VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

ARCHITA V (1BM23CS050)

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)
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B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by ARCHITA V **(1BM23CS050)**, who is a 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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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 3
int s[10],top=-1,i,item,ch;
void push();
int pop();
void display();
void main()
{
    while(1)
    {
    printf("\n 1.PUSH \n 2.POP \n 3.DISPLAY \n 4.EXIT \n");
    printf("Enter your choice: ");
    scanf("%d",&ch);
    switch(ch)
    {
    case 1:
        push();
        break;
    case 2:
        item=pop();
        if(item!=-1)
            printf("Popped element=%d",item);
        break;
     case 3:
        display();
        break;
     case 4:
        exit(0);
     }
   }
}
void push()
{
     if(top==MAX-1)
     {
        printf("Stack overflow");
        return;
     }
     top=top+1;
     printf("Enter the element to be pushed: ");
```

```
    top=top+1;
    printf("Enter the element to be pushed: ");
    scanf("%d",&item);
    s[top]=item;
}
int pop()
{
    if(top==-1)
    {
        printf("stack underflow");
        return(-1);
    }
    item=s[top];
    top=top-1;
    return item;
}
void display()
{
    if(top==-1)
    {
```

```
    {
        printf("stack underflow");
        return(-1);
    }
    item=s[top];
    top=top-1;
    return item;
}
void display()
{
    if(top==-1)
    {
        printf("Stack is empty");
        return;
    }
    printf("Stack contents: ");
    for(i=top;i>=0;i--)
        printf("%d\n",s[i]);
}
```

OUTPUT

```
 1.PUSH
 2.POP
 3.DISPLAY
 4.EXIT
Enter your choice: 1
Enter the element to be pushed: 10

 1.PUSH
 2.POP
 3.DISPLAY
 4.EXIT
Enter your choice: 1
Enter the element to be pushed: 2

 1.PUSH
 2.POP
 3.DISPLAY
 4.EXIT
Enter your choice: 1
Enter the element to be pushed: 3

 1.PUSH
 2.POP
 3.DISPLAY
 4.EXIT
Enter your choice: 3
Stack contents: 3
2
10

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

Lab program 2

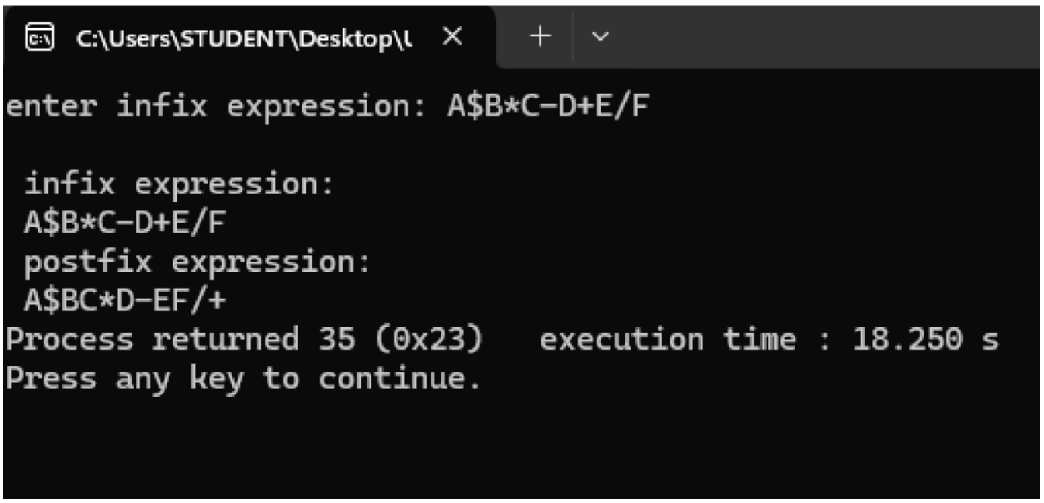
Write a program to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide)

```
#include<stdio.h>
#include<string.h>
void infixtopostfix();
void push(char symbol);
char pop();
int pred(char symb);
int index=0,pos=0,top=-1,length;
char symbol,temp,infix[20],postfix[20],stack[20];
void main()
{
    printf("enter infix expression: ");
    scanf("%s",infix);
     infixtopostfix();
     postfix[pos] = '\0';
    printf("\n infix expression:\n %s ",infix);
    printf("\n postfix expression:\n %s ",postfix);
}
void infixtopostfix()
{
    length=strlen(infix);
    push('#');
    while(index<length)
    {
        symbol=infix[index];
        switch (symbol)
        {
            case'(':push(symbol);
                    break;
            case')':temp=pop();
                    while (temp!='(')
                    {
                        postfix[pos]=temp;
                        pos++;
                        temp=pop();
                    }
                    break;
            case'+':
            case'-':
            case'*':
            case'/':
```

```
            case'/':
            case'^':
                    while (pred(stack[top])>=pred (symbol))
                     {
                        temp=pop();
                        postfix[pos++]=temp;
                     }
                     push(symbol);
                     break;
            default:postfix[pos++]=symbol;
        }
        index++;
    }
    while(top>0)
    {
        temp=pop();
        postfix[pos++]=temp;
    }
}
void push(char symbol)
{
    top=top+1;
    stack[top]=symbol;
}
char pop()
{
    char symb;
    symb=stack[top];
    top=top-1;
    return(symb);
}
int pred(char symbol)
{
    int p;
    switch (symbol)
    {
        case'^':p=3;
                break;
        case'*':
        case'/':p=2;
```

```
    }
    while(top>0)
    {
        temp=pop();
        postfix[pos++]=temp;
    }
}
void push(char symbol)
{
    top=top+1;
    stack[top]=symbol;
}
char pop()
{
    char symb;
    symb=stack[top];
    top=top-1;
    return(symb);
}
int pred(char symbol)
{
    int p;
    switch (symbol)
    {
        case'^':p=3;
                break;
        case'*':
        case'/':p=2;
                break;
        case'+':
        case'-':p=1;
                break;
        case'(':p=0;
                break;
        case'#':p=-1;
                break;
    }
    return (p);
}
```

OUTPUT



LEETCODE 2


```
15.5.24                                    12
Leet Code - Clear digit :

class sol {
    String clear dig (String s)
    {
        int l = s.length();
        for (int i=0; i<l; i++)
        {
            if (isDigit (s[i]))
            {
                if (l!=0)(s.erase (i-1,2);
                    l-=2 ; i-=2;
                }
                else
                { s.erase (i,2); l--; i--; }
            }
        }

Case 1                          Case 2
Input S = "abc"                 S = "cb34"
Output "abc"                    Output " "
Expected "abc"                  Expected " "
```

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

```c
#include<stdio.h>
#define MAX 5
int queue[MAX];
int front=-1;
int rear=-1;
void insert(int value)
{
  if(rear==MAX-1)
  {
    printf("Queue is full.Cannot insert %d \n",value);
    return;
  }
  if(rear==-1 && front==-1)
  {
    front=0;
  }
  rear++;
  queue[rear]=value;
  printf("Inserted: %d\n",value);
}
int delete()
{
    if(rear==-1 && front==-1)
    {
        printf("Queue is empty.Cannot delete\n");
        return -1;
    }
    int item=queue[front];
    if(front>=rear)
    {
        front=-1;
        rear=-1;
    }
    else
    {
        front++;
```

```
    }
    printf("Deleted: %d\n",item);
    return item;
}
void display()
{
    if(rear==-1 && front==-1)
    {
        printf("Queue is empty\n");
        return;
    }
    printf("Queue contents:");
    for(int i=front;i<=rear;i++)
    {
        printf("%d\t",queue[i]);
    }
    printf("\n");
}
int main()
{
    int choice,value;
    do
    {
        printf("\n 1.INSERT \n 2.DELETE \n 3.DISPLAY \n 4.EXIT\n");
        printf("Enter your choice: ");
        scanf("%d",&choice);
        switch(choice)
        {
        case 1:
            printf("Enter the value to be inserted: ");
            scanf("%d",&value);
            insert(value);
            break;
        case 2:
            delete();
            break;
```

```
        switch(choice)
        {
        case 1:
            printf("Enter the value to be inserted: ");
            scanf("%d",&value);
            insert(value);
            break;
        case 2:
            delete();
            break;
        case 3:
            display();
            break;
        case 4:
            printf("Exiting\n");
            break;
        default:printf("Invalid choice \n");
        }
    } while(choice!=4);
   return 0;
}
```

OUTPUT

```
 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 1
Enter the value to be inserted: 10
Inserted: 10

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 1
Enter the value to be inserted: 20
Inserted: 20

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 3
Queue contents:10       20

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 2
Deleted: 10

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 2
Deleted: 20

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 2
Queue is empty.Cannot delete

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 3
Queue is empty
```

```
 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 2
Queue is empty.Cannot delete

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 3
Queue is empty

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 4
Exiting
```

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

```c
#include<stdio.h>
#define SIZE 5
int circularqueue[SIZE];
int front=-1;
int rear=-1;
void insert(int value)
{
    if(front=(rear+1)%SIZE)
    {
        printf("Circular queue is full.Cannot insert %d \n",value);
        return;
    }
    if(front==-1 && rear==-1)
    {
        front=0;
        rear=0;
    }
    else
    {
        rear==(rear+1)%SIZE;

    }
    circularqueue[rear]=value;
    printf("Inserted: %d \n",value);

}
int delete()
{
    if(front==-1 && rear==-1 )
    {
        printf("Circular queue is empty.Cannot delete\n");
        return -1;
    }
    int item=circularqueue[front];
    if(front==rear)
    {
```

```
        front=-1;
        rear=-1;
    }
    else
    {
        front==(front+1)%SIZE;
    }
    printf("Deleted: %d \n",item);
    return item;
}
void display()
{
    if (front==-1 && rear==-1)
    {
        printf("Circular queue is empty \n");
        return;
    }
    printf("Circular queue contents: ");
    if(front<=rear)
    {
        for(int i=front;i<=rear;i++)
        {
            printf("%d \t",circularqueue[i]);
        }
        printf("\n");
    }
    else
    {
        for(int i=front;i<SIZE;i++)
        {
            printf("%d \t",circularqueue[i]);
        }
        for(int i=0;i<=rear;i++)
        {
             printf("%d \t",circularqueue[i]);
        }
```

```
        {
            printf("%d \t",circularqueue[i]);
        }
        for(int i=0;i<=rear;i++)
        {
             printf("%d \t",circularqueue[i]);
        }
        printf("\n");
    }
}
int main()
{
    int choice,value;
    do
    {
        printf("\n 1.INSERT \n 2.DELETE \n 3.DISPLAY \n 4.EXIT\n");
        printf("Enter your choice: ");
        scanf("%d",&choice);
        switch(choice)
        {
            case 1:printf("Enter the value to be inserted: ");
                   scanf("%d",&value);
                   insert(value);
                   break;
            case 2:delete();
                   break;
            case 3:display();
                   break;
            case 4:printf("Exiting\n");
                   break;
        }
    } while(choice!=4);
return 0;
}
```

OUTPUT

```
 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 1
Enter the value to be inserted: 12
Inserted: 12

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 1
Enter the value to be inserted: 23
Inserted: 23

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 2
Deleted: 0

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 2
Deleted: 0

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 3
Circular queue contents: 0      0       0       0       0

 1.INSERT
 2.DELETE
 3.DISPLAY
 4.EXIT
Enter your choice: 4
Exiting

Process returned 0 (0x0)   execution time : 14.938 s
Press any key to continue.
```

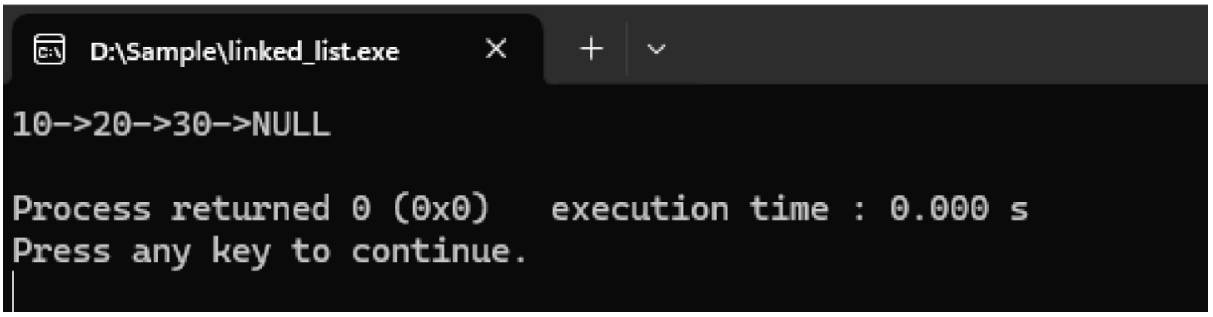
Lab program 4

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

```c
#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 insert(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 display(struct node*head)
{
    struct node*temp=head;
    while(temp!=NULL)
    {
        printf("%d->",temp->data);
        temp=temp->next;
    }
    printf("NULL\n");
}
int main()
```

```
        }
        temp->next=newnode;
    }
}
void display(struct node*head)
{
    struct node*temp=head;
    while(temp!=NULL)
    {
        printf("%d->",temp->data);
        temp=temp->next;
    }
    printf("NULL\n");
}
int main()
{
    struct node*head=NULL;
    insert (&head,10);
    insert (&head,20);
    insert (&head,30);
    display(head);
    return 0;
}
```

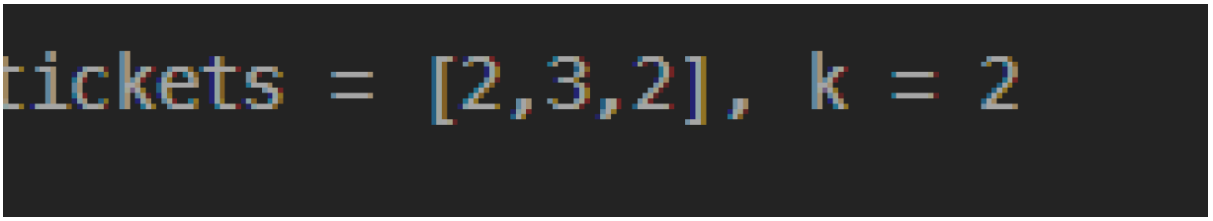
OUTPUT


D:\Sample\linked_list.exe
10->20->30->NULL
Process returned 0 (0x0)   execution time : 0.000 s
Press any key to continue.

LEETCODE 4

```
1
2  public class Solution {
3      public int TimeRequiredToBuy(int[] tickets, int k) {
4          int n = tickets.Length;
5          int time = 0;
6
7          for (int i = 0; i < n; i++) {
8              if (i <= k) {
9                  time += Math.Min(tickets[k], tickets[i]);
10             } else {
11                 time += Math.Min(tickets[k] - 1, tickets[i]);
12             }
13         }
14
15         return time;
16     }
17 }
```

OUTPUT



Lab program 5

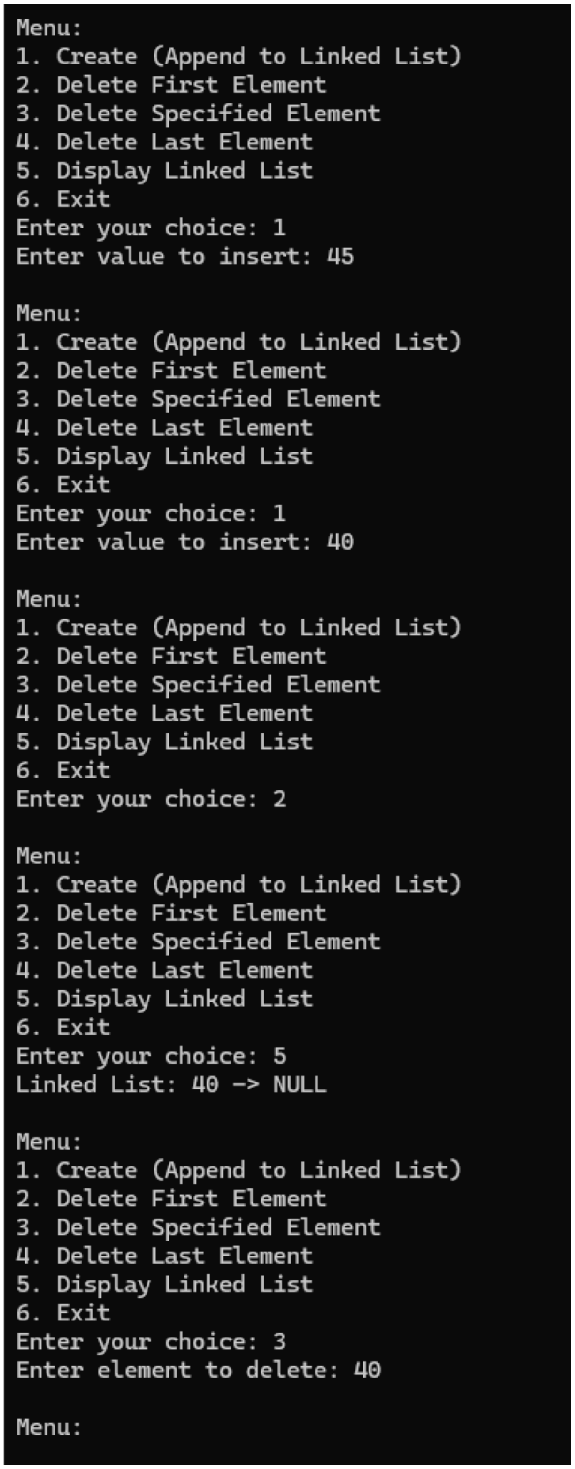
WAP to Implement Singly Linked List with following operations a) Create a linked list. b) Deletion of first element, specified element and last element in the list. c) Display the contents of the linked list.

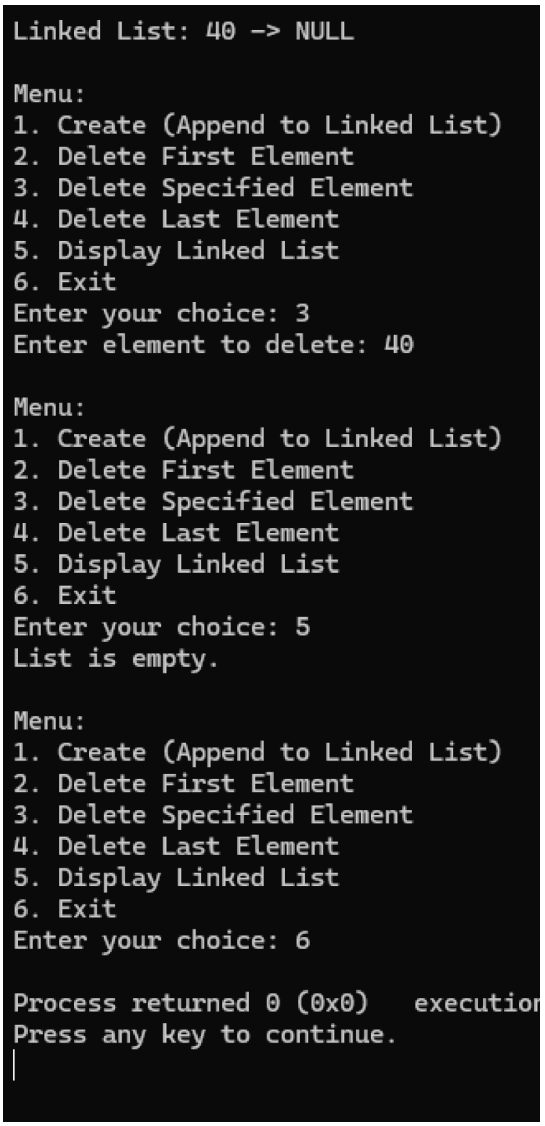
```c
#include <stdio.h>
#include <stdlib.h>

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 append(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 deleteFirst(struct Node** head) {
    if (*head == NULL) {
        printf("List is empty.\n");
        return;
    }
    struct Node* temp = *head;
    *head = (*head)->next;
    free(temp);
}

void deleteElement(struct Node** head, int key) {
    if (*head == NULL) {
        printf("List is empty.\n");
        return;
    }

    if ((*head)->data == key) {
        struct Node* temp = *head;
        *head = (*head)->next;
        free(temp);
        return;
```

```
    if ((*head)->data == key) {
        struct Node* temp = *head;
        *head = (*head)->next;
        free(temp);
        return;
    }

    struct Node* temp = *head;
    while (temp->next != NULL && temp->next->data != key) {
        temp = temp->next;
    }

    if (temp->next != NULL) {
        struct Node* nodeToDelete = temp->next;
        temp->next = temp->next->next;
        free(nodeToDelete);
    } else {
        printf("Element %d not found in the list.\n", key);
    }
}

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

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

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

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

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


int main() {
    struct Node* head = NULL;
    int choice, value, key;

    while (1) {
        printf("\nMenu:\n");
        printf("1. Create (Append to Linked List)\n");
        printf("2. Delete First Element\n");
        printf("3. Delete Specified Element\n");
        printf("4. Delete Last Element\n");
        printf("5. Display Linked List\n");
        printf("6. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert: ");
                scanf("%d", &value);
                append(&head, value);
                break;
            case 2:
                deleteFirst(&head);
                break;
            case 3:
                printf("Enter element to delete: ");
                scanf("%d", &key);
                deleteElement(&head, key);
                break;
            case 4:
                deleteLast(&head);
                break;
            case 5:
                displayList(head);
                break;
            case 6:
                exit(0);
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }
    return 0;
}
```

OUTPUT

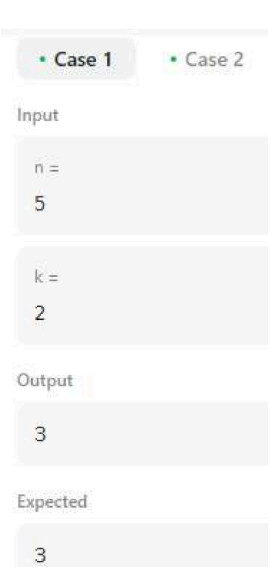

Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 1
Enter value to insert: 45
Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 1
Enter value to insert: 40
Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 2
Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 5
Linked List: 40 -> NULL
Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 3
Enter element to delete: 40
Menu:

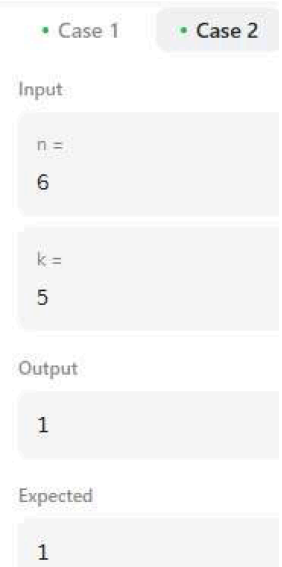

Linked List: 40 -> NULL
Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 3
Enter element to delete: 40
Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 5
List is empty.
Menu:
1. Create (Append to Linked List)
2. Delete First Element
3. Delete Specified Element
4. Delete Last Element
5. Display Linked List
6. Exit
Enter your choice: 6
Process returned 0 (0x0)
Press any key to continue.

LEETCODE 5

```
class Solution {
public:
    int findTheWinner(int n, int k) {
    int *a = (int*)malloc(n * sizeof(int));
    for (int i = 0; i < n; ++i) {
        a[i] = i + 1;
    }
    int size = n;
    int start = 0;
    while (size > 1) {
        start = (start + (k - 1)) % size;
        for (int j = start; j < size - 1; ++j) {
            a[j] = a[j + 1];
        }
        --size;
    }
    int winner = a[0];
    free(a);
    return winner;
}
};
```

OUTPUT





Lab program 6 A

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

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

// Define the structure of a node
struct Node {
    int data;
    struct Node* next;
};

// Function to create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}

// Function to insert a node at the end of the list
struct Node* insertEnd(struct Node* head, int data) {
    struct Node* newNode = createNode(data);
    if (head == NULL) {
        return newNode;
    }
    struct Node* temp = head;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = newNode;
    return head;
}
```

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

// Function to sort the linked list (Bubble Sort)
struct Node* sortList(struct Node* head) {
    if (head == NULL) return head;
    struct Node* current = head;
    struct Node* index = NULL;
    int temp;
    while (current != NULL) {
        index = current->next;
        while (index != NULL) {
            if (current->data > index->data) {
                // Swap data
                temp = current->data;
                current->data = index->data;
                index->data = temp;
            }
            index = index->next;
        }
        current = current->next;
```

```c
struct Node* reverseList(struct Node* head) {
    struct Node* prev = NULL;
    struct Node* current = head;
    struct Node* next = NULL;
    while (current != NULL) {
        next = current->next;
        current->next = prev;
        prev = current;
        current = next;
    }
    return prev;
}

// Function to concatenate two linked lists
struct Node* concatenate(struct Node* head1, struct Node* head2) {
    if (head1 == NULL) return head2;
    if (head2 == NULL) return head1;

    struct Node* temp = head1;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = head2;
    return head1;
}

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

    // Creating first linked list
    list1 = insertEnd(list1, 5);
```

```
    list1 = insertEnd(list1, 9);
    list1 = insertEnd(list1, 3);

    // Creating second linked list
    list2 = insertEnd(list2, 8);
    list2 = insertEnd(list2, 2);
    list2 = insertEnd(list2, 7);

    printf("List 1: ");
    printList(list1);

    printf("List 2: ");
    printList(list2);

    // Sorting list1
    list1 = sortList(list1);
    printf("\nSorted List 1: ");
    printList(list1);

    // Reversing list1
    list1 = reverseList(list1);
    printf("Reversed List 1: ");
    printList(list1);

    // Concatenating list1 and list2
    struct Node* concatenatedList = concatenate(list1, list2);
    printf("\nConcatenated List: ");
    printList(concatenatedList);

    return 0;
}
```

OUTPUT

```
List 1: 5 -> 1 -> 9 -> 3 -> NULL
List 2: 8 -> 2 -> 7 -> NULL

Sorted List 1: 1 -> 3 -> 5 -> 9 -> NULL
Reversed List 1: 9 -> 5 -> 3 -> 1 -> NULL

Concatenated List: 9 -> 5 -> 3 -> 1 -> 8 -> 2 -> 7 -> NULL

Process returned 0 (0x0)   execution time : 0.054 s
Press any key to continue.
```

Lab program 6 B

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

Stack operation-

```c
#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));
    if (!newNode) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}

int isEmpty(struct Node* top) {
    return top == NULL;
}

void push(struct Node** top, int data) {
    struct Node* newNode = createNode(data);
    newNode->next = *top;
    *top = newNode;
    printf("%d pushed onto the stack\n", data);
}
```

```c
int pop(struct Node** top) {
    if (isEmpty(*top)) {
        printf("Stack underflow\n");
        return -1;
    }
    struct Node* temp = *top;
    int poppedData = temp->data;
    *top = (*top)->next;
    free(temp);
    return poppedData;
}

int peek(struct Node* top) {
    if (isEmpty(top)) {
        printf("Stack is empty\n");
        return -1;
    }
    return top->data;
}


void display(struct Node* top) {
    if (isEmpty(top)) {
        printf("Stack is empty\n");
        return;
    }
    struct Node* temp = top;
    printf("Stack elements: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
```

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


int main() {
    struct Node* stackTop = NULL;

    int choice, value;
    do {
        printf("\n--- Stack Operations ---\n");
        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 value to push: ");
                scanf("%d", &value);
                push(&stackTop, value);
                break;
            case 2:
                value = pop(&stackTop);
                if (value != -1)
                    printf("Popped value: %d\n", value);
                break;
            case 3:
                value = peek(stackTop);
```

```
        switch (choice) {
            case 1:
                printf("Enter value to push: ");
                scanf("%d", &value);
                push(&stackTop, value);
                break;
            case 2:
                value = pop(&stackTop);
                if (value != -1)
                    printf("Popped value: %d\n", value);
                break;
            case 3:
                value = peek(stackTop);
                if (value != -1)
                    printf("Top element: %d\n", value);
                break;
            case 4:
                display(stackTop);
                break;
            case 5:
                printf("Exiting...\n");
                break;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    } while (choice != 5);

    return 0;
}
```

OUTPUT

```
--- Stack Operations ---
1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter value to push: 22
22 pushed onto the stack

--- Stack Operations ---
1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter value to push: 30
30 pushed onto the stack

--- Stack Operations ---
1. Push
2. Pop
3. Peek
4. Display
5. Exit
Enter your choice: 3
Top element: 30

--- Stack Operations ---
1. Push
2. Pop
3. Peek
4. Display
```

Queue operation-

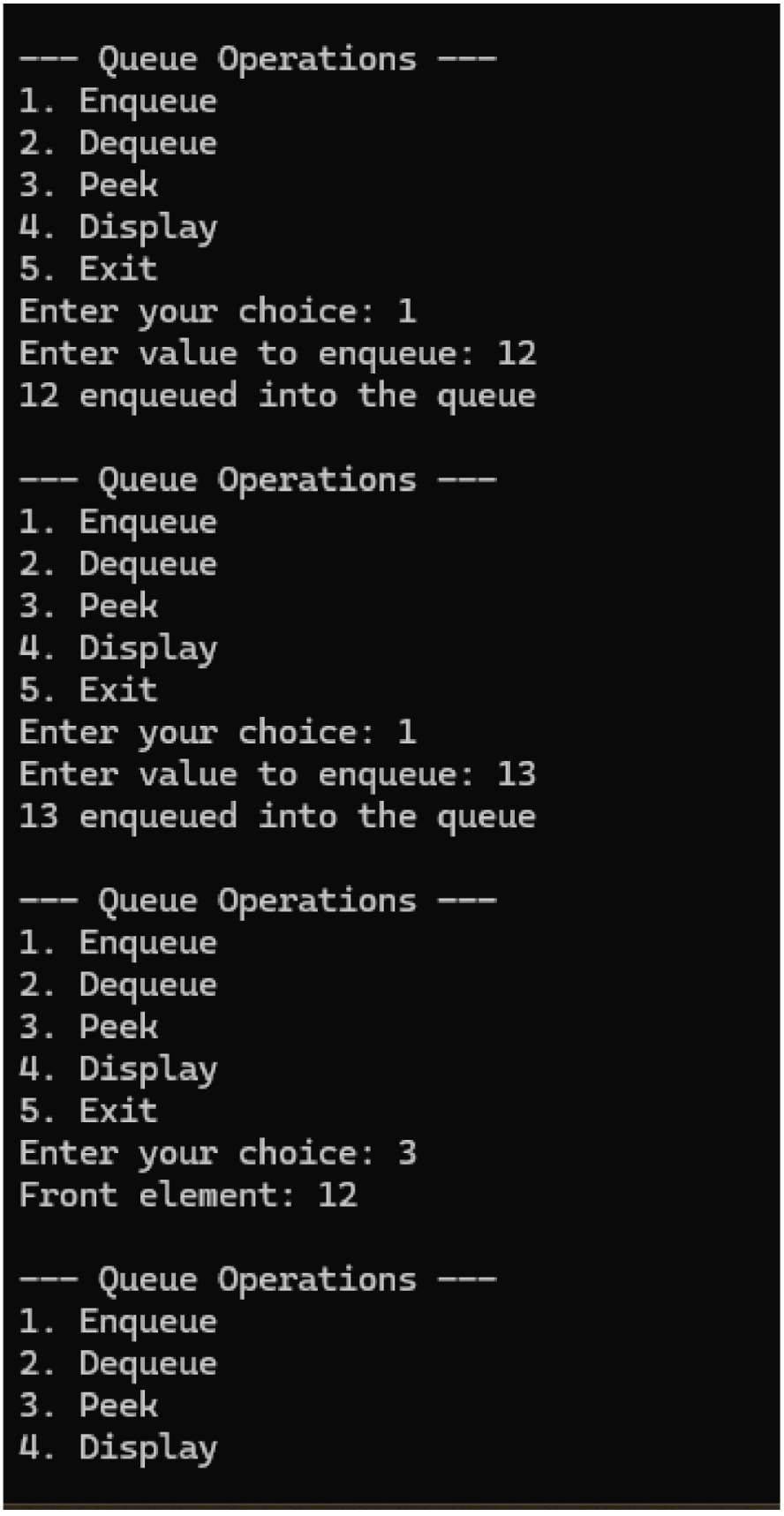
```c
#include <stdio.h>
#include <stdlib.h>
struct Node {
    int data;
    struct Node* next;
};

struct Queue {
    struct Node *front, *rear;
};

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->next = NULL;
    return newNode;
}

struct Queue* createQueue() {
    struct Queue* q = (struct Queue*)malloc(sizeof(struct Queue));
    q->front = q->rear = NULL;
    return q;
}

int isEmpty(struct Queue* q) {
    return q->front == NULL;
```

```
    return q->front == NULL;
}

void enqueue(struct Queue* q, int data) {
    struct Node* newNode = createNode(data);
    if (q->rear == NULL) { // If queue is empty
        q->front = q->rear = newNode;
        printf("%d enqueued into the queue\n", data);
        return;
    }
    q->rear->next = newNode;
    q->rear = newNode;
    printf("%d enqueued into the queue\n", data);
}

int dequeue(struct Queue* q) {
    if (isEmpty(q)) {
        printf("Queue underflow\n");
        return -1;
    }
    struct Node* temp = q->front;
    int dequeuedData = temp->data;
    q->front = q->front->next;

    if (q->front == NULL)
        q->rear = NULL;

    free(temp);
    return dequeuedData;
}
```

```c
int peek(struct Queue* q) {
    if (isEmpty(q)) {
        printf("Queue is empty\n");
        return -1;
    }
    return q->front->data;
}

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


int main() {
    struct Queue* queue = createQueue();

    int choice, value;
    do {
        printf("\n--- Queue Operations ---\n");
        printf("1. Enqueue\n");
        printf("2. Dequeue\n");
```

```c
        switch (choice) {
            case 1:
                printf("Enter value to enqueue: ");
                scanf("%d", &value);
                enqueue(queue, value);
                break;
            case 2:
                value = dequeue(queue);
                if (value != -1)
                    printf("Dequeued value: %d\n", value);
                break;
            case 3:
                value = peek(queue);
                if (value != -1)
                    printf("Front element: %d\n", value);
                break;
            case 4:
                display(queue);
                break;
            case 5:
                printf("Exiting...\n");
                break;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    } while (choice != 5);

    return 0;
}
```

OUTPUT


--- Queue Operations ---
1. Enqueue
2. Dequeue
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter value to enqueue: 12
12 enqueued into the queue
--- Queue Operations ---
1. Enqueue
2. Dequeue
3. Peek
4. Display
5. Exit
Enter your choice: 1
Enter value to enqueue: 13
13 enqueued into the queue
--- Queue Operations ---
1. Enqueue
2. Dequeue
3. Peek
4. Display
5. Exit
Enter your choice: 3
Front element: 12
--- Queue Operations ---
1. Enqueue
2. Dequeue
3. Peek
4. Display

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

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

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

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

Node* createDoublyLinkedList(int n) {
    if (n <= 0) return NULL;

    int data;
    printf("Enter data for node 1: ");
    scanf("%d", &data);

    Node* head = createNode(data);
    Node* temp = head;

    for (int i = 2; i <= n; i++) {
        printf("Enter data for node %d: ", i);
        scanf("%d", &data);

        Node* newNode = createNode(data);
        temp->next = newNode;
        newNode->prev = temp;
        temp = newNode;
    }
    return head;
}


void insertLeft(Node** head, int target, int data) {
    Node* temp = *head;
    while (temp != NULL && temp->data != target) {
        temp = temp->next;
    }

    if (temp == NULL) {
        printf("Node with value %d not found!\n", target);
        return;
    }

    Node* newNode = createNode(data);
    newNode->next = temp;
    newNode->prev = temp->prev;
```

```
    if (temp->prev != NULL) {
        temp->prev->next = newNode;
    } else {
        *head = newNode;
    }
    temp->prev = newNode;
}


void deleteNode(Node** head, int value) {
    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);
    printf("Node with value %d deleted!\n", value);
}

void displayList(Node* head) {
    Node* temp = head;
    printf("Doubly Linked List: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}


int main() {
    Node* head = NULL;
    int choice, n, target, data, value;

    while (1) {
        printf("\nMenu:\n");
        printf("1. Create Doubly Linked List\n");
```

```
        printf("Node with value %d not found!\n", target);
        return;
    }

    Node* newNode = createNode(data);
    newNode->next = temp;
    newNode->prev = temp->prev;

    if (temp->prev != NULL) {
        temp->prev->next = newNode;
    } else {
        *head = newNode;
    }
    temp->prev = newNode;
}


void deleteNode(Node** head, int value) {
    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);
    printf("Node with value %d deleted!\n", value);
}

void displayList(Node* head) {
    Node* temp = head;
    printf("Doubly Linked List: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}
```

```
        temp = temp->next;
    }
    printf("\n");
}int main() {
    Node* head = NULL;
    int choice, n, target, data, value;
    while (1) {
        printf("\nMenu:\n");
        printf("1. Create Doubly Linked List\n");
        printf("2. Insert a Node to the Left of a Specific Node\n");
        printf("3. Delete a Node by Value\n");
        printf("4. Display List\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the number of nodes: ");
                scanf("%d", &n);
                head = createDoublyLinkedList(n);
                break;
                case 2:
                if (head == NULL) {
                    printf("List is empty! Create a list first.\n");
                } else {
                    printf("Enter the target value: ");
                    scanf("%d", &target);
                    printf("Enter the value to insert: ");
                    scanf("%d", &data);
                    insertLeft(&head, target, data);
                }
                break;case 3:
                if (head == NULL) {
                    printf("List is empty! Create a list first.\n");
                } else {
                    printf("Enter the value to delete: ");
                    scanf("%d", &value);
                    deleteNode(&head, value);
                }
                break;case 4:
                if (head == NULL) {
                    printf("List is empty!\n");
                } else {
                    displayList(head);
                }
                break;case 5:
                printf("Exiting...\n");
                exit(0);default:
                printf("Invalid choice! Please try again.\n");}
    }return 0;
}
```

OUTPUT

```
Menu:
1. Create Doubly Linked List
2. Insert a Node to the Left of a Specific Node
3. Delete a Node by Value
4. Display List
5. Exit
Enter your choice: 1
Enter the number of nodes: 3
Enter data for node 1: 13
Enter data for node 2: 14
Enter data for node 3: 15

Menu:
1. Create Doubly Linked List
2. Insert a Node to the Left of a Specific Node
3. Delete a Node by Value
4. Display List
5. Exit
Enter your choice: 2
Enter the target value: 14
Enter the value to insert: 25

Menu:
1. Create Doubly Linked List
2. Insert a Node to the Left of a Specific Node
3. Delete a Node by Value
4. Display List
5. Exit
Enter your choice: 4
Doubly Linked List: 13 25 14 15

Menu:
1. Create Doubly Linked List
2. Insert a Node to the Left of a Specific Node
3. Delete a Node by Value
4. Display List
5. Exit
Enter your choice: 3
Enter the value to delete: 15
Node with value 15 deleted!

Menu:
1. Create Doubly Linked List
2. Insert a Node to the Left of a Specific Node
3. Delete a Node by Value
4. Display List
5. Exit
Enter your choice: 4
Doubly Linked List: 13 25 14

Menu:
1. Create Doubly Linked List
2. Insert a Node to the Left of a Specific Node
3. Delete a Node by Value
4. Display List
5. Exit
Enter your choice: 5
Exiting...
```

Lab program 8

Write a program a) To construct a binary Search tree. b) To traverse the tree using all the methods i.e., inorder, preorder and post order c) To display the elements in the tree

```c
#include <stdio.h>
#include <stdlib.h>
typedef struct Node {
    int data;
    struct Node* left;
    struct Node* right;
} Node;
Node* createNode(int data) {
    Node* newNode = (Node*)malloc(sizeof(Node));
    newNode->data = data;
    newNode->left = NULL;
    newNode->right = NULL;
    return newNode;
}
Node* insertNode(Node* root, int data) {
    if (root == NULL) {
        return createNode(data);
    }
    if (data < root->data) {
        root->left = insertNode(root->left, data);
```

```c
    if (root == NULL) {
        return createNode(data);
    }
    if (data < root->data) {
        root->left = insertNode(root->left, data);
    } else if (data > root->data) {
        root->right = insertNode(root->right, data);
    }
    return root;
}
void inorder(Node* root) {
    if (root != NULL) {
        inorderTraversal(root->left);
        printf("%d ", root->data);
        inorderTraversal(root->right);
    }
}
void preorder(Node* root) {
    if (root != NULL) {
        printf("%d ", root->data);
```

```
    }
}
void preorder(Node* root) {
    if (root != NULL) {
        printf("%d ", root->data);
        preorderTraversal(root->left);
        preorderTraversal(root->right);
    }
}
void postorder(Node* root) {
    if (root != NULL) {
        postorderTraversal(root->left);
        postorderTraversal(root->right);
        printf("%d ", root->data);
    }
}
void displayTree(Node* root) {
    printf("\nInorder : ");
    inorder(root);
    printf("\nPreorder : ");

    inorder(root);
    printf("\nPreorder : ");
    preorder(root);
    printf("\nPostorder : ");
    postorder(root);
}
int main() {
    Node* root = NULL;
    int choice, data;
    while (1) {
        printf("\n1. Insert\n2. Display\n3. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &data);
                root = insertNode(root, data);
                break;
```

```
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &data);
                root = insertNode(root, data);
                break;
            case 2:
                displayTree(root);
                break;
            case 3:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }
}
```

OUTPUT

```
1. Insert
2. Display
3. Exit
Enter your choice: 1
Enter the value to insert: 12

1. Insert
2. Display
3. Exit
Enter your choice: 1
Enter the value to insert: 13

1. Insert
2. Display
3. Exit
Enter your choice: 2

Inorder : 12 13
Preorder : 12 13
Postorder : 13 12
1. Insert
2. Display
3. Exit
Enter your choice: 3
Exiting...

Process returned 0 (0x0)   execution t
Press any key to continue.
```

Lab program 9A

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

```c
#include<stdio.h>
#include<stdlib.h>
#define MAX 50
void bfs(int graph[MAX][MAX],int visited[MAX],int start,int n);
int main()
{
    int n;
    int graph[MAX][MAX];
    int visited[MAX]={0};
    int start;
    printf("Enter the number of vertices: ");
    scanf("%d",&n);
    printf("Enter the adjacency matrix of the graph:\n");
    for(int i=0;i<n;i++)
    {
        for(int j=0;j<n;j++)
        {
            scanf("%d",&graph[i][j]);
        }
    }
    printf("Enter the starting node (0 to %d): ",n-1);
    scanf("%d",&start);
    printf("BFS traversal starting from node %d:\n",start);
    bfs(graph,visited,start,n);
    return 0;
}
void bfs(int graph[MAX][MAX],int visited[MAX],int start,int n)
{
    int queue[MAX],front=0,rear=0;
    queue[rear++]=start;
    visited[start]=1;
    while(front<rear)
    {
        int current=queue[front++];
        printf("%d",current);
        for(int i=0;i<n;i++)
        {
            if(graph[current][i]==1 &&!visited[i])
            {
```

```c
    printf("Enter the starting node (0 to %d): ",n-1);
    scanf("%d",&start);
    printf("BFS traversal starting from node %d:\n",start);
    bfs(graph,visited,start,n);
    return 0;
}
void bfs(int graph[MAX][MAX],int visited[MAX],int start,int n)
{
    int queue[MAX],front=0,rear=0;
    queue[rear++]=start;
    visited[start]=1;
    while(front<rear)
    {
        int current=queue[front++];
        printf("%d",current);
        for(int i=0;i<n;i++)
        {
            if(graph[current][i]==1 &&!visited[i])
            {
                queue[rear++]=i;
                visited[i]=1;
            }
        }
    }
}
```

OUTPUT

```
PS C:\Users\STUDENT\Downloads\canteen\style> cd "c:\Users\STUDENT\Down
Enter the number of vertices: 3
Enter the adjacency matrix of the graph:
0 0 1
1 0 0
1 0 1
Enter the starting node (0 to 2): 1
BFS traversal starting from node 1:
102
PS C:\Users\STUDENT\Downloads\canteen\style>
```

Lab program 9B

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

```c
#include<stdio.h>
#include<stdlib.h>
void dfs(int vertex,int visit[],int graph[][100],int n)
{
    visit[vertex]=1;
    for(int i=0;i<n;i++)
    {
        if(graph[vertex][i]==1 && !visit[i])
        {
            dfs(i,visit,graph,n);
        }
    }
}
int main()
{
    int n;
    int graph[100][100];
    int visit[100]={0};
    printf("Enter the number of vertices:\n");
    scanf("%d",&n);
    printf("Enter the adjacency matrix of the graph:\n");
    for(int i=0;i<n;i++)
    {
        for(int j=0;j<n;j++)
        {
            scanf("%d",&graph[i][j]);
        }
    }
    dfs(0,visit,graph,n);
    int isConnected=1;
    for(int i=0;i<n;i++)
    {
        if(!visit[i])
        {
            isConnected=0;
            break;
        }
    }
    if(isConnected)
```

```
    printf("Enter the number of vertices:\n");
    scanf("%d",&n);
    printf("Enter the adjacency matrix of the graph:\n");
    for(int i=0;i<n;i++)
    {
        for(int j=0;j<n;j++)
        {
            scanf("%d",&graph[i][j]);
        }
    }
    dfs(0,visit,graph,n);
    int isConnected=1;
    for(int i=0;i<n;i++)
    {
        if(!visit[i])
        {
            isConnected=0;
            break;
        }
    }
    if(isConnected)
    {
        printf("The graph is connected\n");
    }
    else
    {
        printf("The graph is not connected\n");
    }
    return 0;
}
```

OUTPUT

```
PS C:\Users\STUDENT\Downloads\canteen\style> cd "c:\Users\STUDENT\Download
Enter the number of vertices:
3
Enter the adjacency matrix of the graph:
1 1 1
0 0 1
0 0 0
The graph is connected
PS C:\Users\STUDENT\Downloads\canteen\dfs> cd "c:\Users\STUDENT\Downloads\
Enter the number of vertices:
2
Enter the adjacency matrix of the graph:
0 0
1 1
The graph is not connected
PS C:\Users\STUDENT\Downloads\canteen\dfs>
```

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.

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#define MAX 50
typedef struct {
    int key;
    char name[50];
} Employee;
void initializeHashTable(Employee *hashTable, int size) {
    for (int i = 0; i < size; i++) {
        hashTable[i].key = -1;
        strcpy(hashTable[i].name, "");
    }
}
int hashFunction(int key, int m) {
    return key % m;
}
void insert(Employee *hashTable, int m, int key, char *name) {
    int index = hashFunction(key, m);
    int originalIndex = index;
```

```c
    int index = hashFunction(key, m);
    int originalIndex = index;
    int i = 0;
    while (hashTable[index].key != -1 && i < m) {
        if (hashTable[index].key == key) {
            printf("Error: Duplicate key %d.\n", key);
            return;
        }
        index = (originalIndex + ++i) % m;
    }
    if (i >= m) {
        printf("Error: Hash table is full. Cannot insert key %d.\n", key);
        return;
    }
    hashTable[index].key = key;
    strcpy(hashTable[index].name, name);
    printf("Inserted key %d at index %d.\n", key, index);
}
void search(Employee *hashTable, int m, int key) {
    int index = hashFunction(key, m);
```

```
    strcpy(hashTable[index].name, name);
    printf("Inserted key %d at index %d.\n", key, index);
}
void search(Employee *hashTable, int m, int key) {
    int index = hashFunction(key, m);
    int originalIndex = index;
    int i = 0;

    while (hashTable[index].key != -1 && i < m) {
        if (hashTable[index].key == key) {
            printf("Key %d found at index %d. Name: %s\n", key, index, hashTable[index].name);
            return;
        }
        index = (originalIndex + ++i) % m;
    }

    printf("Key %d not found.\n", key);
}
void displayHashTable(Employee *hashTable, int m) {
    printf("\nHash Table:\n");
```

```
void displayHashTable(Employee *hashTable, int m) {
    printf("\nHash Table:\n");
    for (int i = 0; i < m; i++) {
        if (hashTable[i].key != -1) {
            printf("Index %d: Key = %d, Name = %s\n", i, hashTable[i].key, hashTable[i].name);
        } else {
            printf("Index %d: Empty\n", i);
        }
    }
}
int main() {
    int m;
    printf("Enter the number of memory locations (m): ");
    scanf("%d", &m);

    Employee *hashTable = (Employee *)malloc(m * sizeof(Employee));
    initializeHashTable(hashTable, m);

    int choice;
    do {
```

```
int choice;
do {
    printf("\nMenu:\n");
    printf("1. Insert\n");
    printf("2. Search\n");
    printf("3. Display\n");
    printf("4. Exit\n");
    printf("Enter your choice: ");
    scanf("%d", &choice);

    switch (choice) {
        case 1: {
            int key;
            char name[50];
            printf("Enter the 4-digit key: ");
            scanf("%d", &key);
            printf("Enter the name: ");
            scanf("%s", name);
            insert(hashTable, m, key, name);
            break;

        case 2: {
            int key;
            printf("Enter the 4-digit key to search: ");
            scanf("%d", &key);
            search(hashTable, m, key);
            break;
        }
        case 3:
            displayHashTable(hashTable, m);
            break;
        case 4:
            printf("Exiting program.\n");
            break;
        default:
            printf("Invalid choice. Please try again.\n");
    }
} while (choice != 4);

free(hashTable);
return 0;
```

OUTPUT

```
Enter the number of memory locations (m): 3

Menu:
1. Insert
2. Search
3. Display
4. Exit
Enter your choice: 1
Enter the 4-digit key: 1234
Enter the name: ABD
Inserted key 1234 at index 1.

Menu:
1. Insert
2. Search
3. Display
4. Exit
Enter your choice: 1
Enter the 4-digit key: 9985
Enter the name: KUL
Inserted key 9985 at index 2.

Menu:
1. Insert
2. Search
3. Display
4. Exit
Enter your choice: 2
Enter the 4-digit key to search: 1234
Key 1234 found at index 1. Name: ABD

Menu:
1. Insert
2. Search
3. Display
```

```
2. Search
3. Display
4. Exit
Enter your choice: 2
Enter the 4-digit key to search: 1234
Key 1234 found at index 1. Name: ABD

Menu:
1. Insert
2. Search
3. Display
4. Exit
Enter your choice: 3

Hash Table:
Index 0: Empty
Index 1: Key = 1234, Name = ABD
Index 2: Key = 9985, Name = KUL

Menu:
1. Insert
2. Search
3. Display
4. Exit
Enter your choice: 4
Exiting program.

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