

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**



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This is to certify that the Lab work entitled “**DATA STRUCTURES**” carried out by Gopal Agrawal(1BM22CS361), who is bonafied student of B.M.S College of Engineering. It's partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24. 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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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 SIZE 10
int stack[SIZE],top=-1;
```

```

void push(int value)
{
    if(top==SIZE-1)
        printf("Overflow\n");
    else{
        top=top+1;
        stack[top]=value;
        printf("%d inserted\n",value);
    }
}

void pop()
{
    int value;
    if(top==-1)
        printf("Underflow\n");
    else{
        value=stack[top];
        printf("Popped element: %d\n",value);
        top=top-1;
    }
}

void display()
{
    int i;
    if(top==-1)
        printf("Stack is empty");
    else{
        printf("The elements in the stack are:\n");
        for(i=0;i<=top;i++)
            printf("%d  ",stack[i]);
    }
}

void main()
{
    int value,choice;
    while(1){
        printf("\n1:Push\n2.Pop\n3.Display\n4.Exit\n");
        printf("Enter your choice:");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1: printf("\nEnter the value: ");

```

```
        scanf("%d",&value);
        push(value);
        break;
    case 2: pop();
        break;
    case 3: display();
        break;
    case 4: exit(0);
        break;
    default: printf("Invalid input\n");
}
}
}
```

OUTPUT:

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

Enter the value: 23
23 inserted

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

Enter the value: 45
45 inserted

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

Enter the value: 78
78 inserted
```

```

1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 2
Popped element: 78

1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 3
The stack elements are:
23  45
1:Push
2.Pop
3.Display
4.Exit
Enter your choice: 4

```

LAB PROGRAM 2:

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

```

#include<stdio.h>

#include<string.h>

int index1=0,top=-1,pos=0,length;

char symbol,temp,infix[20],postfix[20],stack[20];

void infixtopostfix();

void push(char symbol);

char pop();

int precedence(char symbol);

void main()

{

    printf("Enter the infix expression:");

    scanf("%s",infix);

```

```

infixtopostfix();

printf("\nInfix expression:%s",infix);

printf("\nPostfix expression:%s",postfix);
}

void infixtopostfix(){
length=strlen(infix);
push('#');
while(index1<length){
    symbol=infix[index1];
    switch(symbol)
    {
        case '(': push (symbol);
                break;
        case ')': temp=pop();
                while (temp !='(')
                {
                    postfix[pos]=temp;
                    pos++;
                    temp=pop();
                }
                break;
        case '+':
        case '-':
        case '*':
        case '/':
            while(precedence(stack[top])>=precedence(symbol))
            {
                temp=pop();
                postfix[pos++]=temp;
            }
            push(symbol);
            index1++;
        }
    }
}

```

```

        }
        push(symbol);
        break;
    default: postfix[pos++] = symbol;
    }
    Index1++;
}

while(top > 0) {
    temp = pop();
    postfix[pos++] = temp; }
}

void push(char symbol)
{
    top = top + 1;
    stack[top] = symbol;
}

char pop()
{
    char symbol;
    symbol = stack[top];
    top = top - 1;
    return (symbol);
}

int precedence(char symbol)
{
    int p;
    switch(symbol){
        case '*':
        case '/':    p = 2;

```



```

        break;

    case '+':

    case '-':    p=1;

        break;

    case '(':    p=0;

        break;

    case '#':    p=-1;

        break;

    }

    return(p);
}

```

OUTPUT:

```

Enter the infix expression:a+b+c+d-e

Infix expression:a+b+c+d-e
Postfix expression:ab+c+d+e-

```

LAB PROGRAM 3:

a) Write a program 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 10

int queue[MAX];

int front = -1, rear = -1;

void insert()

{

```

```

int item;

if(rear == MAX-1)

    printf("\n OVERFLOW");

else

{

    if(front==-1)

        front=0;

    printf("\n Enter the element to be inserted in the queue : ");

    scanf("%d", &item);

    rear=rear+1;

    queue[rear] = item;

    printf("%d inserted successfully",item);

}

}

void delete()

{

    int val;

    if(front == -1 || front>rear)

    {

        printf("\n QUEUE UNDERFLOW");

    }

    else

    {

        val = queue[front];

        printf("\n The number deleted is : %d", val);

        front=front+1;

        if(front > rear)

            front = rear = -1;

    }

}

```

```

}

void display()
{
    int i;
    printf("\n");
    if(front == -1 || front > rear)
        printf("\n QUEUE IS EMPTY");
    else
    {
        for(i = front; i <= rear; i++)
            printf("%d    ", queue[i]);
    }
}

void main()
{
    int choice;
    while(1)
    {
        printf("\nMENU");
        printf("\n 1. Insert an element");
        printf("\n 2. Delete an element");
        printf("\n 3. Display the queue");
        printf("\n 4. EXIT");
        printf("\n Enter your option :");
        scanf("%d", &choice);
        switch(choice)
        {
            case 1: insert();
                    break;

```

```

        case 2: delete();
                break;
        case 3: display();
                break;
        case 4: exit(0);
                break;
        default: printf("Invalid input");
    }
}
}

```

OUTPUT:

```

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted in the queue : 68
68 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted in the queue : 83
83 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted in the queue : 90
90 inserted successfully

```

```

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :2

The number deleted is : 68

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :3

83      90
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :4

```

b) 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 SIZE 10

int queue[SIZE];

int front = -1, rear = -1;

void insert()
{
    int item;

    if(((front==rear+1)|| (front==0 && rear==SIZE-1))

        printf("\n QUEUE OVERFLOW");

    else

```

```

    {
        if(front==-1)
            front=0;
        printf("\n Enter the element to be inserted : ");
        scanf("%d", &item);
        rear=(rear+1)%SIZE;
        queue[rear] = item;
        printf("%d inserted successfully",item);
    }
}

void delete()
{
    int val;
    if(front == -1)
    {
        printf("\n QUEUE UNDERFLOW");
    }
    else
    {
        val = queue[front];
        if(front==rear)
        {
            front=-1;
            rear=-1;
        }
        else
        {
            front=(front+1)%SIZE;
        }
    }
}

```

```

        printf("\n The number deleted is : %d", val);
    }
}

void display()
{
    int i;
    printf(" \n");
    if(front == -1)
        printf("\n QUEUE IS EMPTY");
    else
    {
        for(i = front; i != rear; i = (i+1)%SIZE)
            printf("%d  ", queue[i]);
    }
    printf("%d", queue[i]);
}

void main()
{
    int choice;
    while(1)
    {
        printf("\nMENU");
        printf("\n 1. Insert an element");
        printf("\n 2. Delete an element");
        printf("\n 3. Display the queue");
        printf("\n 4. EXIT");
        printf("\n Enter your option :");
        scanf("%d", &choice);
        switch(choice)

```

```

        {
            case 1: insert();
                    break;
            case 2: delete();
                    break;
            case 3: display();
                    break;
            case 4: exit(0);
                    break;
            default: printf("Invalid input");
        }
    }
}

```

OUTPUT:

```

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted : 37
37 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted : 43
43 inserted successfully

MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :1

Enter the element to be inserted : 74
74 inserted successfully

```



```
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :2

The number deleted is : 37
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :3

43      74
MENU
1. Insert an element
2. Delete an element
3. Display the queue
4. EXIT
Enter your option :4
```

LAB PROGRAM 4:

1)

Write a program 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.**
- c) Display the contents of the linked list.**

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

struct node
{
    int data;
    struct node * next;
};
```

```
struct node *head=NULL,*newnode,*temp;
```

```
void create()
```

```
{  
    int i,n;  
    printf(" Enter the number of elements:");  
    scanf("%d",&n);  
  
    for(i=0;i<n;i++)  
    {  
        newnode=(struct node *)malloc(sizeof(struct node));  
        printf(" Enter the element %d: ",i+1);  
        scanf("%d",&newnode->data);  
        newnode->next=NULL;  
  
        if(head==NULL)  
        {  
            temp=head=newnode;  
        }  
        else{  
            temp->next=newnode;  
            temp=newnode;  
        }  
    }  
}
```

```
void display()
```

```
{  
    temp=head;  
    printf(" The elements are:\n");
```

```

while(temp!=NULL)
{
    printf(" %d\n",temp->data);
    temp=temp->next;
}
}

void insert_beg()
{
    newnode=(struct node *)malloc(sizeof(struct node));
    printf(" Enter the new element:\n");
    scanf("%d",&newnode->data);
    newnode->next=head;
    head=newnode;
}

void insert_end()
{
    newnode=(struct node *)malloc(sizeof(struct node));
    printf(" Enter the new element:\n");
    scanf("%d",&newnode->data);
    newnode->next=NULL;
    temp=head;
    while(temp->next!=NULL)
    {
        temp=temp->next;
    }
    temp->next=newnode;
}

```

```

void insert_pos()
{
    int pos,i=1;
    newnode=(struct node *)malloc(sizeof(struct node));
    printf(" Enter the position:");
    scanf("%d",&pos);

    if(pos<0)
    {
        printf("Invalid position\n");
    }
    else
    {
        temp=head;
        while(i<pos-1)
        {
            temp=temp->next;
            i++;
        }
        printf(" Enter the new element:");
        scanf("%d",&newnode->data);
        newnode->next=temp->next;
        temp->next=newnode;
    }
}

void main()
{

```

```

int choice;

printf(" MENU\n 1.Create\n 2.Insert at beginnning\n 3.Insert at end\n 4.Insert at position\n
5.Display \n 6.Exit\n");

while(1)
{
    printf("\n Enter operation:");
    scanf("%d",&choice);
    switch(choice)
    {
        case 1:create();
            break;
        case 2: insert_beg();
            break;
        case 3: insert_end();
            break;
        case 4:insert_pos();
            break;
        case 5: display();
            break;
        case 6: exit(0);
            break;
        default: printf(" invalid output\n");
    }
}
}

```

OUTPUT:

```
MENU
1.Create
2.Insert at beginnning
3.Insert at end
4.Insert at position
5.Display
6.Exit

Enter operation:1
Enter the number of elements: 3
Enter the element 1: 2
Enter the element 2: 4
Enter the element 3: 6

Enter operation:2
Enter the new element: 10

Enter operation:3
Enter the new element: 5

Enter operation:4
Enter the position: 2
Enter the new element: 34

Enter operation:5
The elements are:
10      34      2      4      6      5
Enter operation:6
```

2)

Write a program 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 *head=NULL,*newnode,*temp;
```

```
void create()
```

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

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

```
    {  
        newnode=(struct node *)malloc(sizeof(struct node));  
        printf(" Enter the element %d: ",i+1);  
        scanf("%d",&newnode->data);  
        newnode->next=NULL;
```

```
        if(head==NULL)
```

```
        {  
            temp=head=newnode;  
        }
```

```
        else{  
            temp->next=newnode;  
            temp=newnode;  
        }
```

```

    }
}

void display()
{
    temp=head;
    printf(" The elements are:\n");
    while(temp!=NULL)
    {
        printf(" %d\t",temp->data);
        temp=temp->next;
    }
}

void delete_beg()
{
    temp=head;
    if(head==NULL)
    {
        printf("List is empty\n");
    }
    else
    {
        head=temp->next;
        free(temp);
    }
    printf(" Element successfully deleted\n");
}

void delete_end()

```



```

{
    temp=head;
    struct node *prenode;
    while(temp->next!=NULL)
    {
        prenode=temp;
        temp=temp->next;
    }
    if(temp==head)
    {
        head=NULL;
    }
    else
    {
        prenode->next=NULL;
    }
    free(temp);
    printf(" Element successfully deleted\n");
}

```

```

void delete_pos()
{
    struct node *nextnode;
    int pos,i=1;
    printf(" Enter the position:\n");
    scanf("%d",&pos);
    temp=head;
    while(i<pos-1)

```

```

    {
        temp=temp->next;
        i++;
    }
    nextnode=temp->next;
    temp->next=nextnode->next;
    free(nextnode);
    printf(" Element successfully deleted\n");
}
void main()
{
    int choice;

    printf(" MENU\n 1.Create\n 2.Insert at beginnning\n 3.Insert at end\n 4.Insert at position\n
5.Display \n 6.Exit\n");

    while(1)
    {
        printf("\n Enter operation:");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1:create();
                break;
            case 2: delete_beg();
                break;
            case 3: delete_end();
                break;
            case 4:delete_pos();
                break;
            case 5: display();
                break;

```

```
        case 6: exit(0);

        break;

    default: printf(" Invalid output\n");

    }

}

}
```

OUTPUT:

```
MENU
1.Create
2.Insert at beginnning
3.Insert at end
4.Insert at position
5.Display
6.Exit

Enter operation:1
Enter the number of elements:5
Enter the element 1: 2
Enter the element 2: 4
Enter the element 3: 6
Enter the element 4: 8
Enter the element 5: 10

Enter operation:2
Element successfully deleted

Enter operation:3
Element successfully deleted

Enter operation:4
Enter the position: 1
Element successfully deleted

Enter operation:5
The elements are:
4      8
Enter operation:6
```

LAB PROGRAM 5:

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

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

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

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

```
void insertAtBeginning(struct Node** head, int data) {  
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));  
    newNode->data = data;  
    newNode->next = *head;  
    *head = newNode;  
}
```

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

```
void sortList(struct Node** head) {  
    struct Node *current, *nextNode;  
    int temp;  
    current = *head;  
  
    while (current != NULL) {
```

```

    nextNode = current->next;
    while (nextNode != NULL) {
        if (current->data > nextNode->data) {
            temp = current->data;
            current->data = nextNode->data;
            nextNode->data = temp;
        }
        nextNode = nextNode->next;
    }
    current = current->next;
}
}

```

```

void reverseList(struct Node** head) {
    struct Node *prev, *current, *nextNode;
    prev = NULL;
    current = *head;

    while (current != NULL) {
        nextNode = current->next;
        current->next = prev;
        prev = current;
        current = nextNode;
    }
    *head = prev;
}

```

```

void concatenateLists(struct Node** list1, struct Node* list2) {
    if (*list1 == NULL) {
        *list1 = list2;
        return;
    }
    struct Node* temp = *list1;
    while (temp->next != NULL) {

```

```

        temp = temp->next;
    }
    temp->next = list2;
}

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

    while(1)
    {
        printf("\n1. Insert into List 1\n");
        printf("2. Insert into List 2\n");
        printf("3. Sort List 1\n");
        printf("4. Reverse List 1\n");
        printf("5. Concatenate Lists\n");
        printf("6. Print Lists\n");
        printf("7. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter data to insert into List 1: ");
                scanf("%d", &data);
                insertAtBeginning(&list1, data);
                break;
            case 2:
                printf("Enter data to insert into List 2: ");
                scanf("%d", &data);
                insertAtBeginning(&list2, data);
                break;

```

```
case 3:
    sortList(&list1);
    printf("List 1 sorted.\n");
    break;
case 4:
    reverseList(&list1);
    printf("List 1 reversed.\n");
    break;
case 5:
    concatenateLists(&list1, list2);
    printf("Lists concatenated.\n");
    break;
case 6:
    printf("List 1: ");
    printList(list1);
    printf("List 2: ");
    printList(list2);
    break;
case 7:
    exit(0);
    break;
default:
    printf("Invalid choice\n");
}
}
}
```

OUTPUT:

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 1
Enter data to insert into List 1: 5

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 1
Enter data to insert into List 1: 3

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 1
Enter data to insert into List 1: 9
```

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 2
Enter data to insert into List 2: 4

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 3
List 1 sorted.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 4
List 1 reversed.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
```



```

List 1: 9 5 3
List 2: 4

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 5
Lists concatenated.

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 6
List 1: 9 5 3 4
List 2: 4

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 2
5. Concatenate Lists
6. Print Lists
7. Exit
Enter your choice: 7

```

LAB PROGRAM 6:

Write a program to Implement Single Link List to simulate Stack & Queue Operations.

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

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

```

struct node {
    int info;

    struct node *ptr;
}*top,*top1,*temp;

```

```
int count = 0;
```

```
void push(int data)
```

```

{
    if (top == NULL)
    {
        top =(struct node *)malloc(1*sizeof(struct node));

        top->ptr = NULL;

        top->info = data;
    }
    else
    {
        temp =(struct node *)malloc(1*sizeof(struct node));

        temp->ptr = top;

        temp->info = data;

        top = temp;
    }

    count++;

    printf("Node is Inserted\n\n");
}

```

```

int pop()
{
    top1 = top;

    if (top1 == NULL)
    {
        printf("\nStack Underflow\n");

        return -1;
    }
}

```

```

    }

    else

        top1 = top1->ptr;

    int popped = top->info;

    free(top);

    top = top1;

    count--;

    return popped;

}

void display() {

    top1 = top;

    if (top1 == NULL)

    {

        printf("\nStack Underflow\n");

        return;

    }

    printf("The stack is \n");

    while (top1 != NULL)

    {

        printf("%d--->", top1->info);

        top1 = top1->ptr;

    }

    printf("NULL\n\n");

```

```

}

void main() {

    int choice, value;

    printf("\nImplementation of Stack using Linked List\n");

    while (1) {

        printf("\nMENU\n1. Push\n2. Pop\n3. Display\n4. Exit\n");

        printf("Enter your choice : ");

        scanf("%d", &choice);

        switch (choice) {

            case 1:

                printf("\nEnter the value to insert: ");

                scanf("%d", &value);

                push(value);

                break;

            case 2:

                printf("Popped element is :%d\n", pop());

                break;

            case 3:

                display();

                break;

            case 4:

                exit(0);

                break;

            default:

                printf("\Invalid Choice\n");

```

```
    }  
}  
}
```

OUTPUT:

```
Implementation of Stack using Linked List
```

```
MENU  
1. Push  
2. Pop  
3. Display  
4. Exit  
Enter your choice : 1  
  
Enter the value to insert: 4  
Node is Inserted
```

```
MENU  
1. Push  
2. Pop  
3. Display  
4. Exit  
Enter your choice : 1  
  
Enter the value to insert: 6  
Node is Inserted
```

```
MENU  
1. Push  
2. Pop  
3. Display  
4. Exit  
Enter your choice : 1  
  
Enter the value to insert: 5  
Node is Inserted
```

```
MENU  
1. Push  
2. Pop  
3. Display  
4. Exit  
Enter your choice : 2  
Popped element is :5  
MENU  
1. Push  
2. Pop  
3. Display  
4. Exit  
Enter your choice : 3  
The stack is  
6--->4--->NULL
```

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

QUEUE IMPLEMENTATION:

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

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

struct node *front = NULL, *rear = NULL;

void enqueue(int val)
{
    struct node *newNode = malloc(sizeof(struct node));
    newNode->data = val;
    newNode->next = NULL;
    if(front == NULL && rear == NULL)
        front = rear = newNode;
    else
    {
        //add newnode in rear->next
        rear->next = newNode;
        rear = newNode;
    }
}

int dequeue()
{
    if(front == NULL)
```

```

{
    printf("\nUNDERFLOW\n");
    return-1;
}
else
{
    struct node *temp = front;
    int temp_data=front->data;
    front = front->next;
    free(temp);
    return temp_data;
}
}
void display()
{
    struct node *temp = front;
    while(temp)
    {
        printf("%d->",temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}
void main()
{
    int choice, value;
    printf("\nImplementation of Queue using Linked List\n");
    while (1) {
        printf("\nMENU\n1. Enqueue\n2. Dequeue\n3. Display\n4. Exit\n");

```

```
printf("Enter your choice : ");
scanf("%d", &choice);
switch (choice)
{
    case 1:
        printf("\nEnter the value to insert: ");
        scanf("%d", &value);
        enqueue(value);
        break;
    case 2:
        printf("The element removed is :%d\n", dequeue());
        break;
    case 3:
        display();
        break;
    case 4:
        exit(0);
        break;
    default:
        printf("\nInvalid Choice\n");
}
}
```


OUTPUT:

Implementation of Queue using Linked List

MENU

1. Enqueue
2. Dequeue
3. Display
4. Exit

Enter your choice : 1

Enter the value to insert: 5

MENU

1. Enqueue
2. Dequeue
3. Display
4. Exit

Enter your choice : 1

Enter the value to insert: 7

MENU

1. Enqueue
2. Dequeue
3. Display
4. Exit

Enter your choice : 1

Enter the value to insert: 2

MENU

1. Enqueue
2. Dequeue
3. Display
4. Exit

Enter your choice : 2

The element removed is :5

```
MENU
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice : 3
7->2->NULL

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

LAB PROGRAM 7:

Write a program 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* head = NULL;
```

```
void createlist() {
    int i, n;
    struct Node* newNode;
    struct Node* temp;
```

```

printf("Enter the number of elements:");
scanf("%d", &n);
for (i = 0; i < n; i++) {
    newNode = (struct Node*)malloc(sizeof(struct Node));
    printf("Enter the element: ");
    scanf("%d", &newNode->data);
    if (head == NULL) {
        head = temp = newNode;
        head->prev = NULL;
        temp->next = NULL;
    } else {
        temp->next = newNode;
        newNode->prev = temp;
        temp = newNode;
        temp->next = NULL;
    }
}
printf("List created successfully.\n");
}

```

```

void insertLeft(struct Node* temp, int data) {
    struct Node* newNode;
    if (temp == NULL) {
        printf("Target node doesn't exist!\n");
        return;
    }
    newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = temp;
    newNode->prev = temp->prev;
    if (temp->prev != NULL) {
        temp->prev->next = newNode;
    }
    temp->prev = newNode;
    if (head == temp) {
        head = newNode;
    }
    printf("Node inserted successfully.\n");
}

```

```

void deleteNode(int key) {
    struct Node* current = head;
    while (current != NULL) {
        if (current->data == key) {

```

```

        if (current->prev != NULL) {
            current->prev->next = current->next;
        }
        if (current->next != NULL) {
            current->next->prev = current->prev;
        }
        if (current == head) {
            head = current->next;
        }
        free(current);
        printf("Node deleted successfully.\n");
        return;
    }
    current = current->next;
}
printf("Node with value %d not found!\n", key);
}

```

```

void printList() {
    struct Node* temp = head;
    if (temp == NULL) {
        printf("List is empty!\n");
        return;
    }
    printf("Doubly linked list: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

```

```

void main()
{
    int choice, data, targetValue, deleteValue;

    while(1)
    {
        printf("\nMENU:\n");
        printf("1. Create linked list\n");
        printf("2. Insert left of node\n");
        printf("3. Delete node by value\n");
        printf("4. Print the list\n");
    }
}

```

```

printf("5. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);

switch (choice) {
    case 1:
        createlist();
        break;
    case 2:
        printf("Enter the value of the node to insert left of: ");
        scanf("%d", &targetValue);
        printf("Enter the element to insert left of the node: ");
        scanf("%d", &data);
        struct Node* temp = head;
        while (temp != NULL) {
            if (temp->data == targetValue) {
                insertLeft(temp, data);
                break;
            }
            temp = temp->next;
        }
        break;
    case 3:
        printf("Enter the value of the node to delete: ");
        scanf("%d", &deleteValue);
        deleteNode(deleteValue);
        break;
    case 4:
        printList();
        break;
    case 5:
        exit(0);
        break;
    default:
        printf("Invalid choice.\n");
}
}
}

```

OUTPUT:

```
MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 1
Enter the number of elements:3
Enter the element: 2
Enter the element: 4
Enter the element: 6
List created successfully.

MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 2
Enter the value of the node to insert left of: 4
Enter the element to insert left of the node: 3
Node inserted successfully.
```

```
MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 3
Enter the value of the node to delete: 6
Node deleted successfully.

MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 4
Doubly linked list: 2 3 4

MENU:
1. Create linked list
2. Insert left of node
3. Delete node by value
4. Print the list
5. Exit
Enter your choice: 5
```

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>
```

```
struct TreeNode {
    int val;
    struct TreeNode *left;
    struct TreeNode *right;
};
```

```
struct TreeNode* createNode(int value) {
    struct TreeNode* newNode = (struct TreeNode*)malloc(sizeof(struct TreeNode));
    newNode->val = value;
    newNode->left = NULL;
    newNode->right = NULL;
    return newNode;
}
```

```
struct TreeNode* insert(struct TreeNode* node, int value) {
    if (node == NULL) {
        return createNode(value);
    }
    if (value < node->val) {
        node->left = insert(node->left, value);
    } else if (value > node->val) {
        node->right = insert(node->right, value);
    }
    return node;
}
```

```
void inorderTraversal(struct TreeNode* node) {
    if (node != NULL) {
```

```

        inorderTraversal(node->left);
        printf("%d ", node->val);
        inorderTraversal(node->right);
    }
}

void postorderTraversal(struct TreeNode* node) {
    if (node != NULL) {
        postorderTraversal(node->left);
        postorderTraversal(node->right);
        printf("%d ", node->val);
    }
}

void preorderTraversal(struct TreeNode* node) {
    if (node != NULL) {
        printf("%d ", node->val);
        preorderTraversal(node->left);
        preorderTraversal(node->right);
    }
}

void main()
{
    struct TreeNode* root = NULL;
    int n, value, choice;

    printf("\nMENU:\n");
    printf("1. Create tree\n");
    printf("2. Preorder\n");
    printf("3. Inorder\n");
    printf("4. Postorder\n");
    printf("5. Exit\n");
    printf("Enter your choice: ");
    scanf("%d", &choice);
    while(1)
    {
        switch(choice)
        {
            case 1:
                printf("Enter the number of nodes: ");
                scanf("%d", &n);

```



```

        printf("Enter the values of the nodes: ");
        for (int i = 0; i < n; ++i)
        {
            scanf("%d", &value);
            root = insert(root, value);
        }
        break;

    case 2:
        printf("Inorder traversal: ");
        inorderTraversal(root);
        printf("\n");

    case 3:
        printf("Inorder traversal: ");
        inorderTraversal(root);
        printf("\n");
        break;

    case 4:
        printf("Postorder traversal: ");
        postorderTraversal(root);
        printf("\n");
        break;

    case 5:
        exit(0);
        break;

    default:
        printf("Invalid chouce ");

    }

}
}

```

OUTPUT:

```
MENU:
1. Create tree
2. Preorder
3. Inorder
4. Postorder
5. Exit

Enter your choice: 1
Enter the number of nodes: 6
Enter the values of the nodes: 2 5 7 8 6 9

Enter your choice: 2

Inorder traversal: 2 5 6 7 8 9

Enter your choice: 3

Inorder traversal: 2 5 6 7 8 9

Enter your choice: 4

Postorder traversal: 6 9 8 7 5 2

Enter your choice: 5
```

LAB PROGRAM 9:

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

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

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

```
#define SIZE 40
```

```
struct queue {
```

```
    int items[SIZE];
```

```
    int front;
```

```
    int rear;
```

```
};
```

```
struct queue* createQueue();
```

```
void enqueue(struct queue* q, int);
```

```
int dequeue(struct queue* q);
```

```
void display(struct queue* q);
```

```
int isEmpty(struct queue* q);
```

```
void printQueue(struct queue* q);
```

```
struct node {
```

```
    int vertex;
```

```
    struct node* next;
```

```
};
```

```
struct node* createNode(int);
```

```
struct Graph {
```

```
    int numVertices;
```

```
    struct node** adjLists;
```

```
    int* visited;
```

```
};
```

```
void bfs(struct Graph* graph, int startVertex) {
```

```
    struct queue* q = createQueue();
```

```

graph->visited[startVertex] = 1;

enqueue(q, startVertex);


while (!isEmpty(q)) {

    int currentVertex = dequeue(q);

    printf("Visited %d\n", currentVertex);


    struct node* temp = graph->adjLists[currentVertex];


    while (temp) {

        int adjVertex = temp->vertex;

        if (graph->visited[adjVertex] == 0) {

            graph->visited[adjVertex] = 1;

            enqueue(q, adjVertex);

        }

        temp = temp->next;

    }

}


struct node* createNode(int v) {

    struct node* newNode = malloc(sizeof(struct node));

    newNode->vertex = v;

    newNode->next = NULL;

```

```

    return newNode;
}

struct Graph* createGraph(int vertices) {
    struct Graph* graph = malloc(sizeof(struct Graph));

    graph->numVertices = vertices;

    graph->adjLists = malloc(vertices * sizeof(struct node*));
    graph->visited = malloc(vertices * sizeof(int));

    int i;
    for (i = 0; i < vertices; i++) {
        graph->adjLists[i] = NULL;
        graph->visited[i] = 0;
    }

    return graph;
}

void addEdge(struct Graph* graph, int src, int dest) {
    struct node* newNode = createNode(dest);
    newNode->next = graph->adjLists[src];
    graph->adjLists[src] = newNode;

    newNode = createNode(src);

```

```

newNode->next = graph->adjLists[dest];

graph->adjLists[dest] = newNode;
}

struct queue* createQueue() {

    struct queue* q = malloc(sizeof(struct queue));

    q->front = -1;

    q->rear = -1;

    return q;
}

int isEmpty(struct queue* q) {

    if (q->rear == -1)

        return 1;

    else

        return 0;

}

void enqueue(struct queue* q, int value) {

    if (q->rear == SIZE - 1)

        printf("\nQueue is Full!!");

    else {

        if (q->front == -1)

            q->front = 0;

        q->rear++;
    }
}

```

```
    q->items[q->rear] = value;
}
}
```

```
int dequeue(struct queue* q) {
    int item;

    if (isEmpty(q)) {
        printf("Queue is empty");
        item = -1;
    } else {
        item = q->items[q->front];
        q->front++;
        if (q->front > q->rear) {
            printf("Resetting queue ");
            q->front = q->rear = -1;
        }
    }

    return item;
}
```

```
void printQueue(struct queue* q) {
    int i = q->front;

    if (isEmpty(q)) {
        printf("Queue is empty");
    }
}
```

```

    } else {

        printf("\nQueue contains \n");

        for (i = q->front; i < q->rear + 1; i++) {

            printf("%d ", q->items[i]);

        }

    }

}

void main() {

    int vertices, edges, src, dest;

    printf("Enter the number of vertices: ");

    scanf("%d", &vertices);

    printf("Enter the number of edges: ");

    scanf("%d", &edges);

    struct Graph* graph = createGraph(vertices);

    printf("Enter edges (source destination):\n");

    for (int i = 0; i < edges; ++i)
    {

        scanf("%d%d", &src, &dest);

        addEdge(graph, src, dest);

    }

    bfs(graph, 0);

}

```


OUTPUT:

```
Enter the number of vertices: 5
Enter the number of edges: 4
Enter edges (source destination):
0 1
0 2
1 3
2 4
Resetting queue Visited 0
Visited 2
Visited 1
Visited 4
Resetting queue Visited 3
```

b) Write a program to traverse a graph using DFS method.

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

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

```
struct node {
    int vertex;
    struct node* next;
};
```

```
struct node* createNode(int v);
```

```
struct Graph {
    int numVertices;
    int* visited;

    struct node** adjLists;
```

```

};

void DFS(struct Graph* graph, int vertex) {
    struct node* adjList = graph->adjLists[vertex];
    struct node* temp = adjList;

    graph->visited[vertex] = 1;
    printf("Visited %d \n", vertex);

    while (temp != NULL) {
        int connectedVertex = temp->vertex;

        if (graph->visited[connectedVertex] == 0) {
            DFS(graph, connectedVertex);
        }
        temp = temp->next;
    }
}

```

```

struct node* createNode(int v) {
    struct node* newNode = malloc(sizeof(struct node));
    newNode->vertex = v;
    newNode->next = NULL;
    return newNode;
}

```

```

struct Graph* createGraph(int vertices) {

    struct Graph* graph = malloc(sizeof(struct Graph));

    graph->numVertices = vertices;


    graph->adjLists = malloc(vertices * sizeof(struct node*));


    graph->visited = malloc(vertices * sizeof(int));


    int i;

    for (i = 0; i < vertices; i++) {

        graph->adjLists[i] = NULL;

        graph->visited[i] = 0;

    }

    return graph;

}

```

```

void addEdge(struct Graph* graph, int src, int dest) {

    struct node* newNode = createNode(dest);

    newNode->next = graph->adjLists[src];

    graph->adjLists[src] = newNode;


    // Add edge from dest to src

    newNode = createNode(src);

    newNode->next = graph->adjLists[dest];

```

```

graph->adjLists[dest] = newNode;
}

void printGraph(struct Graph* graph) {
    int v;
    for (v = 0; v < graph->numVertices; v++) {
        struct node* temp = graph->adjLists[v];
        printf("\n Adjacency list of vertex %d\n ", v);
        while (temp) {
            printf("%d -> ", temp->vertex);
            temp = temp->next;
        }
        printf("\n");
    }
}

void main()
{
    int vertices, edges, src, dest;

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

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

    struct Graph* graph = createGraph(vertices);

```

```

        printf("Enter edges (source destination):\n");

        for (int i = 0; i < edges; ++i)
        {
            scanf("%d%d", &src, &dest);

            addEdge(graph, src, dest);

        }

        printGraph(graph);

        DFS(graph, 2);
    }

```

OUTPUT:

```

Enter the number of vertices: 4
Enter the number of edges: 4
Enter edges (source destination):
0 1
0 2
1 2
2 3

Adjacency list of vertex 0
2 -> 1 ->

Adjacency list of vertex 1
2 -> 0 ->

Adjacency list of vertex 2
3 -> 1 -> 0 ->

Adjacency list of vertex 3
2 ->
Visited 2
Visited 3
Visited 1
Visited 0

```

LeetCode Programs:

1.Score of Parentheses(LP:856)

Given a balanced parentheses string *s*, return *the score of the string*.

The **score** of a balanced parentheses string is based on the following rule:

- "()" has score 1.
- AB has score A + B, where A and B are balanced parentheses strings.
- (A) has score 2 * A, where A is a balanced parentheses string.

</> Code

C ▼ 🔒 Auto

```
1  int scoreOfParentheses(char* s)
2  {
3      int stack[50];
4      int top = -1;
5      int score = 0;
6
7      for(int i = 0; s[i] != '\0'; i++) {
8          if(s[i] == '(') {
9              stack[++top] = score;
10             score = 0;
11         } else {
12             score = stack[top--] + (score == 0 ? 1 : (score * 2));
13         }
14     }
15     return score;
16 }
17
```

Clicked to test

Testcase

Test Result

Accepted Runtime: 0 ms

Case 1

Case 2

Case 3

Input

s =
"()"

Output

1

Expected

1

2.Odd Even Linked List(LP:328)

Given the head of a singly linked list, group all the nodes with odd indices together followed by the nodes with even indices, and return *the reordered list*.

The **first** node is considered **odd**, and the **second** node is **even**, and so on.

</> Code

C ▾ 🔒 Auto

```
1  /**
2   * Definition for singly-linked list.
3   * struct ListNode {
4   *     int val;
5   *     struct ListNode *next;
6   * };
7   */
8  struct ListNode* oddEvenList(struct ListNode* head) {
9      if (head == NULL || head->next == NULL || head->next->next == NULL)
10         return head;
11
12     struct ListNode *oddHead = head;
13     struct ListNode *evenHead = head->next;
14     struct ListNode *oddCurrent = oddHead;
15     struct ListNode *evenCurrent = evenHead;
16
17     while (evenCurrent != NULL && evenCurrent->next != NULL) {
18         oddCurrent->next = evenCurrent->next;
19         oddCurrent = oddCurrent->next;
20         evenCurrent->next = oddCurrent->next;
21         evenCurrent = evenCurrent->next;
22     }
23     oddCurrent->next = evenHead;
24
25     return oddHead;
26 }
```

☒ Testcase | [> Test Result](#)

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

head =
[1,2,3,4,5]

Output

[1,3,5,2,4]

Expected

[1,3,5,2,4]

3.Delete middle node of linked list.(LP:2095)

You are given the head of a linked list. **Delete** the **middle node**, and return *the head of the modified linked list*.

The **middle node** of a linked list of size n is the $\lfloor n / 2 \rfloor^{\text{th}}$ node from the **start** using **0-based indexing**, where $\lfloor x \rfloor$ denotes the largest integer less than or equal to x .

- For $n = 1, 2, 3, 4$, and 5 , the middle nodes are $0, 1, 1, 2$, and 2 , respectively.

</> Code

C v Auto

```
1  /**
2   * Definition for singly-linked list.
3   * struct ListNode {
4   *     int val;
5   *     struct ListNode *next;
6   * };
7   */
8  int countOfNodes(struct ListNode* head)
9  {
10     int count = 0;
11     while (head != NULL) {
12         head = head->next;
13         count++;
14     }
15     return count;
16 }
17 struct ListNode* deleteMiddle(struct ListNode* head)
18 {
19     if (head == NULL)
20         return NULL;
21     if (head->next == NULL) {
22         free(head);
23         return NULL;
24     }
25     struct ListNode* copyHead = head;
26     int count = countOfNodes(head);
27     int mid = count / 2;
28     while(mid-->1)
29         head = head->next;
30     head->next = head->next->next;
31     return copyHead;
32 }
```

✓ Testcase > Test Result

Accepted Runtime: 2 ms

• Case 1 • Case 2 • Case 3

Input

head =
[1, 3, 4, 7, 1, 2, 6]

Output

[1, 3, 4, 1, 2, 6]

Expected

[1, 3, 4, 1, 2, 6]

4.Delete a node in BST.(LP:450)

Given a root node reference of a BST and a key, delete the node with the given key in the BST. Return *the root node reference (possibly updated) of the BST*.

Basically, the deletion can be divided into two stages:

1. Search for a node to remove.
2. If the node is found, delete the node.

</>Code

C v Auto

```
1  /~~~
2  * Definition for a binary tree node.
3  * struct TreeNode {
4  *     int val;
5  *     struct TreeNode *left;
6  *     struct TreeNode *right;
7  * };
8  */
9  struct TreeNode* minValueNode(struct TreeNode* node) {
10     struct TreeNode* current = node;
11     while (current && current->left != NULL)
12         current = current->left;
13     return current;
14 }
15
16 struct TreeNode* deleteNode(struct TreeNode* root, int key) {
17     if (root == NULL) return root;
18
19     if (key < root->val)
20         root->left = deleteNode(root->left, key);
21     else if (key > root->val)
22         root->right = deleteNode(root->right, key);
23     else {
24         if (root->left == NULL) {
25             struct TreeNode* temp = root->right;
26             free(root);
27             return temp;
28         } else if (root->right == NULL) {
29             struct TreeNode* temp = root->left;
30             free(root);
31             return temp;
32         }
33
34         struct TreeNode* temp = minValueNode(root->right);
35         root->val = temp->val;
36         root->right = deleteNode(root->right, temp->val);
37     }
38     return root;
39 }
```

Testcase | Test Result

Accepted Runtime: 2 ms

Case 1 Case 2 Case 3

Input

root =
[5,3,6,2,4,null,7]

key =
3

Output

[5,4,6,2,null,null,7]

Expected

[5,4,6,2,null,null,7]

5.Bottom Left Tree Value.(LP:513)

Given the root of a binary tree, return the leftmost value in the last row of the tree.

</>Code

C Auto

```
1  /**
2   * Definition for a binary tree node.
3   * struct TreeNode {
4   *     int val;
5   *     struct TreeNode *left;
6   *     struct TreeNode *right;
7   * };
8   */
9  int findBottomLeftValue(struct TreeNode* root) {
10     struct TreeNode* queue[10000]; // Assuming maximum 10000 nodes
11     int front = 0, rear = 0;
12     queue[rear++] = root;
13     int leftmostValue = root->val;
14
15     while (front < rear) {
16         int levelSize = rear - front;
17         for (int i = 0; i < levelSize; i++) {
18             struct TreeNode* current = queue[front++];
19             if (i == 0) // first node at the current level
20                 leftmostValue = current->val;
21             if (current->left != NULL)
22                 queue[rear++] = current->left;
23             if (current->right != NULL)
24                 queue[rear++] = current->right;
25         }
26     }
27
28     return leftmostValue;
29 }
```

✓ Testcase | > Test Result

Accepted Runtime: 5 ms

• Case 1 • Case 2

Input

```
root =  
[1,2,3,4,null,5,6,null,null,7]
```

Output

```
7
```

Expected

```
7
```

✓ Testcase | > Test Result

Accepted Runtime: 5 ms

- Case 1
- Case 2

Input

```
root =  
[1,2,3,4,null,5,6,null,null,7]
```

Output

7

Expected

7

✓ Testcase | > Test Result

Accepted Runtime: 5 ms

- Case 1
- Case 2

Input

```
root =  
[2,1,3]
```

Output

1

Expected

1