VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"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
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B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by Bramha Anilkumar Bajannavar **(1BM23CS071)**, 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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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>

#define max 5

int stack[max];

int top = -1;

void push(int val){
   if(top==max-1){
      printf("overflow, stack is full\n");
   }
   else{
      top++;
      stack[top] = val;
   }
}
void pop(){
   if(top==-1){
      printf("underflow, stack is empty\n");
   }
   else{
      printf("element deleted:%d\n",stack[top]);
      top--;
   }
}
void display(){
   if(top==-1){
      printf("underflow, stack is empty\n");
```

```
    }
    else{
        for(int i=top;i>=0;i--){
            printf("%d ",stack[i]);
        }
        printf("\n");
    }
}
int main() {
    int choice, value;
    while(1) {
        printf("1. Push\n2. Pop\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch(choice) {
            case 1:
                printf("Enter value to push: ");
                scanf("%d", &value);
                push(value);
                break;
            case 2:
                pop();
                break;
            case 3:
                display();
                break;
            case 4:
                return 0;
            default:
```

```
            printf("Invalid choice. Please try again.\n");
        }
    }
    return 0;
}
```

Output:

```
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter value to push: 25
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter value to push: 20
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter value to push: 10
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
10 20 25
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
element deleted:10
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
20 25
```

Lab Program 2:

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<stdlib.h>
#include<ctype.h>
#define max 1000
char stack[max];
int top=-1;
void push(char x){
   if(top==max-1){
      printf("stack full\n");
      return;
   }
   stack[++top]=x;
}
char pop(){
   if(top==-1){
      printf("stack empty\n");
      return -1;
   }
   return stack[top--];
}
int precedence(char x){
   if(x=='+'||x=='-'){
      return 1;
   }
   else if(x=='*'||x=='/'){
      return 2;
```

```
    }
    else if(x=='^'){
        return 3;
    }
    else{
        return 0;
    }
}
int isop(char x){
    return (x=='+'||x=='-'||x=='*'||x=='/'||x=='^');
}
void infixtopostfix(char *exp){
    char postfix[max];
    int i=0;
    char *ptr = exp;
    while(*ptr!='\0'){
        if(isalpha(*ptr)){
            postfix[i++] = *ptr;
        }
        if(*ptr=='('){
            push(*ptr);
        }
        if(*ptr==')'){
            while(stack[top]!='('){
                postfix[i++]=pop();
            }
            pop();
        }
        if(isop(*ptr)){
```

```
            while(precedence(stack[top])>=precedence(*ptr)){
                postfix[i++]=pop();
            }
            push(*ptr);
        }
        ptr++;
    }
    while(top!=-1){
        postfix[i++]=pop();
    }
    postfix[i]='\0';
    printf("Postfix:%s",postfix);
}
int main(){
    char exp[max];
    printf("enter expression:");
    scanf("%s",exp);
    infixtopostfix(exp);
    return 0;
}
```

Output:

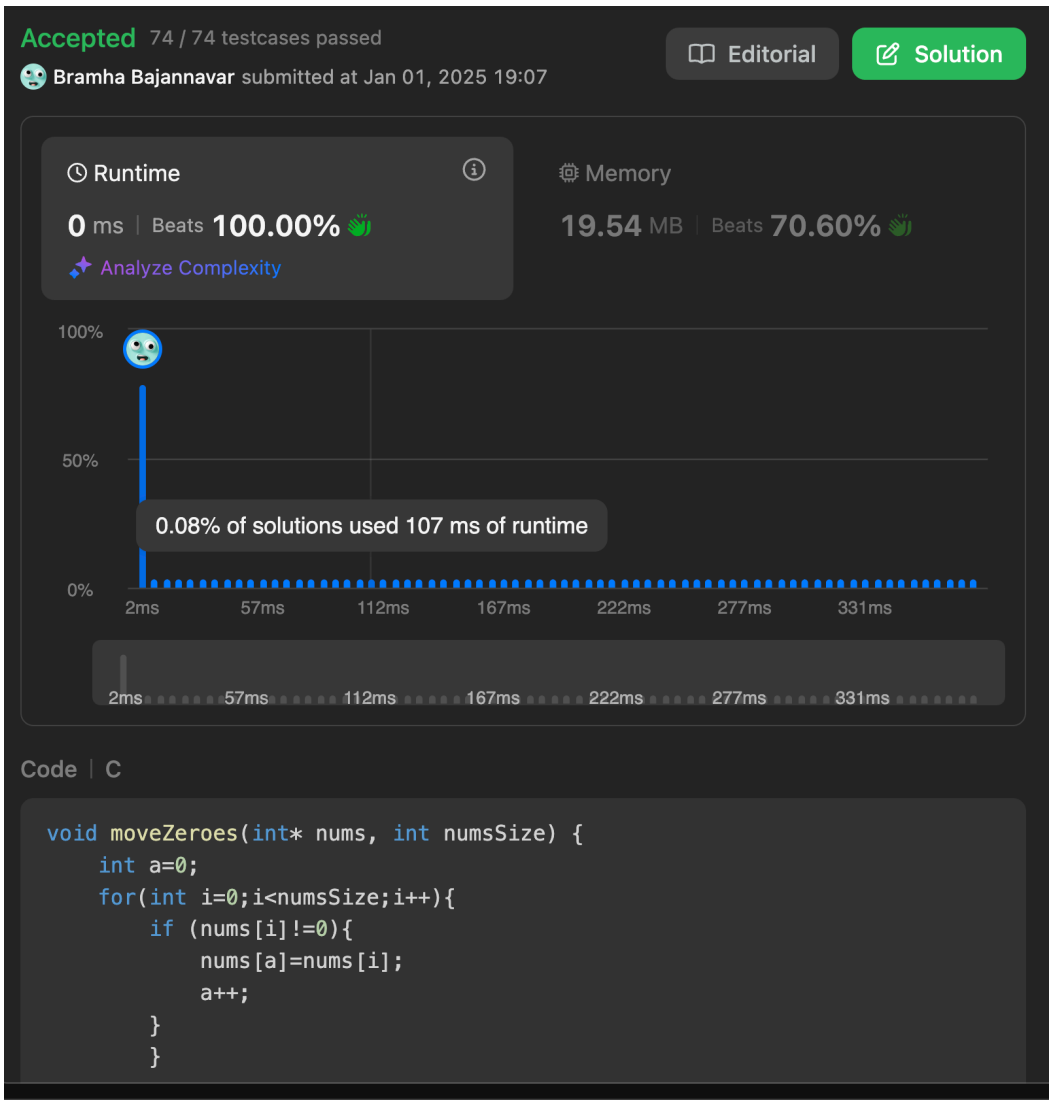
```
enter expression:A+B+C+D
Postfix:AB+C+D+
PS C:\c++ practice\ac\stacks> ./infixtopostfix
enter expression:A+B*C+D
Postfix:ABC*+D+
```

Leetcode Program 1:

Moving Zeroes

```
void moveZeroes(int* nums, int numsSize) {
```

```
    int a=0;
    for(int i=0;i<numsSize;i++){
        if (nums[i]!=0){
            nums[a]=nums[i];
            a++;
        }
        }
    for(int i=a;i<numsSize;i++){
        nums[i]=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

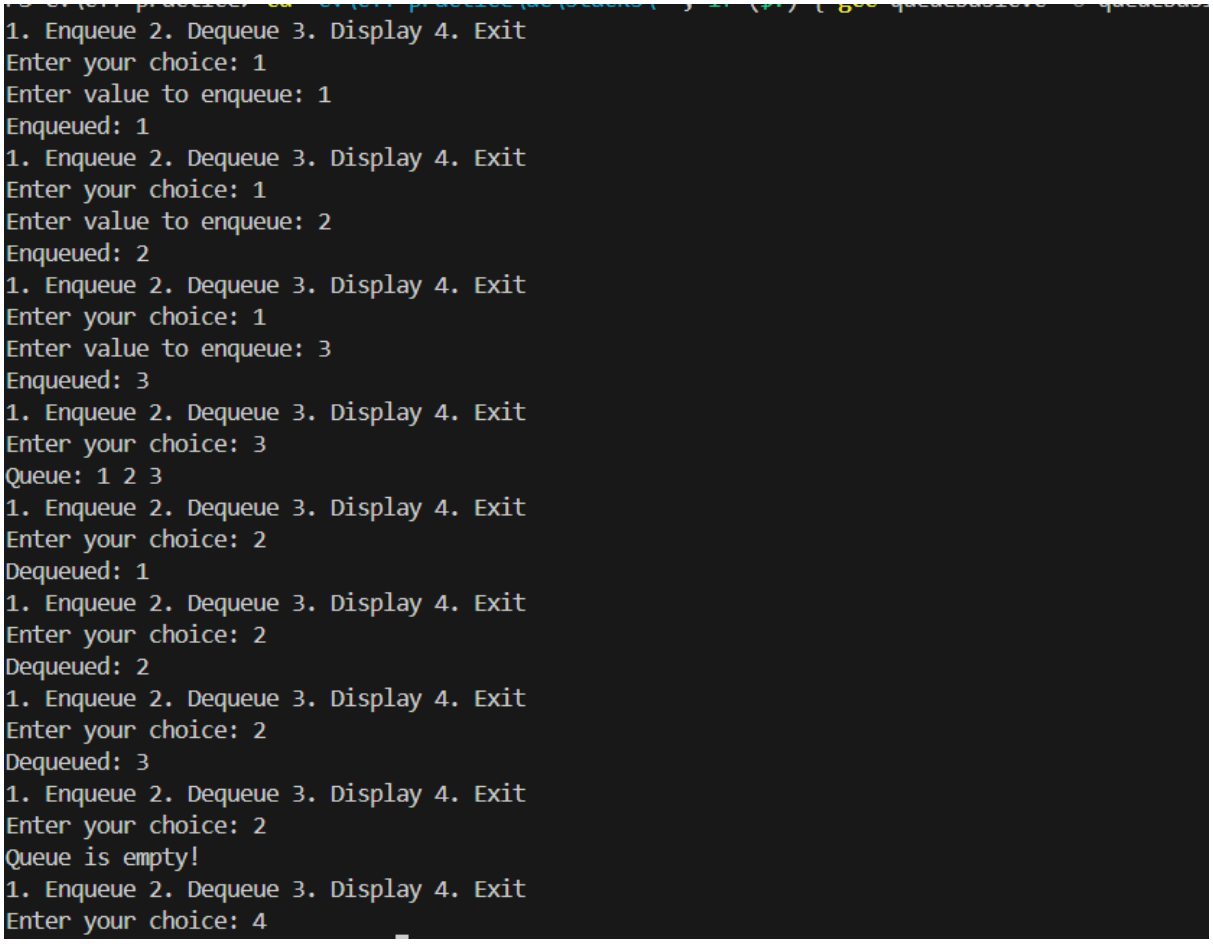
```
#include <stdio.h>
#include <stdlib.h>

#define MAX 5

typedef struct {
    int items[MAX];
    int front;
    int rear;
} LinearQueue;
void initQueue(LinearQueue* q) {
    q->front = -1;
    q->rear = -1;
}
int isEmpty(LinearQueue* q) {
    return q->front == -1;
}
int isFull(LinearQueue* q) {
    return q->rear == MAX - 1;
}
void enqueue(LinearQueue* q, int value) {
    if (isFull(q)) {
        printf("Queue is full!\n");
        return;
    }
```

```
    if (isEmpty(q)) {
        q->front = 0;
    }
    q->rear++;
    q->items[q->rear] = value;
    printf("Enqueued: %d\n", value);
}
int dequeue(LinearQueue* q) {
    if (isEmpty(q)) {
        printf("Queue is empty!\n");
        return -1;
    }
    int item = q->items[q->front];
    q->front++;
    if (q->front > q->rear) {
        q->front = q->rear = -1;
    }
    printf("Dequeued: %d\n", item);
    return item;
}
void display(LinearQueue* q) {
    if (isEmpty(q)) {
        printf("Queue is empty!\n");
        return;
    }
    printf("Queue: ");
    for (int i = q->front; i <= q->rear; i++) {
        printf("%d ", q->items[i]);
    }
```

```
    printf("\n");
}

int main() {
    LinearQueue q;
    initQueue(&q);

    int choice, value;

    while (1) {
        printf("1. Enqueue 2. Dequeue 3. Display 4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to enqueue: ");
                scanf("%d", &value);
                enqueue(&q, value);
                break;
            case 2:
                dequeue(&q);
                break;
            case 3:
                display(&q);
                break;
            case 4:
                exit(0);
            default:
```

```
            printf("Invalid choice! Please try again.\n");
        }
    }

    return 0;
}
```

Output:



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 MAX 5

int circularQueue[MAX];
int front = -1, rear = -1;



void insert(int value) {
    if ((front == 0 && rear == MAX - 1) || (rear == (front - 1) % (MAX - 1))) {
        printf("Queue Overflow! Cannot insert %d\n", value);
        return;
    }
    if (front == -1) {
        front = rear = 0;
    } else if (rear == MAX - 1 && front != 0) {
        rear = 0;
    } else {
        rear++;
    }
    circularQueue[rear] = value;
    printf("Inserted %d into the queue\n", value);
}



void delete() {
    if (front == -1) {
        printf("Queue Underflow! No elements to delete\n");
        return;
```

```
    }
    printf("Deleted %d from the queue\n", circularQueue[front]);
    if (front == rear) {
        front = rear = -1;
    } else if (front == MAX - 1) {
        front = 0;
    } else {
        front++;
    }
}


void display() {
    if (front == -1) {
        printf("Queue is empty!\n");
        return;
    }
    printf("Queue elements: ");
    if (rear >= front) {
        for (int i = front; i <= rear; i++) {
            printf("%d ", circularQueue[i]);
        }
    } else {
        for (int i = front; i < MAX; i++) {
            printf("%d ", circularQueue[i]);
        }
        for (int i = 0; i <= rear; i++) {
            printf("%d ", circularQueue[i]);
        }
```

```
    }
    printf("\n");
}

int main() {
    int choice, value;

    while (1) {
        printf("1. Enqueue 2. Dequeue 3. Display 4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &value);
                insert(value);
                break;
            case 2:
                delete();
                break;
            case 3:
                display();
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice! Please try again.\n");
                break;
```

```
        }
    }
    return 0;
}
```

Output:

```
1. Enqueue 2. Dequeue 3. Display 4. Exit
Enter your choice: 1
Enter the value to insert: 10
Inserted 10 into the queue
1. Enqueue 2. Dequeue 3. Display 4. Exit
Enter your choice: 1
Enter the value to insert: 20
Inserted 20 into the queue
1. Enqueue 2. Dequeue 3. Display 4. Exit
Enter your choice: 1
Enter the value to insert: 30
Inserted 30 into the queue
1. Enqueue 2. Dequeue 3. Display 4. Exit
Enter your choice: 3
Queue elements: 10 20 30
1. Enqueue 2. Dequeue 3. Display 4. Exit
Enter your choice: 2
Deleted 10 from the queue
1. Enqueue 2. Dequeue 3. Display 4. Exit
Enter your choice: 3
Queue elements: 20 30
1. Enqueue 2. Dequeue 3. Display 4. Exit
Enter your choice: 4
```

Lab Program 4:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

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 value){
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode-> data=value;
    newNode->next=NULL;
    return newNode;
}
struct Node* createlinkedlist(){
    struct Node* head = NULL;
    return head;
}
void insertatstart(struct Node** head,int value){
    struct Node* newnode=createnode(value);
    newnode->next=*head;
    *head=newnode;
}
void insertatend(struct Node** head,int value){
    struct Node* newnode = createnode(value);
    if(*head==NULL){
        *head=newnode;
    }
    else{
        struct Node* temp = *head;
        while(temp->next!=NULL){
            temp=temp->next;
        }
        temp->next=newnode;
    }
}
void insertatposition(struct Node** head,int pos,int value){
```

```
    struct Node* newnode=createnode(value);
    if(pos==1){
        newnode->next=*head;
        *head=newnode;
    }
    else{
        struct Node* temp = *head;
        for (int i = 1; i < pos - 1 && temp != NULL; i++) {
        temp = temp->next;
    }
        if (temp == NULL) {
        printf("Position is greater than the length of the list.\n");
        return;
    }
        newnode->next = temp->next;
        temp->next = newnode;
    }
}
void display(struct Node* head){
    if(head==NULL){
        printf("linked list empty\n");
    }
    else{
        struct Node* temp=head;
        while(temp!=NULL){
            printf("%d ",temp->data);
            temp=temp->next;
        }
        printf("\n");
```

```
    }
}
int main(){
    struct Node* head = createlinkedlist();
    insertatstart(&head,3);
    insertatstart(&head,2);
    insertatstart(&head,1);
    display(head);
    insertatend(&head,5);
    insertatposition(&head,4,4);
    display(head);
    return 0;
}
```

Output:

```
1 2 3
1 2 3 4 5
PS C:\c++ practice\ac\stacks>
```

Leetcode Program 2:

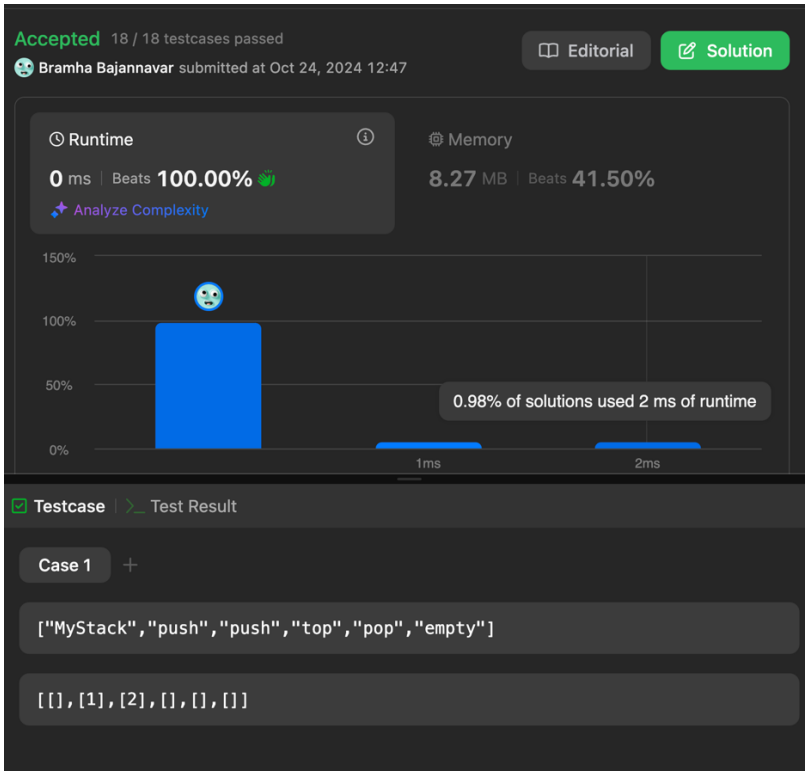
Implement Stacks using Queues

```
#define SIZE 100

typedef struct {
    int q[SIZE];
    int front;
    int rear;
} Queue;

typedef struct {
    Queue q1, q2;
} MyStack;


int isFull(Queue *q) {
    return (q->rear == SIZE - 1);
}

int isEmpty(Queue *q) {
```

```
    return (q->front == -1 || q->front > q->rear);
}

void enqueue(Queue *q, int value) {
    if (isFull(q)) {
        printf("Queue is full!\n");
    } else {
        if (q->front == -1) q->front = 0;
        q->rear++;
        q->q[q->rear] = value;
    }
}

int dequeue(Queue *q) {
    if (isEmpty(q)) {
        printf("Queue is empty!\n");
        return -1;
    } else {
        int value = q->q[q->front];
        q->front++;
        if (q->front > q->rear) {
            q->front = q->rear = -1;
        }
        return value;
    }
}

void displayQueue(Queue *q) {
    if (isEmpty(q)) {
        printf("Queue is empty\n");
    } else {
        printf("Queue elements are:\n");
        for (int i = q->front; i <= q->rear; i++) {
            printf("%d ", q->q[i]);
        }
        printf("\n");
    }
}

MyStack* myStackCreate() {
    MyStack* stack = (MyStack*)malloc(sizeof(MyStack));
    stack->q1.front = stack->q1.rear = -1;
    stack->q2.front = stack->q2.rear = -1;
    return stack;
}

void myStackPush(MyStack* obj, int x) {
    enqueue(&obj->q2, x);
    while (!isEmpty(&obj->q1)) {
        int no = dequeue(&obj->q1);
```

```
        enqueue(&obj->q2, no);
    }
    Queue temp = obj->q1;
    obj->q1 = obj->q2;
    obj->q2 = temp;
}

int myStackPop(MyStack* obj) {
    return dequeue(&obj->q1);
}

int myStackTop(MyStack* obj) {
    if (isEmpty(&obj->q1)) {
        printf("Stack is empty!\n");
        return -1;
    }
    return obj->q1.q[obj->q1.front];
}

bool myStackEmpty(MyStack* obj) {
    return isEmpty(&obj->q1);
}

void myStackFree(MyStack* obj) {
    free(obj);
}
```

Output:

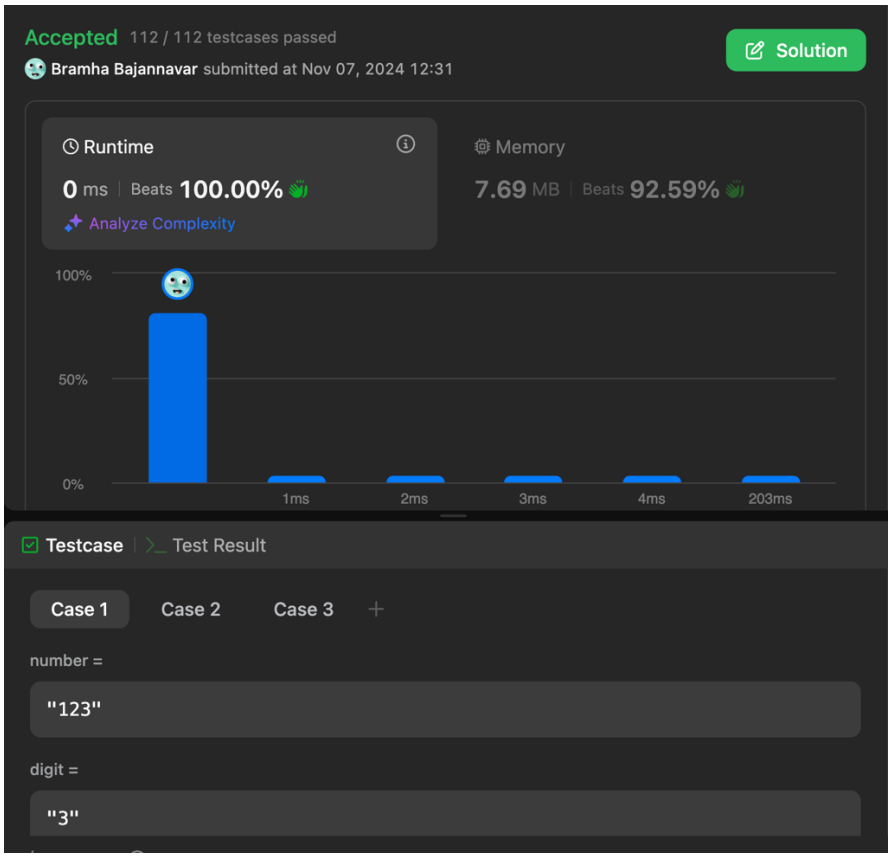


Leetcode Program 3:

Remove digit from number to maximise result

```
char* removeDigit(char* number, char digit) {
    int len = strlen(number);
    for (int i =0 ;i<len-1;++i){
        if ( number[i]==digit && number[i+1]>number[i]){
            for (int j=i ; j<len; ++j){
                number[j]=number[j+1];
            }
            return number;
        }
    }

    for (int i =len-1 ;i>=0;--i){
        if ( number[i]==digit){
            for (int j=i ; j<len; ++j){
                number[j]=number[j+1];
            }
            return number;
        }
    }

    return number;
}
```

Output:



Lab Program 5:

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 val){
    struct Node* newnode=(struct Node*) malloc (sizeof(struct Node));
    newnode->data=val;
    newnode->next=NULL;
    return newnode;
}
struct Node* createll(){
    struct Node* head=NULL;
    return head;
}
void insertatstart(struct Node** head,int data){
    struct Node* node1=createnode(data);
    node1->next=*head;
    *head=node1;
```

```
}
void insertatend(struct Node** head,int data){
    struct Node* node1=createnode(data);
    if(*head==NULL){
        *head=node1;
    }
    else{
        struct Node* temp=*head;
        while(temp->next!=NULL){
            temp=temp->next;
        }
        temp->next=node1;
    }
}
void display(struct Node** head){
    struct Node* temp=*head;
    while(temp!=NULL){
        printf("%d ",temp->data);
        temp=temp->next;
    }
    printf("\n");
}
void deletefirst(struct Node** head){
    struct Node* temp=*head;
    *head=temp->next;
    temp->next=NULL;
    free(temp);
```

```
}
void deletelast(struct Node** head){
    struct Node* temp = *head;
    struct Node* prev = NULL;
    if (temp->next == NULL) {
        *head = NULL;
        free(temp);
        return;
    }
    while (temp->next != NULL) {
        prev = temp;
        temp = temp->next;
    }
    prev->next = NULL;
    free(temp);
}
void deletebyval(struct Node** head,int val){
    struct Node* temp = *head;
    if(temp!=NULL && temp->data==val){
        *head=temp->next;
        free(temp);
    }
    struct Node* prev=NULL;
    while(temp!=NULL && temp->data!=val){
        prev=temp;
        temp=temp->next;
    }
```

```
    if(temp==NULL){
        printf("element not found\n");
    }
    prev->next=temp->next;
    free(temp);
}
int main(){
    struct Node* head=createll();
    insertatstart(&head,5);
    insertatstart(&head,4);
    insertatstart(&head,3);
    insertatstart(&head,2);
    insertatstart(&head,1);
    display(&head);
    deletefirst(&head);
    display(&head);
    deletelast(&head);
    display(&head);
    deletebyval(&head,3);
    display(&head);
    return 0;
}
```

Output:

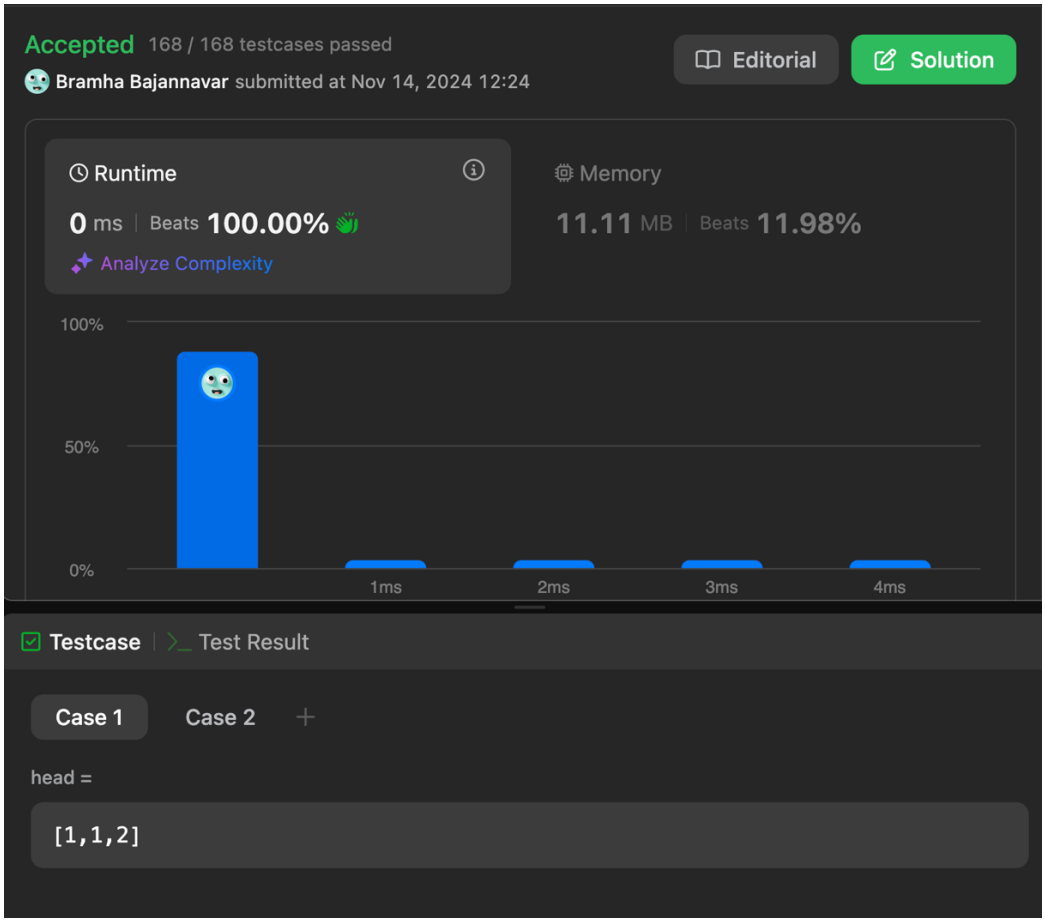
```
1 2 3 4 5
2 3 4 5
2 3 4
2 4
PS C:\c++ practice\ac\stacks>
```

Leetcode Program 4:

Delete Duplicates

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* deleteDuplicates(struct ListNode* head) {

    if (head == NULL || head->next ==NULL){
        return head;
    }

    struct ListNode* curr = head;
    while (curr->next != NULL){
        if (curr->val==curr->next->val) curr->next=curr->next->next;
        else curr = curr->next;
    }
    return head;
}
```

Output:

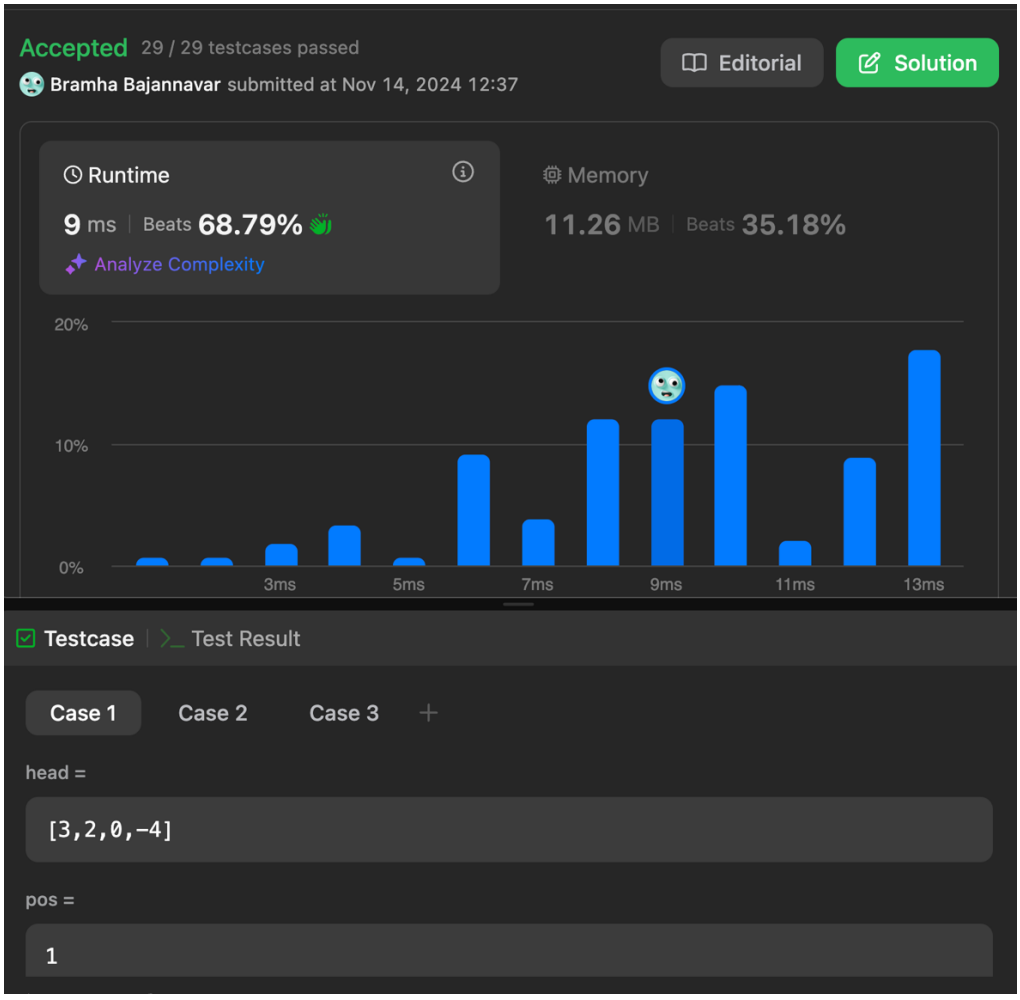


Leetcode Program 5:

Linked List Cycle

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
bool hasCycle(struct ListNode *head) {
    struct ListNode *slow = head;
    struct ListNode *fast = head;

    while (fast!= NULL && fast->next!= NULL){
        slow = slow->next;
        fast = fast->next->next;
        if (fast == slow)return true;
    }
    return false;
}
```

Output:



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.

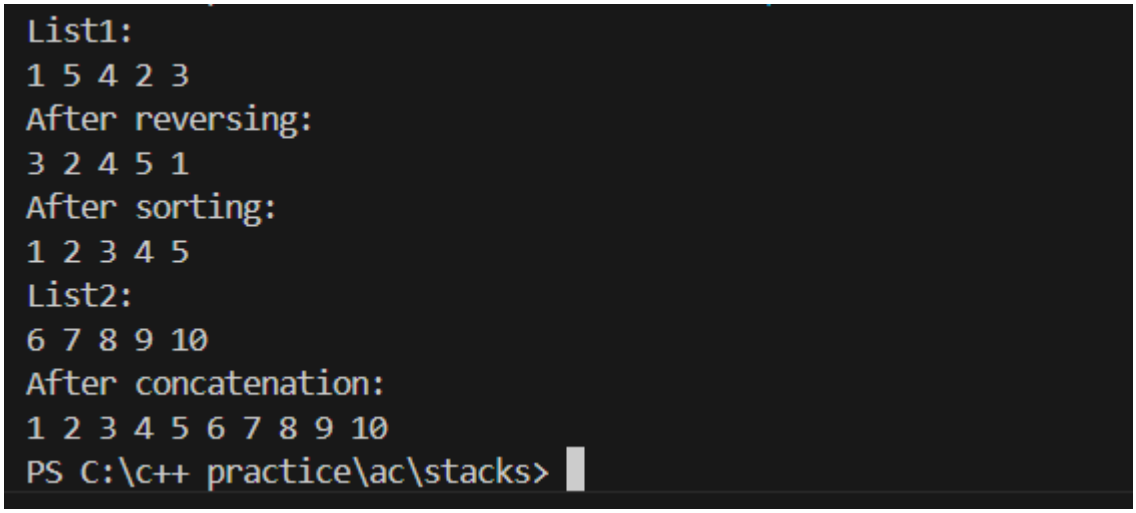
```
#include<stdio.h>
#include<stdlib.h>
struct Node{
    int data;
    struct Node* next;
};
struct Node* createnode(int val){
    struct Node* newnode=(struct Node*) malloc (sizeof(struct Node));
    newnode->data = val;
    newnode->next = NULL;
    return newnode;
}
struct Node* createll(){
    struct Node* head = NULL;
    return head;
}
void insertatstart(struct Node** head,int val){
    struct Node* newnode = createnode(val);
    newnode->next = *head;
    *head = newnode;
}
void display(struct Node* head){
    struct Node* temp = head;
    while(temp!=NULL){
```

```
        printf("%d ",temp->data);
        temp = temp->next;
    }
    printf("\n");
}
int len(struct Node* head){
    int count = 0;
    struct Node* temp = head;
    while(temp!=NULL){
        temp = temp->next;
        count++;
    }
    return count;
}
void sort(struct Node** head){
    int n = len(*head);
    for(int i=0;i<n;i++){
        struct Node* temp = *head;
        while(temp!=NULL && temp->next!=NULL){
            if(temp->data > temp->next->data){
                int x = temp->data;
                temp->data = temp->next->data;
                temp->next->data = x;
            }
            temp = temp->next;
        }
    }
```

```
}
void rev(struct Node** head){
    struct Node* prev = NULL;
    struct Node* curr = *head;
    struct Node* forward = NULL;
    while(curr!=NULL){
        forward = curr->next;
        curr->next = prev;
        prev = curr;
        curr = forward;
    }
    *head = prev;
}
void concat(struct Node** head1, struct Node** head2){
    struct Node* temp = *head1;
    while(temp->next!=NULL){
        temp = temp->next;
    }
    temp->next = *head2;
}
int main(){
    struct Node* head1 = createll();
    insertatstart(&head1,3);
    insertatstart(&head1,2);
    insertatstart(&head1,4);
    insertatstart(&head1,5);
    insertatstart(&head1,1);
```

```
    printf("List1:\n");
    display(head1);
    printf("After reversing:\n");
    rev(&head1);
    display(head1);
    printf("After sorting:\n");
    sort(&head1);
    display(head1);
    struct Node* head2 = createll();
    insertatstart(&head2,10);
    insertatstart(&head2,9);
    insertatstart(&head2,8);
    insertatstart(&head2,7);
    insertatstart(&head2,6);
    printf("List2:\n");
    display(head2);
    printf("After concatenation:\n");
    concat(&head1,&head2);
    display(head1);
    return 0;
}
```

Output:



Lab Program 6b:

WAP to Implement Single Link List to simulate Stack & Queue Operations.

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

typedef struct s_node {
    int data;
    struct s_node* next;
} s_node;

s_node* init(int data) {
    s_node *n = (s_node*)malloc(sizeof(s_node));
    if (n == NULL) {
        printf("Memory allocation failed!\n");
        exit(1);
    }
    n->data = data;
    n->next = NULL;
```

```
    return n;
}

s_node* push(s_node **last, int data, s_node **head) {
    if (*head == NULL) {

        *head = init(data);
        *last = *head;
        return *head;
    }

    s_node *l = *last;
    l->next = init(data);
    *last = l->next;
    return l->next;
}

s_node* pop(s_node **head) {
    if (*head == NULL) {
        printf("List is empty, nothing to pop.\n");
        return NULL;
    }

    s_node *h = *head;
    if (h->next == NULL) {
        free(h);
        *head = NULL;
```

```
        return NULL;
    }


    while (h->next->next != NULL) {
        h = h->next;
    }

    s_node *temp = h->next;
    free(temp);
    h->next = NULL;
    return h;
}


void print_list(s_node *head) {
    if (head == NULL) {
        printf("List is empty.\n");
        return;
    }

    s_node *current = head;
    while (current != NULL) {
        printf("%d -> ", current->data);
        current = current->next;
    }
    printf("NULL\n");
```

```
}

int main() {
    s_node *head = NULL;
    s_node *last = NULL;

    int choice, data;
    while (1) {
        printf("\nMenu:\n");
        printf("1. Push a node\n");
        printf("2. Pop a node\n");
        printf("3. Print the list\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the data to push: ");
                scanf("%d", &data);
                last = push(&last, data, &head);
                break;

            case 2:
                last = pop(&head);
                break;
```

```
            case 3:
                print_list(head);
                break;

            case 4:

                while (head != NULL) {
                    head = pop(&head);
                }
                printf("Exiting...\n");
                return 0;

            default:
                printf("Invalid choice! Please try again.\n");
        }
    }
}
```

Output:

```
1. Push a node
2. Pop a node
3. Print the list
4. Exit
Enter your choice: 1
Enter the data to push: 10

Menu:
1. Push a node
2. Pop a node
3. Print the list
4. Exit
Enter your choice: 1
Enter the data to push: 20

Menu:
1. Push a node
2. Pop a node
3. Print the list
4. Exit
Enter your choice: 1
Enter the data to push: 30

Menu:
1. Push a node
2. Pop a node
3. Print the list
4. Exit
Enter your choice: 2

Menu:
1. Push a node
2. Pop a node
3. Print the list
4. Exit
Enter your choice: 3
10 -> 20 -> NULL
```

```
#include <stdio.h>

#include <stdlib.h>

typedef struct p_node {

    int data;

    struct p_node* next;

} p_node;

p_node* init(int data) {

    p_node *n = (p_node*)malloc(sizeof(p_node));

    if (n == NULL) {

        printf("Memory allocation failed!\n");

        exit(1);

    }
```

```
    n->data = data;
    n->next = NULL;
    return n;
}
p_node* enquee(p_node **last, int data, p_node **head) {
    if (*head == NULL) {
        *head = init(data);
        *last = *head;
        return *head;
    }
    p_node *l = *last;
    l->next = init(data);
    *last = l->next;
    return l->next;
}
int dequee(p_node **head) {
    if (*head == NULL) {
        printf("Queue is empty, nothing to dequeue.\n");
        return -1;
    }
    p_node *h = *head;
    int r = h->data;
    *head = h->next;
    free(h);
    return r;
}
void print_list(p_node *head) {
```

```
    if (head == NULL) {
        printf("Queue is empty.\n");
        return;
    }
    p_node *current = head;
    while (current != NULL) {
        printf("%d -> ", current->data);
        current = current->next;
    }
    printf("NULL\n");
}
int main() {
    p_node *head = NULL;
    p_node *last = NULL;
    int choice, data;
    while (1) {
        printf("\nMenu:\n");
        printf("1. Enqueue a node\n");
        printf("2. Dequeue a node\n");
        printf("3. Print the queue\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                printf("Enter the data to enqueue: ");
                scanf("%d", &data);
```

```
            last = enquee(&last, data, &head);
            break;
        case 2:
            data = dequee(&head);
            if (data != -1) {
                printf("Dequeued: %d\n", data);
            }
            break;
        case 3:
            print_list(head);
            break;
        case 4:
            while (head != NULL) {
                dequee(&head);
            }
            printf("Exiting...\n");
            return 0;
        default:
            printf("Invalid choice! Please try again.\n");
      }
   }
}
```

Output:

```
Menu:
1. Enqueue a node
2. Dequeue a node
3. Print the queue
4. Exit
Enter your choice: 1
Enter the data to enqueue: 10

Menu:
1. Enqueue a node
2. Dequeue a node
3. Print the queue
4. Exit
Enter your choice: 1
Enter the data to enqueue: 20

Menu:
1. Enqueue a node
2. Dequeue a node
3. Print the queue
4. Exit
Enter your choice: 1
Enter the data to enqueue: 30

Menu:
1. Enqueue a node
2. Dequeue a node
3. Print the queue
4. Exit
Enter your choice: 2
Dequeued: 10

Menu:
1. Enqueue a node
2. Dequeue a node
3. Print the queue
4. Exit
Enter your choice: 3
20 -> 30 -> NULL
```

Lab Program 7:

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 val) {
    struct Node* n = (struct Node*)malloc(sizeof(struct Node));
    n->data = val;
    n->prev = n->next = NULL;
    return n;
}

void insertEnd(struct Node** head, int val) {
    struct Node* n = createNode(val);
    if (!*head) {
        *head = n;
        return;
    }
    struct Node* t = *head;
    while (t->next) t = t->next;
    t->next = n;
    n->prev = t;
}

void insertLeft(struct Node** head, int target, int val) {
    struct Node* t = *head;
    while (t && t->data != target) t = t->next;
```

```
    if (!t) return;
    struct Node* n = createNode(val);
    n->next = t;
    n->prev = t->prev;
    if (t->prev) t->prev->next = n;
    else *head = n;
    t->prev = n;
}

void deleteNode(struct Node** head, int val) {
    struct Node* t = *head;
    while (t && t->data != val) t = t->next;
    if (!t) return;
    if (t->prev) t->prev->next = t->next;
    else *head = t->next;
    if (t->next) t->next->prev = t->prev;
    free(t);
}

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

```
int main() {
    struct Node* dll = NULL;

    insertEnd(&dll, 10);
    insertEnd(&dll, 20);
    insertEnd(&dll, 30);
    printf("Doubly Linked List: ");
    display(dll);

    insertLeft(&dll, 20, 15);
    printf("After Inserting 15 to the left of 20: ");
    display(dll);

    deleteNode(&dll, 10);
    printf("After Deleting 10: ");
    display(dll);

    return 0;
}
```

Output:

```
Doubly Linked List: 10 <-> 20 <-> 30 <-> NULL
After Inserting 15 to the left of 20: 10 <-> 15 <-> 20 <-> 30 <-> NULL
After Deleting 10: 15 <-> 20 <-> 30 <-> NULL
```

Lab Program 8:

Write a program

a) To construct a binary Search tree.

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.

```
#include<stdio.h>
#include<stdlib.h>
typedef struct BST{
    int data;
    struct BST* left;
    struct BST* right;
}node;
node* create(){
    node* newnode = (node*)malloc(sizeof(node));
    printf("enter data:");
    scanf("%d",&newnode->data);
    newnode->left = newnode->right = NULL;
    return newnode;
}
void insert(node* root,node* newnode){
    if(newnode->data < root->data){
        if(root->left!=NULL){
            insert(root->left,newnode);
        }
        else{
            root->left = newnode;
        }
    }
    if(newnode->data > root->data){
        if(root->right!=NULL){
            insert(root->right,newnode);
        }
```

```
        else{
            root->right = newnode;
        }
    }
}
void inorder(node* root){
    if(root!=NULL){
        inorder(root->left);
        printf("%d ",root->data);
        inorder(root->right);
    }
}
void postorder(node* root){
    if(root!=NULL){
        postorder(root->left);
        postorder(root->right);
        printf("%d ",root->data);
    }
}
void preorder(node* root){
    if(root!=NULL){
        printf("%d ",root->data);
        preorder(root->left);
        preorder(root->right);
    }
}
int main() {
```

```
    char ch;
    node *root = NULL, *temp;

    do {
        temp = create();
        if (root == NULL)
            root = temp;
        else
            insert(root, temp);

        printf("\nDo you want to enter more(y/n)? ");
        getchar();  // To consume the newline character from previous input
        scanf("%c", &ch);
    } while (ch == 'y' || ch == 'Y');

    printf("\nPreorder Traversal: ");
    preorder(root);

    printf("\nInorder Traversal: ");
    inorder(root);

    printf("\nPostorder Traversal: ");
    postorder(root);

    return 0;
}
```

Output:

```
enter data:20

Do you want to enter more(y/n)? y
enter data:10

Do you want to enter more(y/n)? y
enter data:5

Do you want to enter more(y/n)? y
enter data:25

Do you want to enter more(y/n)? y
enter data:30

Do you want to enter more(y/n)? n

Preorder Traversal: 20 10 5 25 30
Inorder Traversal: 5 10 20 25 30
Postorder Traversal: 5 10 30 25 20
```

Lab Program 9a:

Write a program to traverse a graph using BFS method.

```
#include<stdio.h>

#include<conio.h>

int adj[10][10];

int n;

int vis[10];

void bfs(int v){

   int q[10],rear=1,front=1,u;

   vis[v] = 1;

   q[rear] = v;

   while(front<=rear){

      u = q[front];

      printf("%d ",u);
```

```
        for(int i=1;i<=n;i++){
            if(adj[u][i]==1 && vis[i]==0){
                vis[i] = 1;
                rear++;
                q[rear] = i;
            }
        }
        front++;
    }
}
int main(){
    printf("enter no of vertices:");
    scanf("%d",&n);
    printf("enter adjacency matrix:");
    for(int i=1;i<=n;i++){
        for(int j=1;j<=n;j++){
            scanf("%d",&adj[i][j]);
        }
        vis[i] = 0;
    }
    int v;
    printf("enter node to start traversing:");
    scanf("%d",&v);
    bfs(v);
}
```

Output:

```
enter no of vertices:4
enter adjacency matrix:0 1 1 0 1 0 0 1 1 0 0 1 0 1 1 0
enter node to start traversing:2
2 1 4 3
PS C:\c++ practice\ac\stacks>
```

Lab Program 9b:

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

```
#include <stdio.h>


#define MAX 10


int adj[MAX][MAX], visited[MAX], n;


void dfs(int v) {
    visited[v] = 1;
    for (int i = 1; i <= n; i++) {
        if (adj[v][i] != 0 && visited[i] == 0) {
            dfs(i);
        }
    }
}


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

```
printf("Enter the adjacency matrix (0 for no edge):\n");
for (int i = 1; i <= n; i++) {
    for (int j = 1; j <= n; j++) {
        scanf("%d", &adj[i][j]);
    }
}

// Initialize the visited array
for (int i = 1; i <= n; i++) {
    visited[i] = 0;
}

// Start DFS from the first vertex
dfs(1);

// Check if all vertices are visited
int connected = 1;
for (int i = 1; i <= n; i++) {
    if (visited[i] == 0) {
        connected = 0;
        break;
    }
}

if (connected) {
    printf("The graph is connected.\n");
} else {
```

```
        printf("The graph is disconnected.\n");
    }

    return 0;
}
```

Output:

```
Enter the number of vertices: 4
Enter the adjacency matrix (0 for no edge):
0 1 1 0 1 0 0 1 1 0 0 1 0 1 1 0
The graph is connected.
PS C:\c++ practice\ac\stacks>
```

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>

int key[20], n, m;
int *ht, index;
int count = 0;
```

```
void insert(int key) {
    index = key % m;
    while (ht[index] != -1) {
        index = (index + 1) % m;
    }
    ht[index] = key;
    count++;
}

void display() {
    if (count == 0) {
        printf("\nHash Table is empty");
        return;
    }
    printf("\nHash Table contents are:\n");
    for (int i = 0; i < m; i++) {
        printf("\nT[%d] --> %d", i, ht[i]);
    }
}

void main() {
    printf("\nEnter the number of employee records (N): ");
    scanf("%d", &n);

    printf("\nEnter the two-digit memory locations (m) for hash table: ");
    scanf("%d", &m);
```

```
    ht = (int *)malloc(m * sizeof(int));
    for (int i = 0; i < m; i++)
        ht[i] = -1;

    printf("\nEnter the four-digit key values (K) for %d Employee Records:\n", n);
    for (int i = 0; i < n; i++)
        scanf("%d", &key[i]);

    for (int i = 0; i < n; i++) {
        if (count == m) {
            printf("\nHash table is full. Cannot insert record %d key", i + 1);
            break;
        }
        insert(key[i]);
    }

    display();
    free(ht);
}
```

Output:

```
Enter the number of employee records (N): 5

Enter the two-digit memory locations (m) for hash table: 7

Enter the four-digit key values (K) for 5 Employee Records:
1234
2345
4567
5678
6789

Hash Table contents are:

T[0] --> 2345
T[1] --> 5678
T[2] --> 1234
T[3] --> 4567
T[4] --> -1
T[5] --> -1
T[6] --> 6789
PS C:\c++ practice\ac\stacks>
```