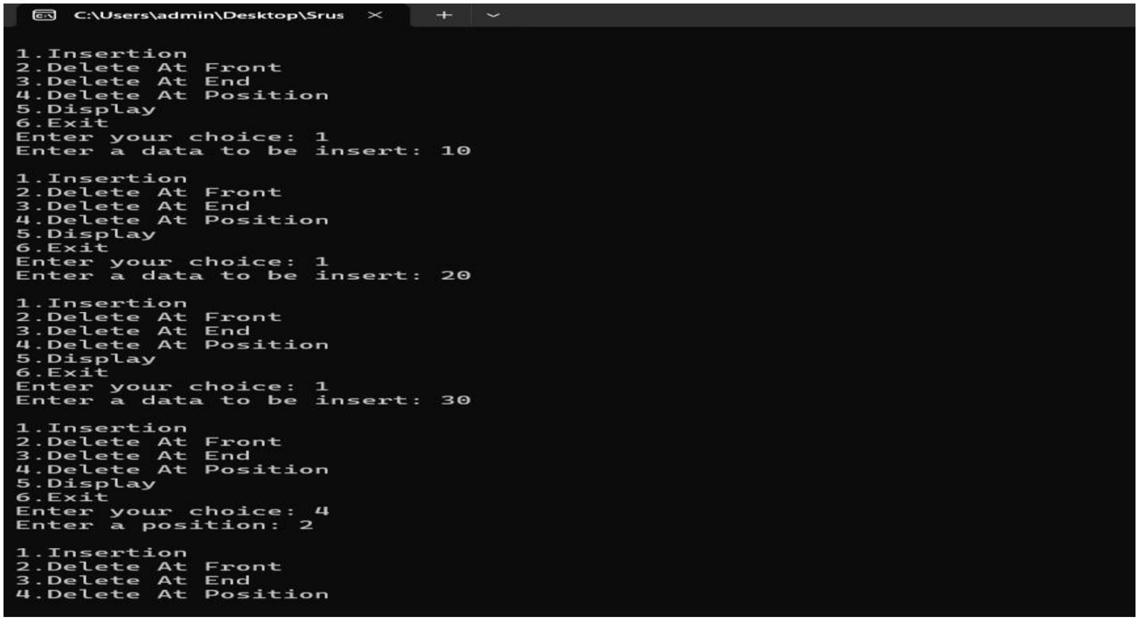
b) Deletion of first element, specified element and last element in the list.

c) Display the contents of the linked list.

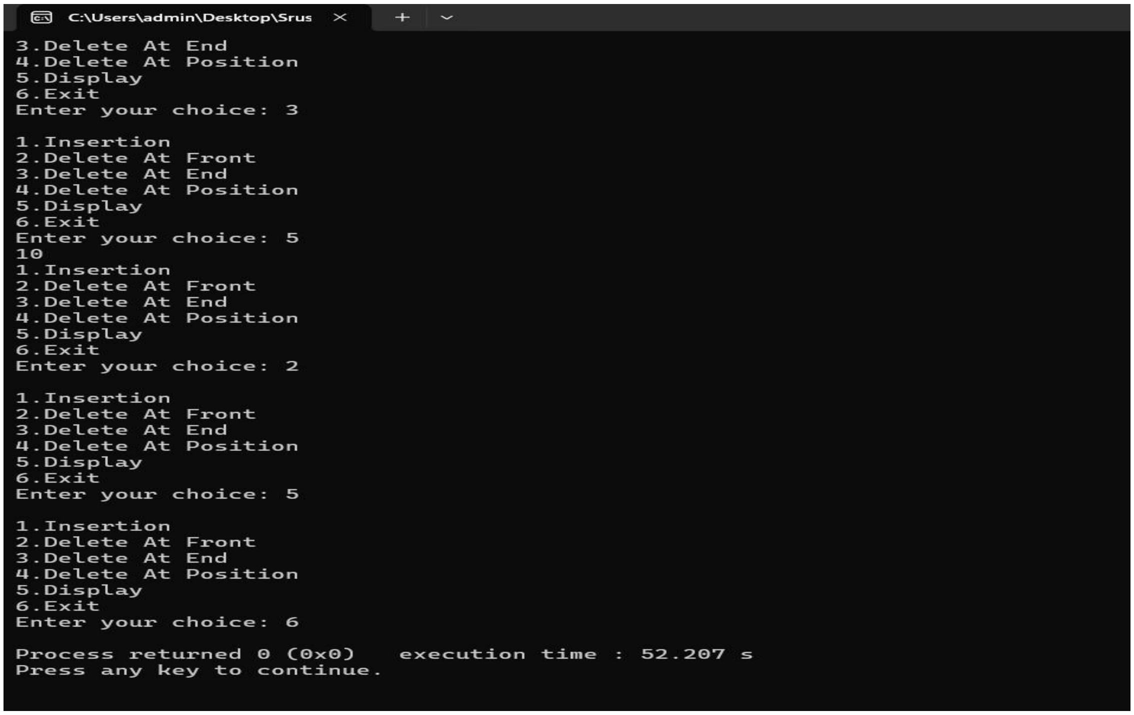
```
#include<stdio.h>
#include<stdlib.h>

struct Node{ int
   data;
   struct Node *next;
};

struct Node *CreateNode(int data){ struct Node *newnode=(struct
   Node*)malloc(sizeof(struct Node)); newnode->data=data;
   newnode->next=NULL;
   return newnode;
}

void insertAtEnd(struct Node* *head,int data){
   struct   Node*   newnode=CreateNode(data);
   if(*head==NULL){ *head=newnode;
      return;
   }
   struct Node *temp=*head; while(temp-
   >next!=NULL){ temp=temp->next;
   }
   temp->next=newnode;
}

void deleteAtFront(struct Node* *head){
   if(*head==NULL){       printf("List       is
   Empty\n");
   }
   struct Node *temp1=*head; struct
   Node *temp2=temp1->next;
   *head=temp2;
   free(temp1);
}

void deleteAtEnd(struct Node* *head){
   if(*head==NULL){      printf("List      is
   empty\n");
   }

   struct Node *temp1=*head; struct
   Node *temp2=NULL;

   if(temp1->next==NULL){
      free(temp1);
```

```
        *head=NULL;
    }

    while(temp1->next!=NULL){
        temp2=temp1;
        temp1=temp1->next;
    }
    temp2->next=NULL;
    free(temp1);
}

void deleteAtPos(struct Node* *head,int pos){
    if(*head==NULL){ printf("List
        is empty\n");
    }
    struct Node *temp1=*head; struct
    Node *temp2=NULL;
    if(pos==1){
        *head=temp1->next;
        free(temp1);
    }
    for(int i=1;i<pos-1 && temp1!=NULL;i++){
        temp1=temp1->next;
    }
    if(temp1==NULL       ||       temp1->next==NULL){
        printf("Position out of range\n");
    }
    temp2=temp1->next;          temp1->next=temp2-
    >next;
    free(temp2);
}

void display(struct Node *head){
    struct   Node   *temp=head;
    while(temp!=NULL){
    printf("%d ",temp->data);
        temp=temp->next;
    }
}

void main(){
    struct Node *head=NULL; int data, choice,pos; while(1){ printf("\n1.Insertion \n2.Delete At Front
    \n3.Delete At End \n4.Delete At Position \n5.Display
\n6.Exit"); printf("\nEnter your
        choice: ");
        scanf("%d",&choice);
        switch(choice){
            case 1:printf("Enter a data to be insert: ");
                   scanf("%d",&data);
                   insertAtEnd(&head,data);
            break;
        case          2:deleteAtFront(&head);
            break;
        case 3:deleteAtEnd(&head);
            break;
        case 4:printf("Enter a position: ");
            scanf("%d",&pos);
            deleteAtPos(&head,pos);
            break;
        case 5:display(head);
            break;
        case 6:exit(0);
            break;
        default:printf("Invalid choice.");

      }
   }
}
```

Output:



```
1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 1
Enter a data to be insert: 10

1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 1
Enter a data to be insert: 20

1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 1
Enter a data to be insert: 30

1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 4
Enter a position: 2

1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
```



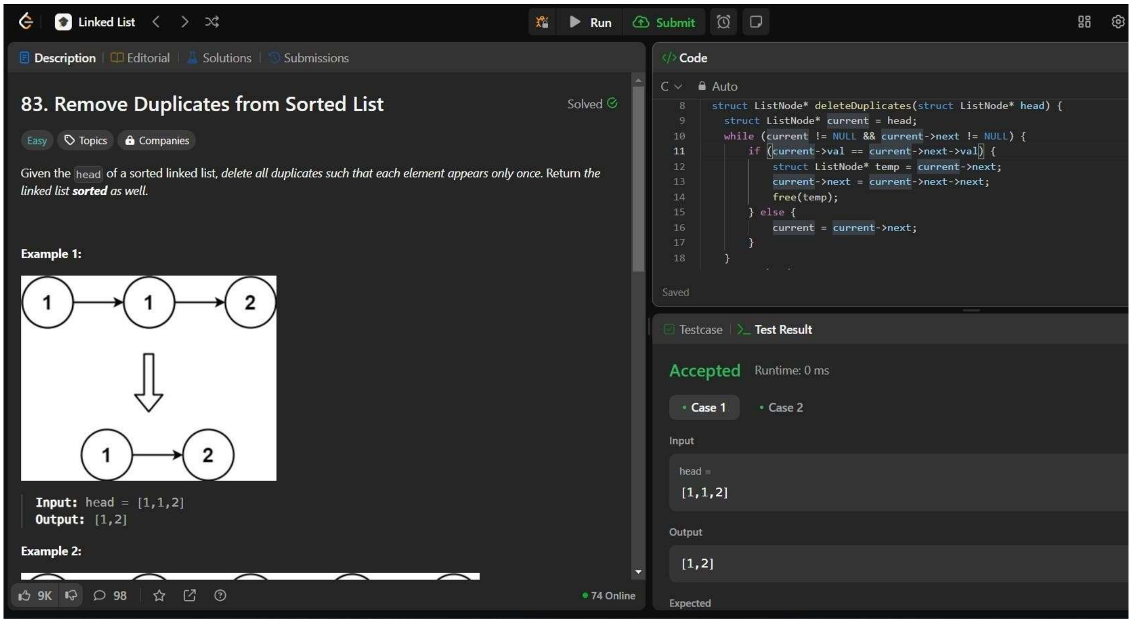
```
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 3

1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 5
10
1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 2

1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 5

1.Insertion
2.Delete At Front
3.Delete At End
4.Delete At Position
5.Display
6.Exit
Enter your choice: 6

Process returned 0 (0x0)   execution time : 52.207 s
Press any key to continue.
```

Lab program 5b:

Program - Leetcode platform

```
struct ListNode*
deleteDuplicates(struct ListNode* head) { struct ListNode*
current = head;
        while (current != NULL && current->next != NULL) { if
                (current->val == current->next->val) { struct
                ListNode* temp = current->next; current->next
                = current->next->next; free(temp);
                }       else
                {
                        current = current->next;
                }
        }
        return head;
}
struct ListNode* createNode(int val) { struct ListNode* newNode = (struct
        ListNode*)malloc(sizeof(struct ListNode)); newNode->val = val; newNode-
        >next = NULL;
        return newNode;
}
void printList(struct ListNode* head) { struct
        ListNode* current = head; while
        (current != NULL) { printf("%d -> ",
        current->val); current = current-
        >next;
        }
        printf("NULL\n");
}
```

Output:



83. Remove Duplicates from Sorted List

Solved

Easy · Topics · Companies

Given the `head` of a sorted linked list, *delete all duplicates such that each element appears only once. Return the linked list* ***sorted*** *as well.*

Example 1:

```
Input: head = [1,1,2]
Output: [1,2]
```

Example 2:

```
struct ListNode* deleteDuplicates(struct ListNode* head) {
  struct ListNode* current = head;
  while (current != NULL && current->next != NULL) {
      if (current->val == current->next->val) {
          struct ListNode* temp = current->next;
          current->next = current->next->next;
          free(temp);
      } else {
          current = current->next;
      }
  }
```

Accepted   Runtime: 0 ms

Case 1   Case 2

Input

```
head =
[1,1,2]
```

Output

```
[1,2]
```

Expected

Lab program 6a:

WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

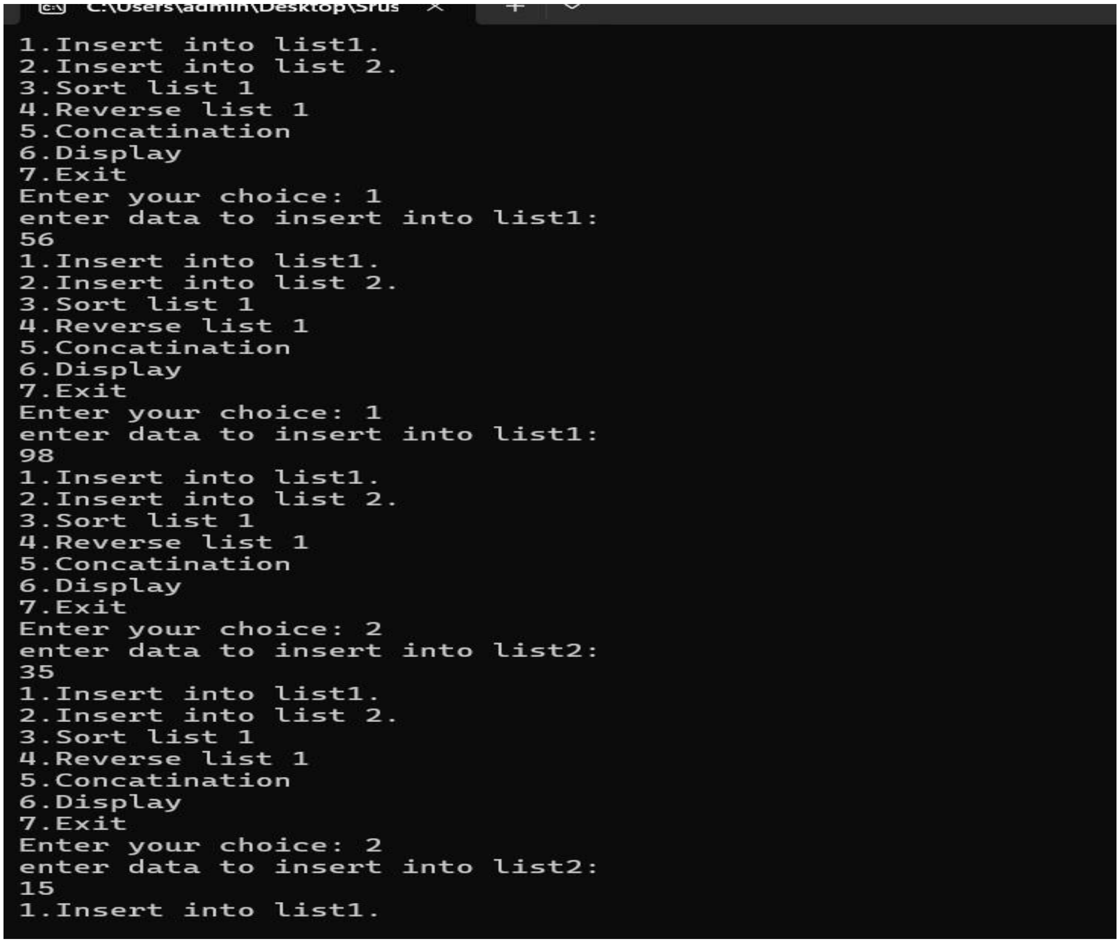
```
#include<stdio.h>
#include<stdlib.h>
#include<stdbool.h>

struct    Node{    int
   data;  struct  Node
   *next;
};

struct Node *createNode(int data){
   struct Node *newnode=(struct Node *)malloc(sizeof(struct Node));
   newnode->data=data; newnode->next=NULL; return newnode;
}

void insertEnd(struct Node* *head,int data){
   struct Node *newnode=createNode(data);
   if(*head==NULL){
       *head=newnode;
```

```
   }else{
   struct Node *temp=*head; while(temp-
   >next!=NULL){ temp=temp->next;
   }
   temp->next=newnode;
   }
}

void       sort(struct       Node*       *head){
   if(*head==NULL || (*head)->next==NULL){
   return;
   }
   struct   Node   *i=*head;
   while(i!=NULL){      struct
   Node             *j=i->next;
   while(j!=NULL){        if(i-
   >data   >   j->data){   int
   temp=i->data;  i->data=j-
   >data;
         j->data=temp;
       }
       j=j->next;
     }
     i=i->next;
   }
}

void reverse(struct Node* *head){
   struct Node *prev=NULL; struct
   Node *curr=*head; struct Node
   *nextn=NULL;

   while(curr!=NULL){
     nextn=curr->next;
     curr->next=prev;
     prev=curr;
     curr=nextn;
   }
   *head=prev;
}

void concate(struct Node* *head1,struct Node* *head2){
   if(*head1==NULL){
     *head1=*head2;
   }
```

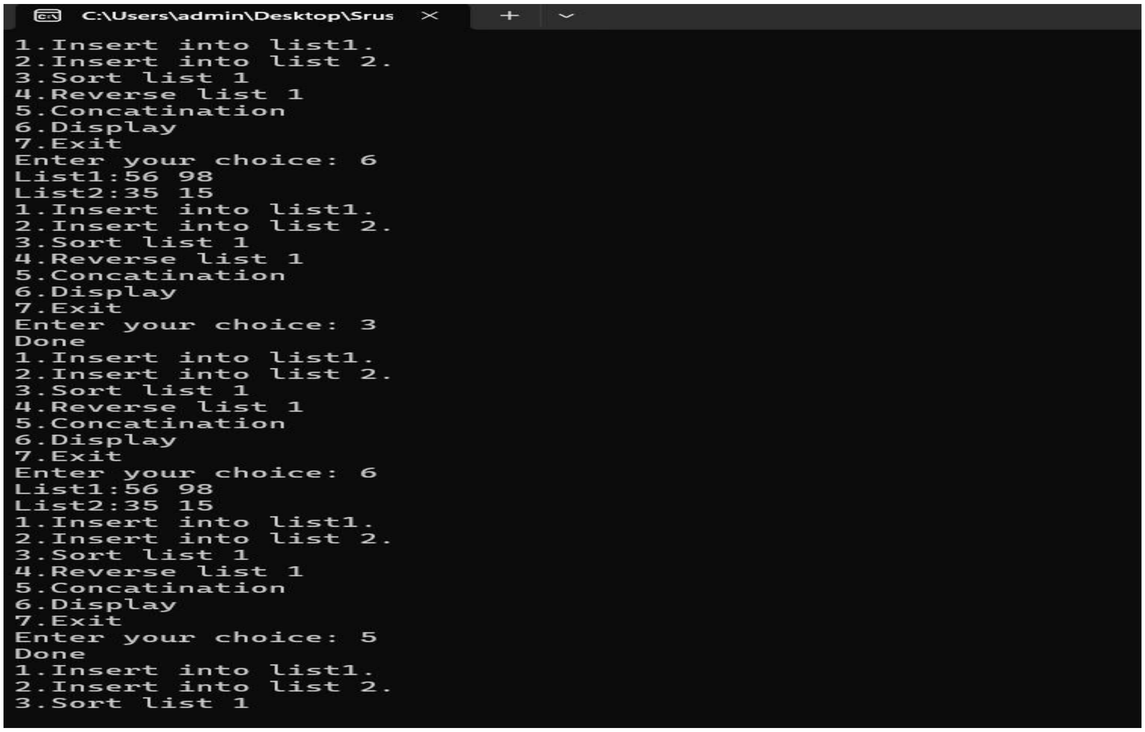
```
    struct Node *temp=*head1; while(temp-
    >next!=NULL){ temp=temp->next;
    }
    temp->next=*head2;
    *head2=NULL;
}
void display(struct Node* head){
    struct    Node    *temp=head;
    while(temp!=NULL){
    printf("%d        ",temp->data);
    temp=temp->next;
    }
    printf("\n");
}

void main()
{
    struct Node *list1=NULL;
    struct Node *list2=NULL; int
    data,choice;

    while(true){ printf("1.Insert into
        list1.\n"); printf("2.Insert into
        list  2.\n");  printf("3.Sort  list
        1\n");   printf("4.Reverse   list
        1\n");
        printf("5.Concatination\n");
        printf("6.Display\n");
        printf("7.Exit\n");

        printf("Enter your choice: "); scanf("%d",&choice);
        switch(choice){ case 1:printf("enter data to insert
        into list1: \n"); scanf("%d",&data);
        insertEnd(&list1,data); break;
            case 2:printf("enter data to insert into list2:
                  \n"); scanf("%d",&data);
                  insertEnd(&list2,data); break;
            case 3:sort(&list1);
                  printf("Done\n");
                  break;
            case 4:reverse(&list1);
```

```
                printf("Done\n");
                break;
            case 5:concate(&list1,&list2);
                printf("Done\n");
                break;
            case 6:printf("List1:");
                display(list1);
                printf("List2:");
                display(list2);
                break;
            case 7:exit(0);
                break;
            default:printf("Invalid Choice.... \n");
                break;

        }
    }
}
```

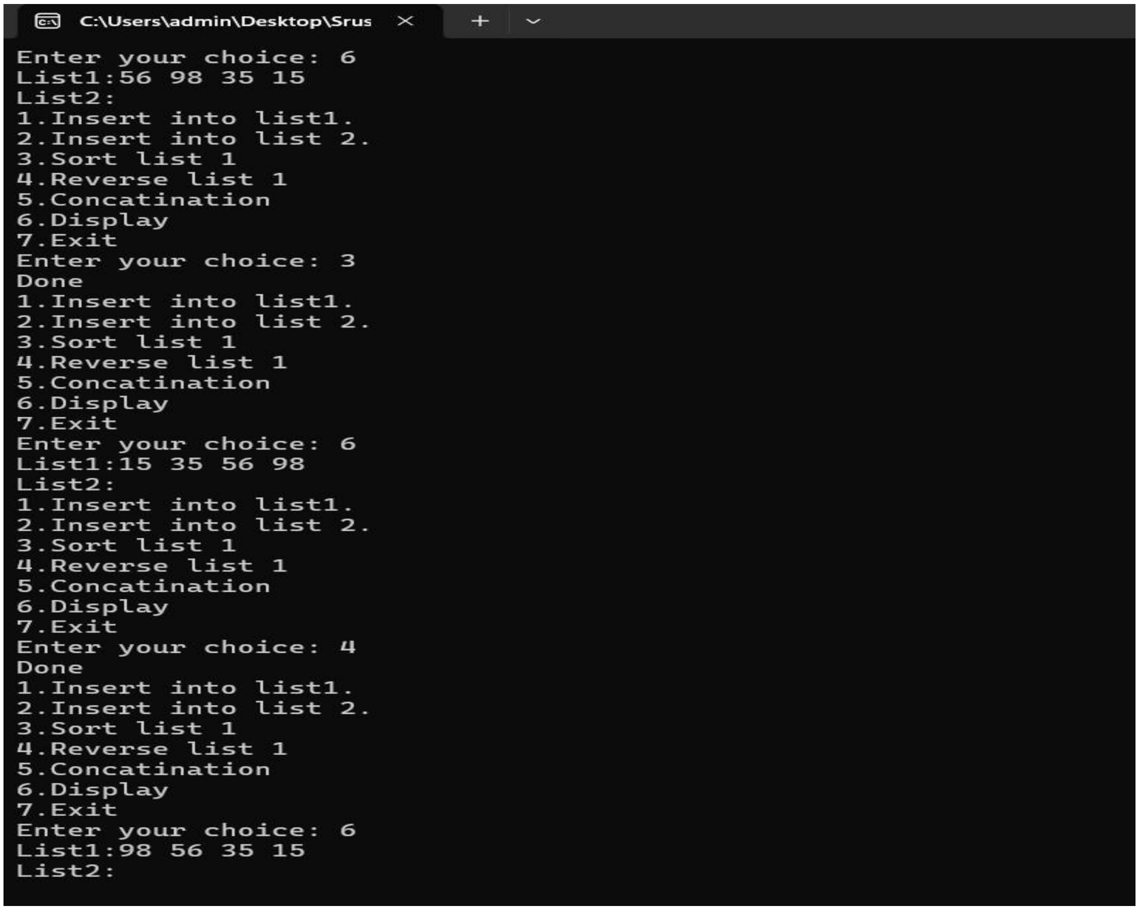
Output:



```
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 1
enter data to insert into list1:
56
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 1
enter data to insert into list1:
98
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 2
enter data to insert into list2:
35
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 2
enter data to insert into list2:
15
1.Insert into list1.
```



```
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 6
List1:56 98
List2:35 15
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 3
Done
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 6
List1:56 98
List2:35 15
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 5
Done
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
```



```
Enter your choice: 6
List1:56 98 35 15
List2:
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 3
Done
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 6
List1:15 35 56 98
List2:
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 4
Done
1.Insert into list1.
2.Insert into list 2.
3.Sort list 1
4.Reverse list 1
5.Concatination
6.Display
7.Exit
Enter your choice: 6
List1:98 56 35 15
List2:
```

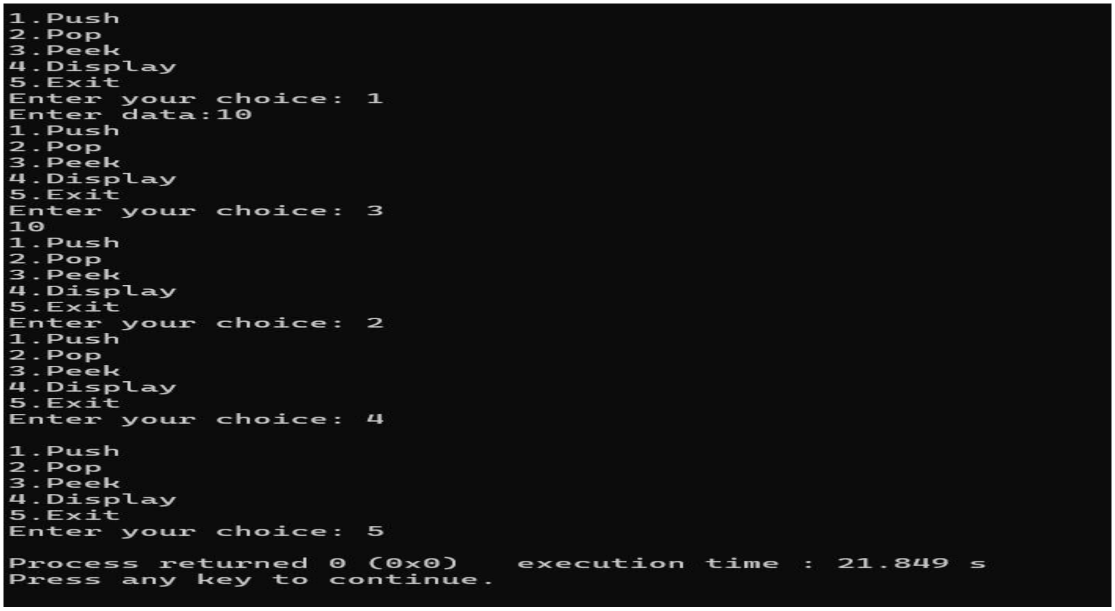
Lab program 6b:

WAP to Implement Single Link List to simulate Stack Operation.

```
#include<stdio.h>
#include<stdlib.h>
#include<stdbool.h>

struct Node{ int
   data;
   struct Node *next;
};

void push(int x,struct Node* *top){ struct Node newnode=(struct
   Node)malloc(sizeof(struct      Node));      newnode->data=x;
   newnode->next=*top;
   *top=newnode;
}

void pop(struct Node* *top){
   if(*top==NULL){
   printf("Empty\n");
   }
   struct Node *temp=*top;
   *top=(*top)->next;
   free(temp);
}
void peek(struct Node* top) {
   if   (top   ==   NULL)   {
   printf("Empty\n");
   } else { printf("%d \n", top-
      >data);
   }
}

void display(struct Node* top) {
   struct  Node*  temp  =  top;
   while  (temp  !=  NULL)  {
   printf("%d  ",  temp->data);
   temp = temp->next;
   }
   printf("\n");
}

void      main(){      int
   data,choice;      struct
   Node *top=NULL;
```

```
    while(true){
      printf("1.Push\n");
      printf("2.Pop\n");
      printf("3.Peek\n");
      printf("4.Display\n");
      printf("5.Exit\n");

      printf("Enter your choice: ");
      scanf("%d",&choice);

      switch(choice){
        case 1:printf("Enter data:");
            scanf("%d",&data
            );
            push(data,&top);
            break;
        case 2:pop(&top); break;
        case 3:peek(top); break;
        case 4:display(top);
            break;
        case 5:exit(0);
            break;
        default:printf("Invalid Choice\n");
             break;
      }
    }
  }
```

Output:



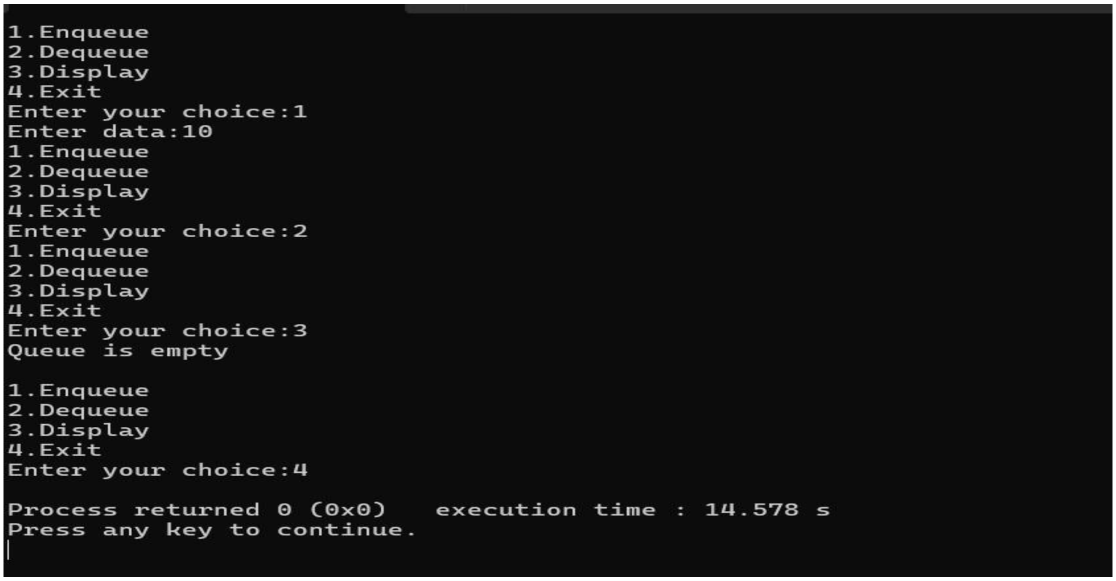
```
1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 1
Enter data:10
1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 3
10
1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 2
1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 4

1.Push
2.Pop
3.Peek
4.Display
5.Exit
Enter your choice: 5

Process returned 0 (0x0)   execution time : 21.849 s
Press any key to continue.
```

WAP to Implement Single Link List to simulate Queue Operation.

```
#include<stdio.h>
#include<stdlib.h>

struct Node{ int
  data;
  struct Node *next;
};

void enqueue(struct Node* *front,struct Node* *rear,int data){
  struct Node *newnode=(struct Node*)malloc(sizeof(struct Node));
  newnode->data=data; newnode->next=NULL;

  if(*front==NULL && *rear==NULL){
    *front=*rear=newnode;
  }
  else{
    (*rear)->next=newnode;
    *rear=newnode;
  }
}

void dequeue(struct Node* *front,struct Node* *rear){
  if(*front==NULL && *rear==NULL){ printf("Queue is
  empty\n");
  }
  else if(*front==*rear){
    *front=*rear=NULL;
  }
  else{
    *front=(*front)->next;
  }
}

void display(struct Node* front){
  struct Node *temp=front;
  if(front==NULL){
  printf("Queue is empty\n");
  }
  while(temp!=NULL){
    printf("%d ",temp->data);
    temp=temp->next;
  }
  printf("\n");
}
```

```
void main(){
   int    data,choice;    struct
   Node           *front=NULL;
   struct Node *rear=NULL;

   while(1){
      printf("1.Enqueue\n");
      printf("2.Dequeue\n");
      printf("3.Display\n");
      printf("4.Exit\n");

      printf("Enter                  your                  choice:");
      scanf("%d",&choice);

      switch(choice){
         case 1:printf("Enter data:");
              scanf("%d",&data);
              enqueue(&front,&rear,data);
              break;
         case 2:dequeue(&front,&rear);
              break;
         case 3:display(front);
              break;
         case 4:exit(0);
              break;
         default:printf("Invalid choice\n");
      }
   }
}
```

Output:



```
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice:1
Enter data:10
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice:2
1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice:3
Queue is empty

1.Enqueue
2.Dequeue
3.Display
4.Exit
Enter your choice:4

Process returned 0 (0x0)   execution time : 14.578 s
Press any key to continue.
```

Lab program 7a:

WAP to Implement doubly link list with primitive operations a) Create a doubly linked list.

b) Insert a new node to the left of the node.

c) Delete the node based on a specific value.

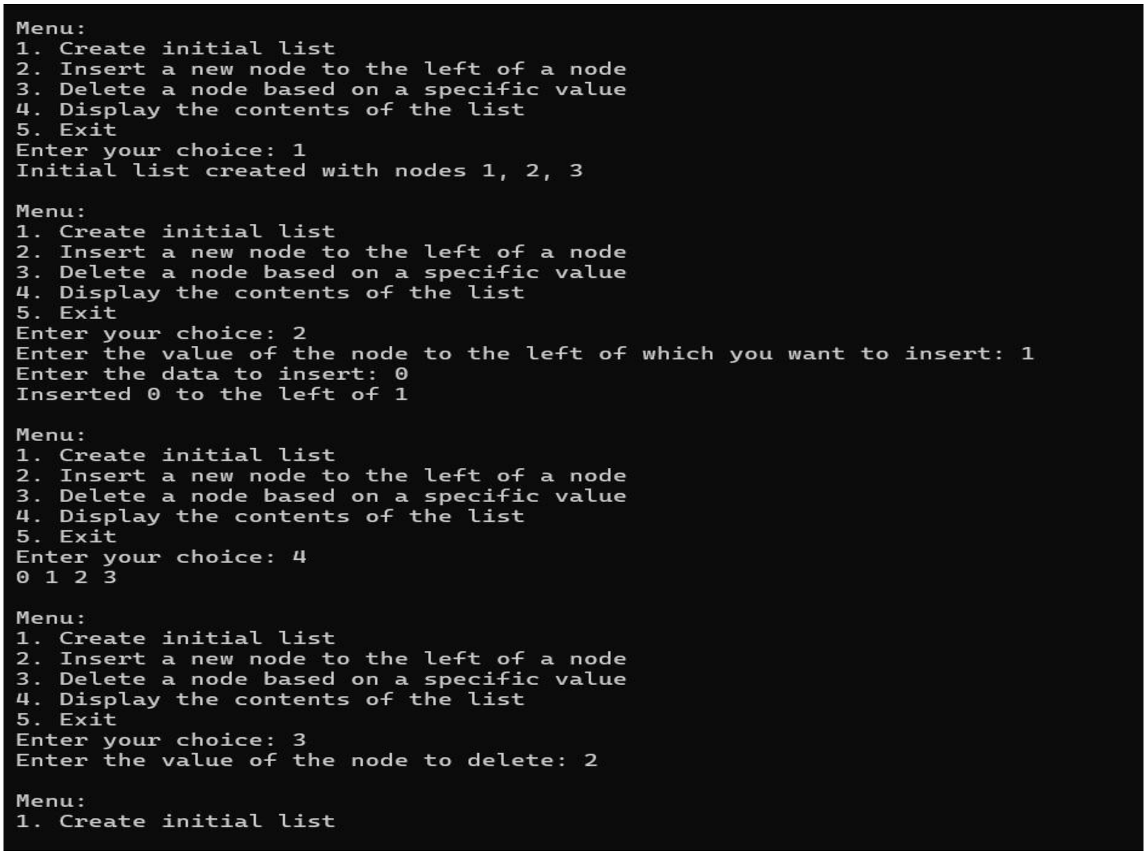
d) Display the contents of the list.

```
#include    <stdio.h>
#include    <stdlib.h>
struct   Node   {   int
data;   struct   Node
*prev;
   struct Node *next;
};
struct Node* createNode(int data) { struct Node *newNode = (struct
   Node *)malloc(sizeof(struct Node)); if (!newNode) { printf("Memory
   allocation failed\n"); exit(1);
   }
   newNode->data = data;
   newNode->prev = NULL;
   newNode->next = NULL;
   return newNode;
}
void insertLeft(struct Node **head, struct Node *node, int data) {
   struct Node *newNode = createNode(data); newNode->next =
   node; newNode->prev = node->prev; if (node->prev != NULL) {
   node->prev->next = newNode;
   } else {
      *head = newNode;
   }
   node->prev = newNode;
}
void deleteNode(struct Node **head, int value) { struct
   Node *temp = *head;
   while (temp != NULL && temp->data != value) { temp
      = temp->next;
   }
   if (temp == NULL) { printf("Node with value %d not
      found\n", value); return;
   }
```

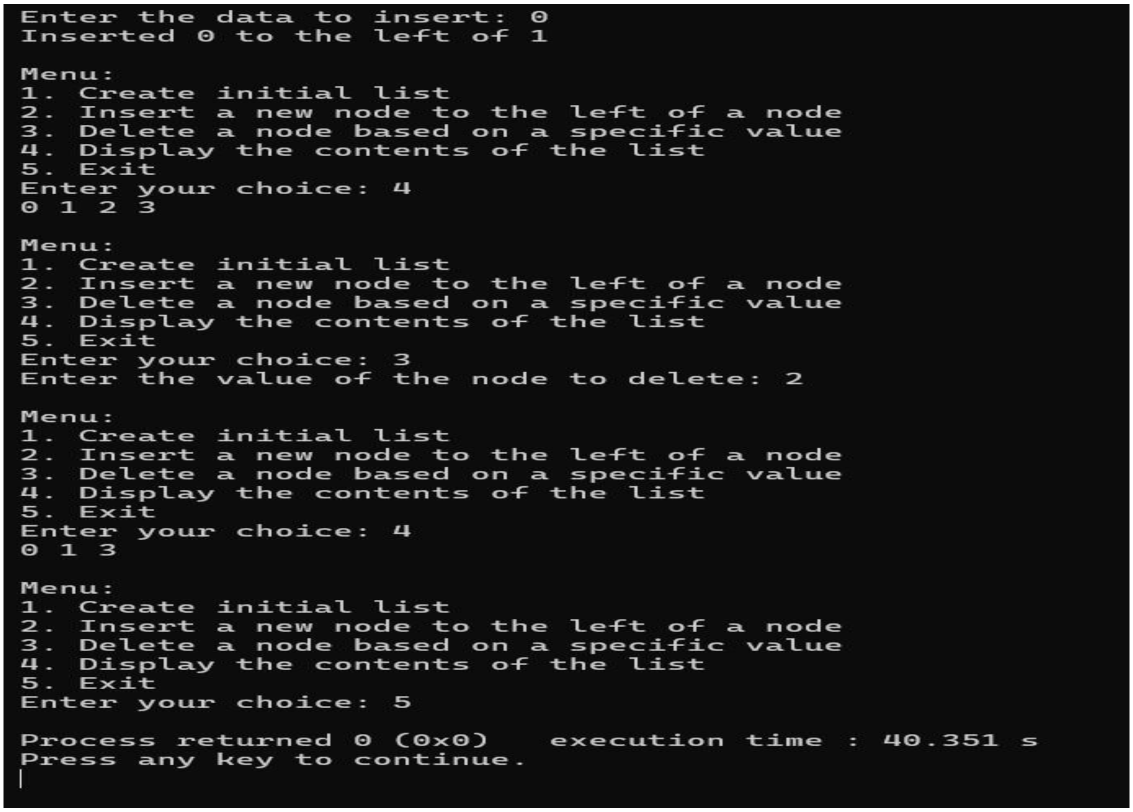
```
  if (temp->prev != NULL) { temp->prev->next
    = temp->next;
  } else {
    *head = temp->next;
  }
  if (temp->next != NULL) { temp->next->prev
    = temp->prev;
  }
  free(temp);
}
void displayList(struct Node *head) {
  struct Node *temp = head; while
  (temp != NULL) { printf("%d ",
  temp->data);
    temp = temp->next;
  }
  printf("\n");
}
int main() { struct Node *head = NULL;
  struct Node *node1, *node2, *node3;
  int choice, data, value; while (1) {
  printf("\nMenu:\n");    printf("1.
  Create initial list\n");
    printf("2. Insert a new node to the left of a node\n");
    printf("3. Delete a node based on a specific value\n");
    printf("4. Display the contents of the list\n");
    printf("5. Exit\n"); printf("Enter your choice: ");
    scanf("%d", &choice); switch (choice) { case 1:node1 =
    createNode(1); node2 = createNode(2); node3 =
    createNode(3); head = node1; node1->next = node2;
    node2->prev = node1; node2->next = node3; node3-
    >prev = node2;
          printf("Initial list created with nodes 1, 2, 3\n"); break;

      case 2:printf("Enter the value of the node to the left of which you want to insert: ");
          scanf("%d", &value);
          printf("Enter the data to insert: ");
```

```
                scanf("%d", &data); struct Node *temp = head;
                while (temp != NULL && temp->data != value) {
                 temp = temp->next;
                }

              if (temp != NULL) { insertLeft(&head,
                 temp, data);
                 printf("Inserted %d to the left of %d\n", data, value);
              } else {
                 printf("Node with value %d not found\n", value);
              }
              break;

           case 3:
              printf("Enter the value of the node to delete: ");
              scanf("%d",      &value);      deleteNode(&head,
              value); break;

           case 4:
              displayList(head);
              break;

           case 5:
              exit(0);
              break;

           default: printf("Invalid
              choice\n"); break;
        }
     }

     return 0;
  }
```

Output:



```
Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 1
Initial list created with nodes 1, 2, 3

Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 2
Enter the value of the node to the left of which you want to insert: 1
Enter the data to insert: 0
Inserted 0 to the left of 1

Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 4
0 1 2 3

Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 3
Enter the value of the node to delete: 2

Menu:
1. Create initial list
```



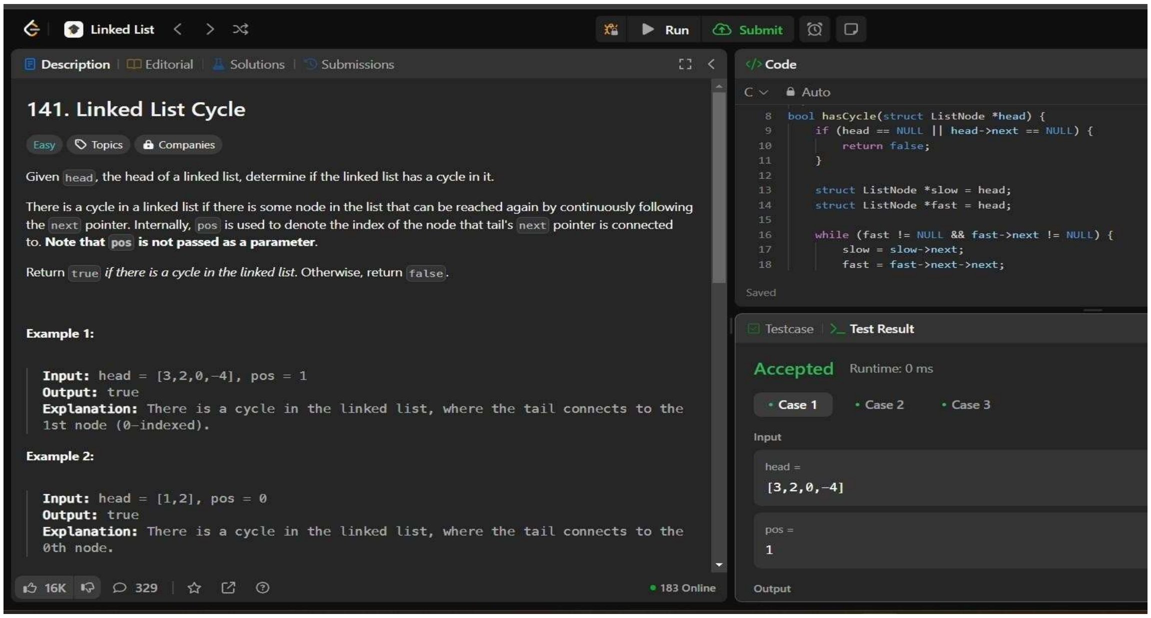
```
Enter the data to insert: 0
Inserted 0 to the left of 1

Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 4
0 1 2 3

Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 3
Enter the value of the node to delete: 2

Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 4
0 1 3

Menu:
1. Create initial list
2. Insert a new node to the left of a node
3. Delete a node based on a specific value
4. Display the contents of the list
5. Exit
Enter your choice: 5

Process returned 0 (0x0)   execution time : 40.351 s
Press any key to continue.
```

Lab program 7b:

Program - Leetcode platform

```
bool hasCycle(struct ListNode *head) { if (head ==
    NULL || head->next == NULL) { return
    false;
    }
    struct ListNode *slow = head; struct
    ListNode *fast = head;
    while (fast != NULL && fast->next != NULL) {
        slow = slow->next; fast
        = fast->next->next; if
        (slow == fast) {
            return true;
        }
    }
    return false;
}
struct ListNode* createNode(int val) { struct ListNode* newNode = (struct
    ListNode*)malloc(sizeof(struct ListNode)); newNode->val = val; newNode-
    >next = NULL; return newNode;
}
struct ListNode* createLinkedListWithCycle(int arr[], int size, int pos) {
    if (size == 0) return NULL;
    struct ListNode* head = createNode(arr[0]); struct
    ListNode* current = head;
    struct ListNode* cycleNode = NULL;
    for (int i = 1; i < size; i++) { current->next =
        createNode(arr[i]);     current     =
        current->next; if (i == pos) {
            cycleNode = current;
        }
    }
    if (cycleNode != NULL) { current->next
    = cycleNode;
} return head;
}
```

Output:



141. Linked List Cycle

Given `head`, the head of a linked list, determine if the linked list has a cycle in it.

There is a cycle in a linked list if there is some node in the list that can be reached again by continuously following the `next` pointer. Internally, `pos` is used to denote the index of the node that tail's `next` pointer is connected to. **Note that `pos` is not passed as a parameter.**

Return `true` *if there is a cycle in the linked list*. Otherwise, return `false`.

Example 1:

```
Input: head = [3,2,0,-4], pos = 1
Output: true
Explanation: There is a cycle in the linked list, where the tail connects to the
1st node (0-indexed).
```

Example 2:

```
Input: head = [1,2], pos = 0
Output: true
Explanation: There is a cycle in the linked list, where the tail connects to the
0th node.
```

```c
bool hasCycle(struct ListNode *head) {
    if (head == NULL || head->next == NULL) {
        return false;
    }

    struct ListNode *slow = head;
    struct ListNode *fast = head;

    while (fast != NULL && fast->next != NULL) {
        slow = slow->next;
        fast = fast->next->next;
```

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

head =
[3,2,0,-4]

pos =
1

Lab program 8a:

Write a program

a) ToconstructabinarySearchtree.

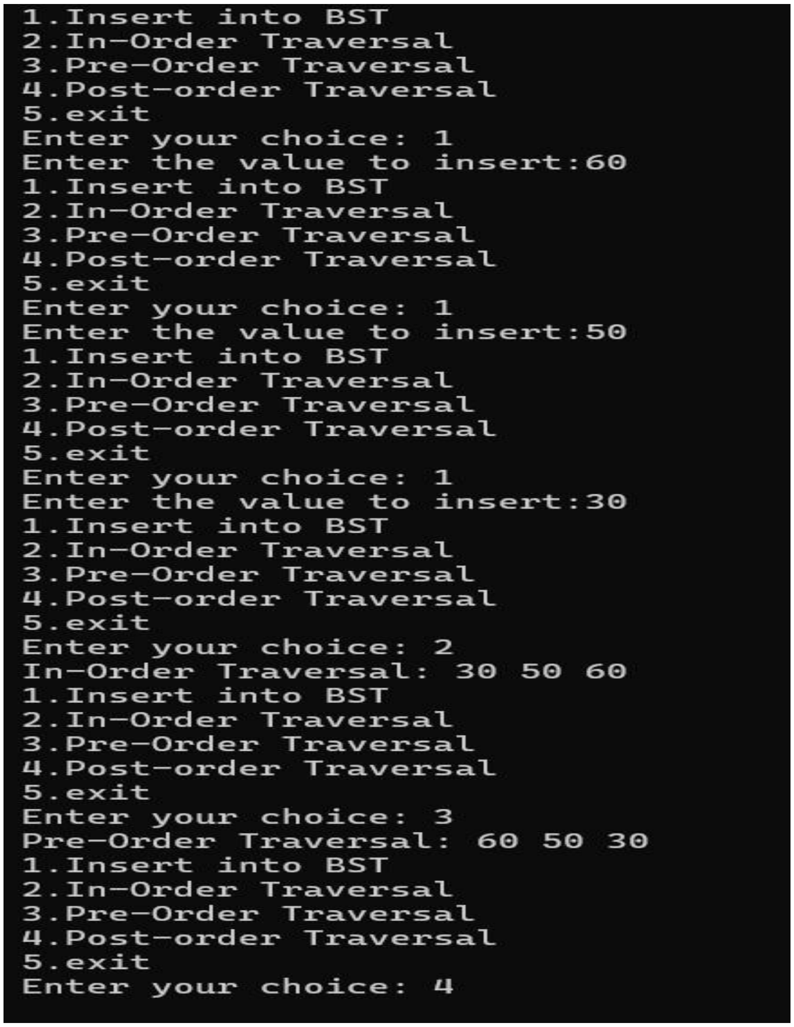
b) To traverse the tree using all the methods i.e., in-order, preorder and post order

c) To display the elements in the tree.

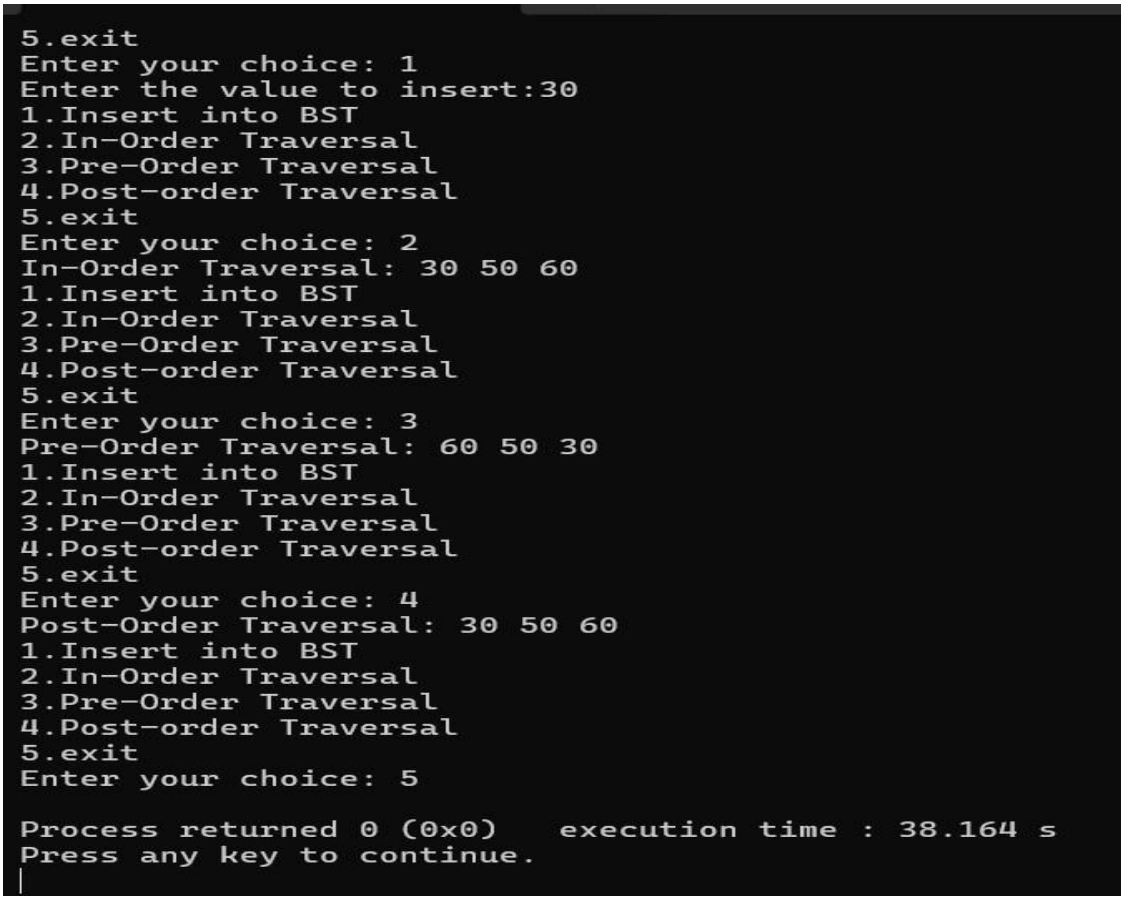
```c
#include<stdio.h>
#include<stdlib.h>

struct   Node{   int   data;
   struct Node *left,*right;
};

struct Node *createNode(int data){
   struct Node *newnode=(struct Node*)malloc(sizeof(struct Node)); newnode->data=data;
   newnode->left=newnode->right=NULL;
   return newnode;
};

struct Node*insert(struct Node *root,int data){
   if(root==NULL){
      return createNode(data);
   }
   if(data<root-data){
      root->left=insert(root->left,data);
    }
    else if(data>root->data){ root->right=insert(root-
      >right,data);
    }
    return root;
  };
  void inOrder(struct Node*root){
    if(root!=NULL){ inOrder(root-
    >left); printf("%d ",root->data);
      inOrder(root->right);
    }
  }
  void preOrder(struct Node
    *root){ if(root!=NULL){
    printf("%d ",root->data);
    preOrder(root->left);
      preOrder(root->right);
    }
  }
  void postOrder(struct Node *root){
    if(root!=NULL){ postOrder(root-
    >left); postOrder(root->right);
      printf("%d ",root->data);
    }
  }

  void  main(){  struct  Node
    *root=NULL;
    int choice,data; while(1){ printf("1.Insert into BST \n2.In-Order Traversal \n3.Pre-Order
    Traversal \n4.Post-order
  Traversal                  \n5.exit\n");
      printf("Enter your choice: ");
      scanf("%d",&choice);
switch(choice){

        case 1:printf("Enter the value to insert:");
            scanf("%d",&data);
            root=insert(root,data); break;
        case 2:printf("In-Order Traversal: "); inOrder(root);
```

```
                printf("\n");
                break;
            case 3:printf("Pre-Order Traversal: ");
                preOrder(root);
                printf("\n");
                break;
            case 4:printf("Post-Order Traversal: ");
                postOrder(root);
                printf("\n");
                break;
            case 5:exit(0);
                break;
            default:printf("Invalid choice...\n");
        }
    }
}
```

Output:



```
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 1
Enter the value to insert:60
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 1
Enter the value to insert:50
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 1
Enter the value to insert:30
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 2
In-Order Traversal: 30 50 60
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 3
Pre-Order Traversal: 60 50 30
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 4
```



```
5.exit
Enter your choice: 1
Enter the value to insert:30
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 2
In-Order Traversal: 30 50 60
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 3
Pre-Order Traversal: 60 50 30
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 4
Post-Order Traversal: 30 50 60
1.Insert into BST
2.In-Order Traversal
3.Pre-Order Traversal
4.Post-order Traversal
5.exit
Enter your choice: 5

Process returned 0 (0x0)   execution time : 38.164 s
Press any key to continue.
```

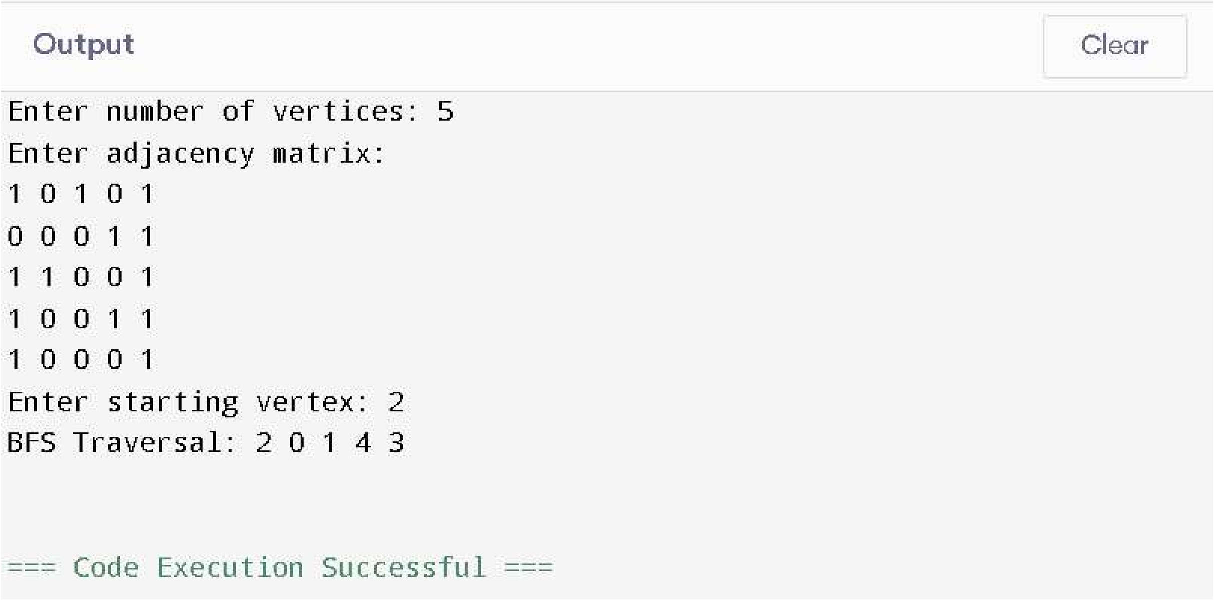
Lab program 9:

9a. Write a program to traverse a graph using BFS method.

```
#include <stdio.h>

#define MAX 100

int graph[MAX][MAX], visited[MAX], queue[MAX]; int
front = 0, rear = 0;

// BFS Function void
BFS(int start, int n) {
printf("BFS Traversal: ");
visited[start] = 1;
queue[rear++] = start;

   while (front < rear) {        int
current = queue[front++];
printf("%d ", current);

      for (int i = 0; i < n; i++) {           if
(graph[current][i] == 1 && !visited[i]) {
visited[i] = 1;              queue[rear++] = i;
         }
      }
   }
   printf("\n");
}

int main() {
int n, start;

   printf("Enter number of vertices: ");
scanf("%d", &n);

   printf("Enter adjacency matrix:\n");
for (int i = 0; i < n; i++) {        for (int j =
0; j < n; j++) {           scanf("%d",
&graph[i][j]);
      }
   }

   printf("Enter starting vertex: ");
scanf("%d", &start);
```

```
    BFS(start, n);

    return 0;
}
```

Output:



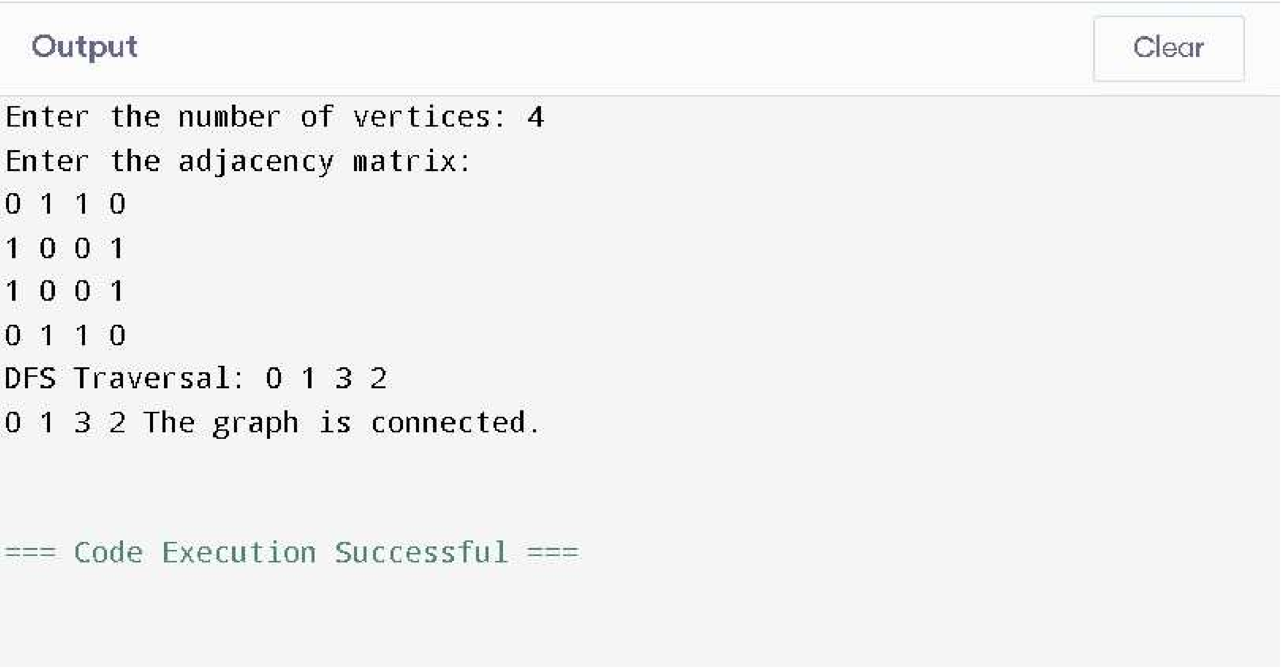
```
Enter number of vertices: 5
Enter adjacency matrix:
1 0 1 0 1
0 0 0 1 1
1 1 0 0 1
1 0 0 1 1
1 0 0 0 1
Enter starting vertex: 2
BFS Traversal: 2 0 1 4 3


=== Code Execution Successful ===
```

9b. Write a program to check whether given graph is connected or not using DFS method.

```
#include <stdio.h>

#define MAX 100

int graph[MAX][MAX], visited[MAX];

// DFS Function void
DFS(int start, int n) {
   printf("%d ", start); // Print the current vertex
   visited[start] = 1;   // Mark the current vertex as visited

   for (int i = 0; i < n; i++) {
      if (graph[start][i] == 1 && !visited[i]) {
         DFS(i, n); // Recursively visit connected vertices
      }
   }
}

// Check Connectivity int
isConnected(int n) {     //
Reset visited array to 0
for (int i = 0; i < n; i++) {
      visited[i] = 0;
```

```
    }

    // Perform DFS starting from vertex 0
    DFS(0, n);

    // Check if all vertices were visited
    for (int i = 0; i < n; i++) {
if (!visited[i]) {
            return 0; // If any vertex is not visited, the graph is not connected
        }
    }
    return 1; // All vertices are visited, graph is connected
}

int main() {
int n;

    printf("Enter the number of vertices: ");
scanf("%d", &n);

    printf("Enter the adjacency matrix:\n");
for (int i = 0; i < n; i++) {         for (int j = 0; j
< n; j++) {
            scanf("%d", &graph[i][j]);
        }
    }

    // Reset visited array before traversal
    for (int i = 0; i < n; i++) {
        visited[i] = 0;
    }

    printf("DFS Traversal: ");
    DFS(0, n); // Perform DFS traversal from vertex 0
printf("\n");

    if (isConnected(n)) {
        printf("The graph is connected.\n");
    } else {
        printf("The graph is not connected.\n");
    }
    return 0;
}
```

Output:



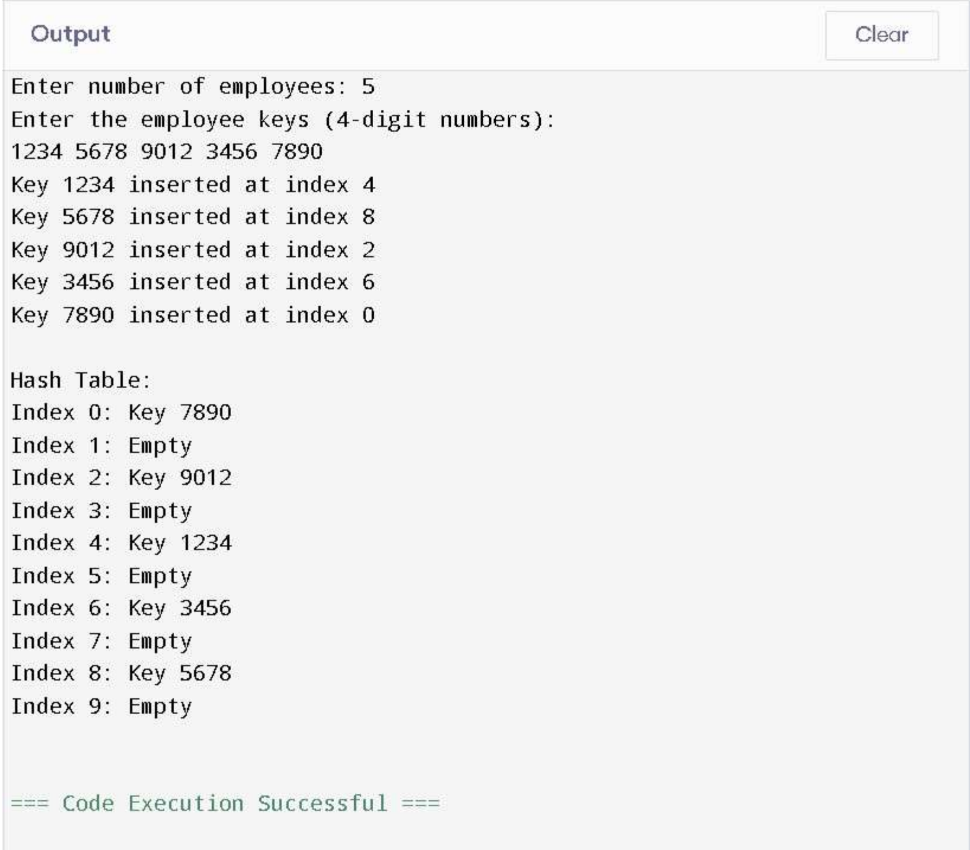
```
Enter the number of vertices: 4
Enter the adjacency matrix:
0 1 1 0
1 0 0 1
1 0 0 1
0 1 1 0
DFS Traversal: 0 1 3 2
0 1 3 2 The graph is connected.


=== Code Execution Successful ===
```

Lab program 10:
Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F. Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT. Let the keys in K and addresses in L are integers. Design and develop a Program in C that uses Hash function H: K -> L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing.

```
#include <stdio.h>
#include <stdlib.h>

#define MAX_EMPLOYEES 100 // Maximum number of employees
#define MAX_KEYS 100      // Maximum number of keys
#define TABLE_SIZE 10     // Size of hash table (m)

typedef struct {
    int key;
    // You can add other employee details here
    // For simplicity, we use just the key
} Employee;

int hashTable[TABLE_SIZE]; // Hash table to store keys
```

```
Employee employees[MAX_EMPLOYEES]; // Array to store employee records int
N; // Number of employees
int m = TABLE_SIZE; // Size of the hash table

// Hash function: H(K) = K mod m int
hashFunction(int key) {
  return key % m;
}

// Linear Probing to resolve collisions
int linearProbing(int key) {    int
index = hashFunction(key);
  int originalIndex = index; // Store original index to detect full table

  while (hashTable[index] != -1) {
if (hashTable[index] == key) {
      return index; // Key already exists (no insertion needed)
    }
    // Linear probing: move to the next index
    index = (index + 1) % m;

    // If we have checked all positions, return -1 indicating table is full
if (index == originalIndex) {
      return -1;
    }
  }
  return index;
}

// Function to insert a key into the hash table void
insert(int key) {
  int index = linearProbing(key);

  if (index != -1) {
    hashTable[index] = key; // Store the key at the found index
    printf("Key %d inserted at index %d\n", key, index);
  } else {
    printf("Error: Hash table is full. Key %d cannot be inserted.\n", key);
  }
}

// Function to display the hash table
void displayHashTable() {
printf("\nHash Table:\n");    for (int
i = 0; i < m; i++) {      if (hashTable[i]
!= -1) {
      printf("Index %d: Key %d\n", i, hashTable[i]);
    } else {
      printf("Index %d: Empty\n", i);
    }
  }
}

int main() {
    // Initialize hash table to -1 (empty)
    for (int i = 0; i < m; i++) {
        hashTable[i] = -1;
    }

    printf("Enter number of employees: ");
scanf("%d", &N);

    printf("Enter the employee keys (4-digit numbers):\n");
for (int i = 0; i < N; i++) {
        scanf("%d", &employees[i].key); // Read key for each employee
    }

    // Insert the employee keys into the hash table
for (int i = 0; i < N; i++) {
        insert(employees[i].key);
    }

    // Display the final hash table
    displayHashTable();

    return 0;
}
```

Output:



```
Enter number of employees: 5
Enter the employee keys (4-digit numbers):
1234 5678 9012 3456 7890
Key 1234 inserted at index 4
Key 5678 inserted at index 8
Key 9012 inserted at index 2
Key 3456 inserted at index 6
Key 7890 inserted at index 0

Hash Table:
Index 0: Key 7890
Index 1: Empty
Index 2: Key 9012
Index 3: Empty
Index 4: Key 1234
Index 5: Empty
Index 6: Key 3456
Index 7: Empty
Index 8: Key 5678
Index 9: Empty


=== Code Execution Successful ===
```