# VISVESVARAYA TECHNOLOGICAL UNIVERSITY

**“JnanaSangama”, Belgaum -590014, Karnataka.**

**LAB REPORT**
**On**

**DATA STRUCTURES (23CS3PCDST)**

**Submitted by**

**RUSHIL MAGAZINE (1BM22CS225)**

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

**B.M.S. COLLEGE OF ENGINEERING**
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**B. M. S. College of Engineering, Bull Temple Road, Bangalore 560019 (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 RUSHIL MAGAZINE **(1BM22CS225)**, 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 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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**Index Sheet**

| Sl. No. | Experiment Title | Page No. |
|---|---|---|
| 1 | Stack Implementation: Pop, Push, and Display | 4 |
| 2 | Infix to Postfix and Postfix Evaluation | 6 |
| 3 | Queue and Circular Queue Implementation | 10 |
| 4 | Singly Linked List: Insert, Delete and Display | 17 |
| 5 | Singly Linked list: Operations at any position | 23 |
| 6 | Sort, Reverse, concat, and Stack & Queue Implementation using list | 31 |
| 7 | Doubly linked list | 41 |
| 8 | Binary search tree | 48 |
| 9 | Implementing Graphs and BFS | 54 |
| 10 | Implementing Hash Tables | 61 |

**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

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

**Push**

**b)**

**Pop**

**c)**

**Display**

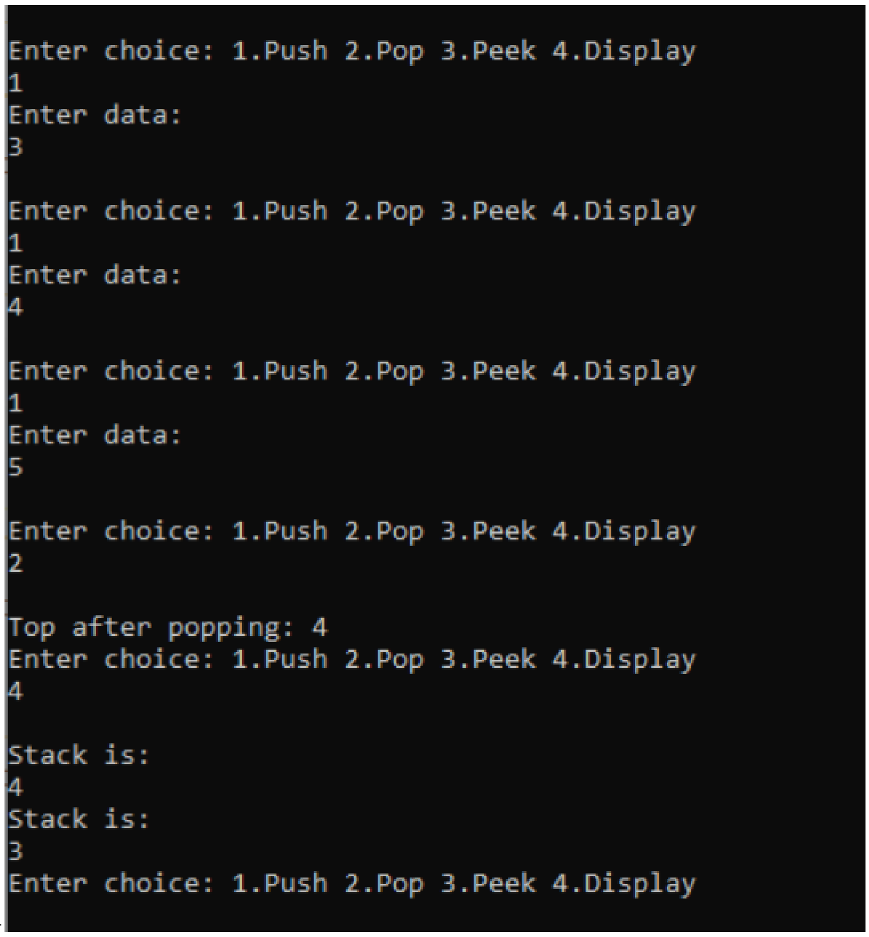
**The**

**program should print appropriate messages for stack overflow, stack underflow**

```
#include <stdio.h>

#define MAX_SIZE 5

int stack[MAX_SIZE];
int top = -1;

void push(int value) {
        if (top == MAX_SIZE - 1) {
        printf("Stack Overflow: Cannot push %d, stack is full.\n", value);
        } else { top++;
        stack[top] = value;

        printf("Pushed %d onto the stack.\n", value);
        }
}
```

```
void pop() {
        if (top == -1) {
        printf("Stack Underflow: Cannot pop, stack is empty.\n");
        } else {
        printf("Popped %d from the stack.\n", stack[top]);
        top--;
        }
}

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

int main() {
        push(10);
        push(20);
        push(30);
        display();

        pop();
        display();
```

```
    push(40);

    push(50);

    push(60); // This will cause a stack overflow

    display();


    pop();

    pop();

    pop();

    pop(); // This will cause a stack underflow

    display();


    return 0;
```



```
Enter choice: 1.Push 2.Pop 3.Peek 4.Display
1
Enter data:
3

Enter choice: 1.Push 2.Pop 3.Peek 4.Display
1
Enter data:
4

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

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

Top after popping: 4
Enter choice: 1.Push 2.Pop 3.Peek 4.Display
4

Stack is:
4
Stack is:
3
Enter choice: 1.Push 2.Pop 3.Peek 4.Display
```

```
}
```

## LAB Program – 2

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

```
#include <stdio.h>

#include <stdlib.h>

#include <ctype.h>


#define MAX_SIZE 50


char stack[MAX_SIZE];

int top = -1;


// Function to check if the given character is an

operator int isOperator(char ch) {

        return (ch == '+' || ch == '-' || ch == '*' || ch == '/');

}


// Function to get the precedence of an operator

int getPrecedence(char ch) {

        switch (ch) {

        case '+':

        case '-':

        return 1;

        case '*':

        case '/':

        return 2;

        default:

        return 0;

        }

}


// Function to push a character onto the stack
```

```
void push(char ch) {

        if (top == MAX_SIZE - 1) {

        printf("Stack Overflow: Cannot push %c, stack is full.\n",

        ch); exit(1);

        } else { top++;

        stack[top] =

        ch;

        }

}


// Function to pop a character from the stack

char pop() {

        if (top == -1) {

        printf("Stack Underflow: Cannot pop, stack is

        empty.\n"); exit(1);

        } else {

        return stack[top--];

        }

}


// Function to convert infix to postfix

void infixToPostfix(char infix[]) {

        printf("Infix Expression: %s\n", infix);

        printf("Postfix Expression: ");


        for (int i = 0; infix[i] != '\0'; i++) {

        if (isalnum(infix[i])) {

        printf("%c", infix[i]);

        } else if (infix[i] == '(') {
```

```
        push(infix[i]);

        } else if (infix[i] == ')') {

        while (top != -1 && stack[top] != '(') {

        printf("%c", pop());

        }

        if (top != -1 && stack[top] == '(') {

        pop(); // Discard '('

        }

        } else if (isOperator(infix[i])) {

        while (top != -1 && getPrecedence(stack[top]) >= getPrecedence(infix[i])) {

        printf("%c", pop());

        }

        push(infix[i]);

        }

        }


        // Pop remaining operators from the stack

        while (top != -1) {

        printf("%c", pop());

        }


        printf("\n");

}


int main() {

        char infixExpression[MAX_SIZE];


        // Get infix expression as input

        printf("Enter a valid parenthesized infix arithmetic expression: ");
        fgets(infixExpression, sizeof(infixExpression), stdin);


        // Remove newline character from the input

        for (int i = 0; infixExpression[i] != '\0'; i++)

        { if (infixExpression[i] == '\n') {

        infixExpression[i] = '\0';

        break;

        }

        }


        // Convert infix to postfix and display the

        result infixToPostfix(infixExpression);


        return 0;

}
```

[redacted]

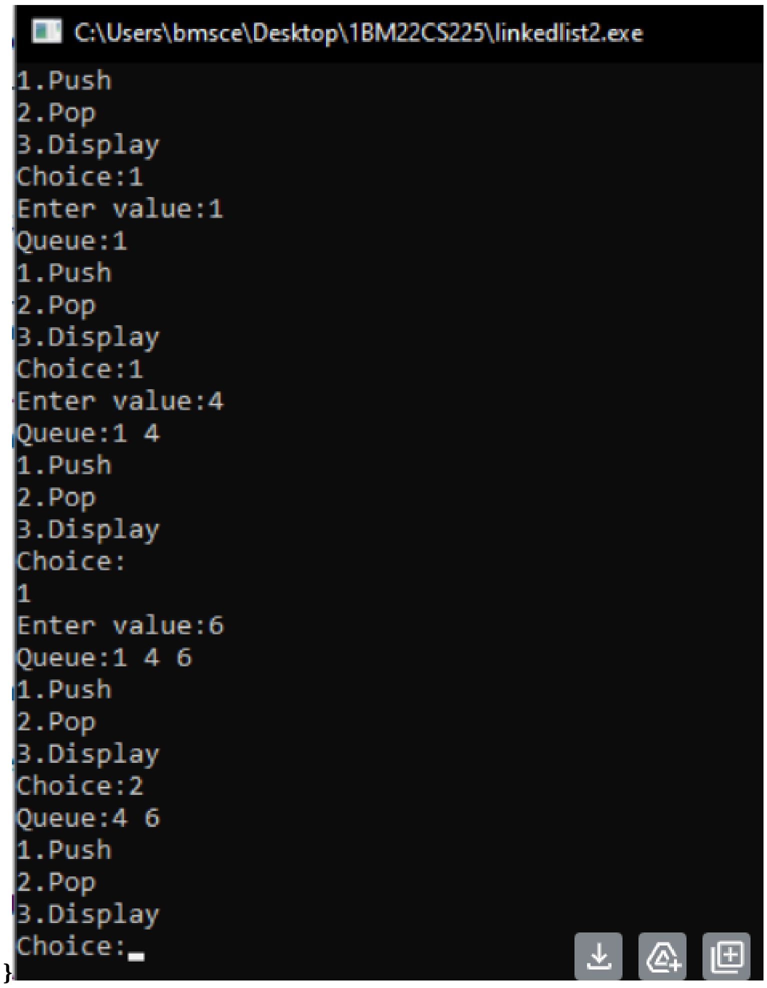
## LAB Program – 3

### 3a) WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display

### The program should print appropriate messages for queue empty and queue overflow conditions

```
#include<stdio.h>
#define size 30

int queue[size];
int front=-1,rear=-1;
```

```
void insert(int a){
    if(rear==size-1){
        printf("Queue overflow\n");
        return;
    }
    else{
        if(front==-1)
            front=0;
        queue[++rear]=a;
    }
}

void delete(){
    if(front==-1||front>rear){
        printf("Queue Empty\n");
    }
    else{
        front++;
    }
}

void display(){
    if(front==-1){
        printf("Queue Empty\n");
        return;
    }
    printf("Queue:");
    for(int i=front;i<=rear;i++){
        printf("%d ",queue[i]);
    }
    printf("\n--------------\n");
}


void main(){
    int choice;
    int a;
    while(1){
        printf("Queue operations:\n1.Push\n2.Pop\n3.Display\nChoice:");
        scanf("%d",&choice);

        switch (choice)
        {
        case 1:
            printf("Enter Element:");
            scanf("%d",&a);
            insert(a);
            display();
            break;

        case 2:
            delete();
            display();
            break;

        case 3:
            display();
            break;
        }
    }

}
```



```
C:\Users\bmsce\Desktop\1BM22CS225\linkedlist2.exe
1.Push
2.Pop
3.Display
Choice:1
Enter value:1
Queue:1
1.Push
2.Pop
3.Display
Choice:1
Enter value:4
Queue:1 4
1.Push
2.Pop
3.Display
Choice:
1
Enter value:6
Queue:1 4 6
1.Push
2.Pop
3.Display
Choice:2
Queue:4 6
1.Push
2.Pop
3.Display
Choice:_
```

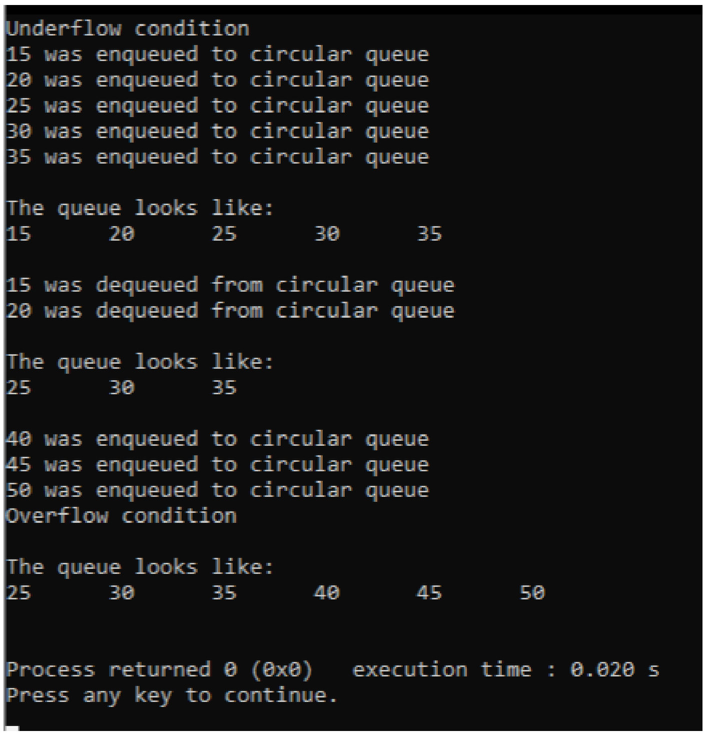
}

**3b ) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display**

**The program should print appropriate messages for queue empty and queue overflow conditions**

```
#include <stdio.h>

#define MAX_SIZE 5

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

// Function to check if the circular queue is
empty int isEmpty() {
        return front == -1;
}

// Function to check if the circular queue is
full int isFull() {
        return (rear + 1) % MAX_SIZE == front;
}

// Function to insert an element into the circular
queue void insert(int value) {
        if (isFull()) {
        printf("Circular Queue Overflow: Cannot insert %d, queue is full.\n", value);
        } else {
        if (front == -1) {
        front = 0;
        }
        rear = (rear + 1) % MAX_SIZE;
        circularQueue[rear] = value;
        printf("Inserted %d into the circular queue.\n", value);
        }
}
```

```
// Function to delete an element from the circular
queue void delete() {
        if (isEmpty()) {
        printf("Circular Queue Underflow: Cannot delete, queue is
        empty.\n"); } else {
        printf("Deleted %d from the circular queue.\n",
        circularQueue[front]); if (front == rear) {
        // If there was only one element in the circular
        queue front = rear = -1;
        } else {
        front = (front + 1) % MAX_SIZE;
        }
        }
}

// Function to display the elements in the circular
queue void display() {
        if (isEmpty()) {
        printf("Circular Queue is empty.\n");
        } else {
        printf("Circular Queue elements: ");
        int i = front;
        do {
        printf("%d ", circularQueue[i]);
        i = (i + 1) % MAX_SIZE;
        } while (i != (rear + 1) %
        MAX_SIZE); printf("\n");
        }
}

int main() {
        insert(10);

        insert(20);

        insert(30);

        display();



        delete();

        display();



        insert(40);

        insert(50);

        insert(60); // This will cause a circular queue overflow

        display();



        delete();

        delete();

        delete();

        delete(); // This will cause a circular queue underflow

        display();



        return 0;
}
```



```
Underflow condition
15 was enqueued to circular queue
20 was enqueued to circular queue
25 was enqueued to circular queue
30 was enqueued to circular queue
35 was enqueued to circular queue

The queue looks like:
15      20      25      30      35

15 was dequeued from circular queue
20 was dequeued from circular queue

The queue looks like:
25      30      35

40 was enqueued to circular queue
45 was enqueued to circular queue
50 was enqueued to circular queue
Overflow condition

The queue looks like:
25      30      35      40      45      50


Process returned 0 (0x0)   execution time : 0.020 s
Press any key to continue.
```

## LAB Program – 4

**WAP to Implement Singly Linked List with following operations**

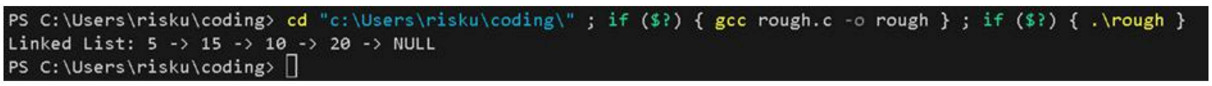
**a. Create a linked list.**

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

**Display the contents of the linked list.**

```
#include <stdio.h>

#include <stdlib.h>


// Node structure

struct Node {

        int data;

        struct Node* next;

};


// Function to create a new node struct

Node* createNode(int value) {

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

        if (newNode == NULL) {

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

        exit(1);

        }

        newNode->data = value;

        newNode->next = NULL;

        return newNode;

}


// Function to insert a node at the first position of the linked list

struct Node* insertFirst(struct Node* head, int value) {
        struct Node* newNode = createNode(value);
        newNode->next = head;
        return newNode;
}

// Function to insert a node at any position of the linked list
struct Node* insertAtPosition(struct Node* head, int value, int position)
        { struct Node* newNode = createNode(value);

        if (position == 1) {
        newNode->next = head;
        return newNode;
        }

        struct Node* current = head;
        for (int i = 1; i < position - 1 && current != NULL; i++) {
        current = current->next;
        }

        if (current == NULL) {
        printf("Invalid position for insertion.\n");
        free(newNode);
        return head;
        }

        newNode->next = current->next;
        current->next = newNode;
        return head;
}

// Function to insert a node at the end of the linked list
```

```
struct Node* insertEnd(struct Node* head, int value) {
        struct Node* newNode = createNode(value);

        if (head == NULL) {
        return newNode;
        }

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

        current->next = newNode;
        return head;
}

// Function to display the contents of the linked list
void display(struct Node* head) {
        printf("Linked List: "); struct
        Node* current = head; while
        (current != NULL) { printf("%d
        -> ", current->data); current =
        current->next;
        }
        printf("NULL\n");
}

// Function to free the memory allocated for the linked list
void freeList(struct Node* head) {
        struct Node* current = head;
        struct Node* nextNode;
        while (current != NULL) {
        nextNode = current->next;
        free(current);
        current = nextNode;
        }
}

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

        // Inserting nodes at various positions
        head = insertEnd(head, 10);
        head  =  insertEnd(head,  20);
        head = insertFirst(head, 5);
        head = insertAtPosition(head, 15, 2);

        // Displaying the linked list
        display(head);

        // Freeing the memory allocated for the linked list
        freeList(head);

        return 0;
}
```



```
PS C:\Users\risku\coding> cd "c:\Users\risku\coding\" ; if ($?) { gcc rough.c -o rough } ; if ($?) { .\rough }
Linked List: 5 -> 15 -> 10 -> 20 -> NULL
PS C:\Users\risku\coding> 
```

## LEETCODE – 206 Reverse Linked list

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

//Reverse the linked list from node head, and link it with
other //nodes which came from the original one's tail
struct ListNode* reverse(struct ListNode* head,int len){
            if(len == 1){
            return head;
            }

            int count = 0;
            struct ListNode* p = head;
            while(count < len-1){
            p = p->next;
            count++;
            }
            struct ListNode* pEnd = p->next;

            struct ListNode* pPre = head;
            p = head->next;
            struct ListNode* pNext;

            count = 0;
            while(count < len-1){
            pNext = p->next;
            p->next = pPre;
```

```
        pPre = p;

        p = pNext;

        count++;

        }

        head->next = pEnd;


        return pPre;

}


struct ListNode* reverseBetween(struct ListNode* head, int left, int right){

        struct ListNode* p = head;struct ListNode* pPre = NULL;

        int count = 1;

        while(count < left){

        pPre = p;

        p = p->next;

        count++;

        }

        if(pPre){

        pPre->next = reverse(p,right-left+1);

        }

        else{

        head = reverse(p,right-left+1);

        }


        return head;

}
```

## LAB Program – 5

**WAP to Implement Singly Linked List with following operations**

**a. Create a linked list.**

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

**c. Display the contents of the linked list.**

```
#include <stdio.h>

#include <stdlib.h>



// Node structure

struct Node {

        int data;

        struct Node* next;
};


// Function to create a new node struct

Node* createNode(int value) {

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

        if (newNode == NULL) {

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

        exit(1);

        }

        newNode->data = value;

        newNode->next = NULL;

        return newNode;

}


// Function to insert a node at the end of the linked list

struct Node* insertEnd(struct Node* head, int value) {

        struct Node* newNode = createNode(value);


        if (head == NULL) {

        return newNode;

        }


        struct Node* current = head;

        while (current->next != NULL) {

        current = current->next;

        }


        current->next = newNode;

        return head;

}
```

```
// Function to delete the first element from the linked

list struct Node* deleteFirst(struct Node* head) {

        if (head == NULL) {

        printf("List is empty. Cannot

        delete.\n"); return NULL;

        }


        struct Node* newHead = head->next;

        free(head);

        return newHead;

}


// Function to delete a specified element from the linked list

struct Node* deleteElement(struct Node* head, int value) {

        if (head == NULL) {

        printf("List is empty. Cannot

        delete.\n"); return NULL;

        }


        if (head->data == value) {

        struct Node* newHead = head->next;

        free(head);

        return newHead;

        }


        struct Node* current = head;

        while (current->next != NULL && current->next->data != value) {

        current = current->next;

        }


        if (current->next == NULL) {
```

```
        printf("Element %d not found in the list. Cannot delete.\n", value);

        return head;

        }


        struct Node* temp = current->next;

        current->next = current->next->next;

        free(temp);

        return head;

}


// Function to delete the last element from the linked list

struct Node* deleteLast(struct Node* head) {

        if (head == NULL) {

        printf("List is empty. Cannot

        delete.\n"); return NULL;

        }


        if (head->next == NULL) {

        free(head);

        return NULL;

        }


        struct Node* current = head;

        while (current->next->next != NULL) {

        current = current->next;

        }


        free(current->next);

        current->next = NULL;

        return head;

}
```

```
// Function to display the contents of the linked list
void display(struct Node* head) {
        printf("Linked List: "); struct
        Node* current = head; while
        (current != NULL) { printf("%d
        -> ", current->data); current =
        current->next;
        }
        printf("NULL\n");
}

// Function to free the memory allocated for the linked list
void freeList(struct Node* head) {
        struct Node* current = head;
        struct Node* nextNode;

        while (current != NULL) {
        nextNode = current->next;
        free(current);
        current = nextNode;
        }
}

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

        // Inserting nodes at the end of the linked list
        head = insertEnd(head, 10);
        head  =  insertEnd(head,  20);
        head = insertEnd(head, 30);
        // Displaying the linked list
        display(head);

        // Deleting the first element
        head = deleteFirst(head);
        display(head);

        // Deleting a specified element
        head = deleteElement(head, 20);
        display(head);

        // Deleting the last element
        head = deleteLast(head);
        display(head);

        // Freeing the memory allocated for the linked list
        freeList(head);

        return 0;
}
```

```
Linked List: NULL                 Linked List: NULL
Linked List: NULL                 Linked List: NULL
Linked List: NULL                 Linked List: NULL
Linked List: NULL                 Linked List: NULL
Linked List: NULL                 Linked List: NULL
```

## LEETCODE – 155 (MIN STACK)

```
#include <stack>

#include <climits>


class MinStack {

private:

        std::stack<int> mainStack;

        std::stack<int> minStack;


public:

        /** initialize your data structure here */

        MinStack() {}


        void push(int val) {

        mainStack.push(val);

        if (minStack.empty() || val <= minStack.top()) {

        minStack.push(val);

        }

        }


        void pop() {

        if (mainStack.top() == minStack.top()) {

        minStack.pop();

        }

        mainStack.pop();

        }


        int top() {

        return mainStack.top();

        }


        int getMin() {
```

```
        return minStack.top();
        }
};


// Example usage:
int main() {
        MinStack minStack;
        minStack.push(-2);
        minStack.push(0);
        minStack.push(-3);

        // Output: -3
        std::cout << minStack.getMin() << std::endl;

        minStack.pop();

        // Output: 0
        std::cout << minStack.top() << std::endl;

        // Output: -2
        std::cout << minStack.getMin() << std::endl;

        return 0;
}
```

## LAB Program – 6

**6a) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.**

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


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

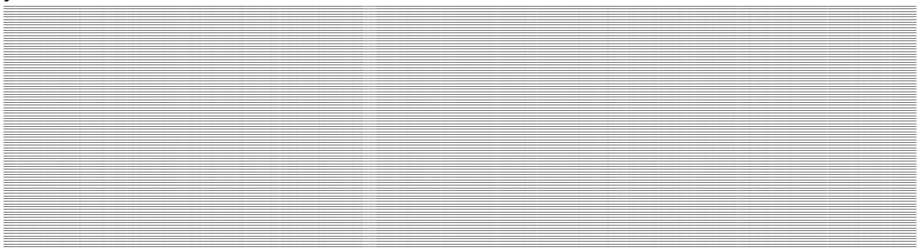
```
// Function to create a new node struct

Node* createNode(int value) {

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

        if (newNode == NULL) {

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

        exit(1);

        }

        newNode->data = value;

        newNode->next = NULL;

        return newNode;

}


// Function to insert a node at the end of the linked list

struct Node* insertEnd(struct Node* head, int value) {

        struct Node* newNode = createNode(value);


        if (head == NULL) {

        return newNode;

        }


        struct Node* current = head;

        while (current->next != NULL) {

        current = current->next;

        }


        current->next = newNode;

        return head;

}


// Function to display the contents of the linked list
```

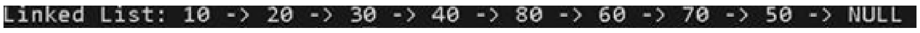
```
void display(struct Node* head) {
        printf("Linked List: ");
        struct Node* current = head;
        while (current != NULL) {
        printf("%d -> ", current->data);
        current = current->next;
        }
        printf("NULL\n");
}

// Function to sort the linked list (bubble sort)
struct Node* sortLinkedList(struct Node* head) {
        if (head == NULL || head->next == NULL)
        { return head;
        }

        int swapped;
        struct Node* temp;
        struct Node* current;

        do {
        swapped = 0;
        current = head;

        while (current->next != NULL) {
        if (current->data > current->next->data) {
        // Swap the data of current and next
        nodes temp = createNode(current->data);
        current->data = current->next->data;
        current->next->data = temp->data;
        free(temp);
        swapped = 1;
        }

        current = current->next;
        }
        } while (swapped);

        return head;
}

// Function to reverse the linked list
struct Node* reverseLinkedList(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;
        }

        head = prev;
        return head;
}

// Function to concatenate two linked lists
struct Node* concatenateLinkedLists(struct Node* list1, struct Node* list2)
        { if (list1 == NULL) {
```

```
        return list2;
        }

        struct Node* current = list1;
        while (current->next != NULL) {
        current = current->next;
        }

        current->next = list2;
        return list1;
}

// Function to free the memory allocated for the linked list
void freeList(struct Node* head) {
        struct Node* current = head;
        struct Node* nextNode;

        while (current != NULL) {
        nextNode = current->next;
        free(current);
        current = nextNode;
        }
}

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

        // Inserting nodes into list1
        list1 = insertEnd(list1, 10);
        list1 = insertEnd(list1, 30);
```

```
list1 = insertEnd(list1, 20);

list1 = insertEnd(list1, 40);


// Inserting  nodes  into  list2

list2  =  insertEnd(list2,  50);

list2  =  insertEnd(list2,  70);

list2  =  insertEnd(list2,  60);

list2 = insertEnd(list2, 80);


// Displaying the original linked

lists printf("Original List 1:\n");

display(list1);

printf("Original List

2:\n"); display(list2);


// Sorting list1

list1 = sortLinkedList(list1);

printf("Sorted List 1:\n");

display(list1);


// Reversing list2

list2 = reverseLinkedList(list2);

printf("Reversed List 2:\n");

display(list2);


// Concatenating list1 and list2

list1 = concatenateLinkedLists(list1, list2);

printf("Concatenated List 1 and List 2:\n");

display(list1);


// Freeing the memory allocated for the linked lists
```

```
        freeList(list1);


        return 0;
}
```





```
Linked List: 10 -> 20 -> 30 -> 40 -> 80 -> 60 -> 70 -> 50 -> NULL
```

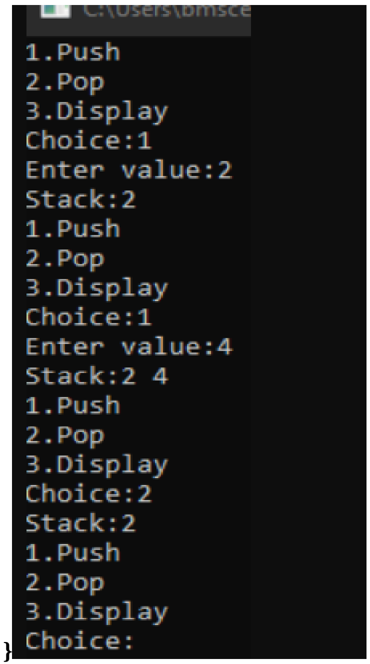
## 6b) WAP to Implement Single Link List to simulate Stack & Queue Operations

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


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


// Function to create a new node struct
Node* createNode(int value) {
        struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
        if (newNode == NULL) {
```

```
printf("Memory allocation failed.\n");

exit(1);
```

```
        }
        newNode->data = value;
        newNode->next = NULL;
        return newNode;
}

// Function to insert a node at the end of the linked list (for both stack and
queue) struct Node* insertEnd(struct Node* head, int value) {
        struct Node* newNode = createNode(value);

        if (head == NULL) {
        return newNode;
        }

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

        current->next = newNode;
        return head;
}

// Function to delete the first node (for both stack and
queue) struct Node* deleteFirst(struct Node* head) {
        if (head == NULL) {
        printf("List is empty.\n");
        return NULL;
        }

        struct Node* temp = head;
        head = head->next;

        free(temp);

        return head;

}


// Function to display the contents of the linked list

void display(struct Node* head) {

        printf("Linked List: "); struct

        Node* current = head; while

        (current != NULL) { printf("%d

        -> ", current->data); current =

        current->next;

        }

        printf("NULL\n");

}


int main() {

        struct Node* stack = NULL;

        struct Node* queue = NULL;


        // Pushing elements onto the stack

        stack = insertEnd(stack, 10);

        stack = insertEnd(stack, 20);

        stack = insertEnd(stack, 30);


        // Displaying the stack

        printf("Stack:\n");

        display(stack);


        // Popping an element from the stack

        stack = deleteFirst(stack);
```

```
printf("After popping from the stack:\n");

display(stack);


// Enqueuing elements into the queue

queue = insertEnd(queue, 40); queue

= insertEnd(queue, 50); queue =

insertEnd(queue, 60);


// Displaying the queue

printf("Queue:\n");

display(queue);


// Dequeuing an element from the queue

queue = deleteFirst(queue); printf("After

dequeuing from the queue:\n");

display(queue);


// Freeing the memory allocated for the linked

lists while (stack != NULL) {

stack = deleteFirst(stack);

}


while (queue != NULL) {

queue = deleteFirst(queue);

}


return 0;
```



```
C:\Users\bmsce
1.Push
2.Pop
3.Display
Choice:1
Enter value:2
Stack:2
1.Push
2.Pop
3.Display
Choice:1
Enter value:4
Stack:2 4
1.Push
2.Pop
3.Display
Choice:2
Stack:2
1.Push
2.Pop
3.Display
Choice:
```

}

## LAB Program – 7

**WAP to Implement doubly link list with primitive operations**

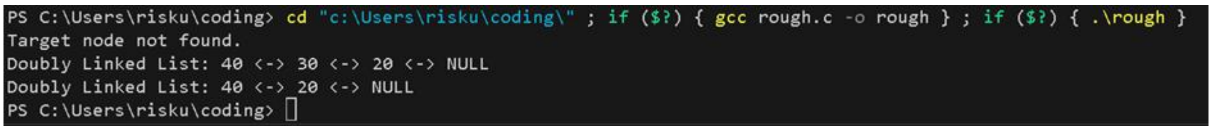
a. **Create a doubly linked list.**

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

c. **Delete the node based on a specific value**

d. **Display the contents of the list**

```
#include <stdio.h>

#include <stdlib.h>


// Node structure

struct Node {

        int data;

        struct  Node*  prev;

        struct Node* next;

};


// Function to create a new node struct

Node* createNode(int value) {

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

        if (newNode == NULL) {

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

        exit(1);
        }
        newNode->data = value;
        newNode->prev = NULL;
        newNode->next = NULL;
        return newNode;
}

// Function to insert a new node to the left of a specific node
struct Node* insertLeft(struct Node* head, int value, int targetValue)
        { struct Node* newNode = createNode(value);

        if (head == NULL) {
        return newNode;
        }

        struct Node* current = head;

        // Find the target node
        while (current != NULL && current->data != targetValue) {
        current = current->next;
        }

        if (current == NULL) {
        printf("Target node not found.\n");
        free(newNode);
        return head;
        }

        // Insert the new node to the left if
        (current->prev != NULL) {
        current->prev->next = newNode;
        newNode->prev = current->prev;
        } else {
        head = newNode;
        }

        newNode->next = current;
        current->prev = newNode;

        return head;
}

// Function to delete a node based on a specific value
struct Node* deleteNode(struct Node* head, int value) {
        if (head == NULL) {
        printf("List is empty.\n");
        return NULL;
        }

        struct Node* current = head;

        // Find the node with the specified value
        while (current != NULL && current->data != value) {
        current = current->next;
        }

        if (current == NULL) {
        printf("Node with specified value not found.\n");
        return head;
        }

        // Update the pointers of the adjacent nodes
        if (current->prev != NULL) {
        current->prev->next = current->next;
        } else {
        head = current->next;
        }

        if (current->next != NULL) {
        current->next->prev = current->prev;
        }

        free(current);
        return head;
}

// Function to display the contents of the doubly linked list
void display(struct Node* head) {
        printf("Doubly Linked List: ");
        struct Node* current = head;
        while (current != NULL) {
        printf("%d <-> ", current->data);
        current = current->next;
        }
        printf("NULL\n");
}

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

        // Inserting nodes into the doubly linked list
        doublyLinkedList = insertLeft(doublyLinkedList, 20, 0);
        doublyLinkedList = insertLeft(doublyLinkedList, 30, 20);
        doublyLinkedList = insertLeft(doublyLinkedList, 40, 30);

        doublyLinkedList = insertLeft(doublyLinkedList, 50, 0);


        // Displaying the original doubly linked list

        display(doublyLinkedList);


        // Deleting a node with a specific value

        doublyLinkedList = deleteNode(doublyLinkedList, 30);


        // Displaying the doubly linked list after deletion

        display(doublyLinkedList);


        // Freeing the memory allocated for the doubly linked list

        while (doublyLinkedList != NULL) {

        struct Node* temp = doublyLinkedList;

        doublyLinkedList = doublyLinkedList-

        >next; free(temp);

        }


        return 0;

}
```



```
PS C:\Users\risku\coding> cd "c:\Users\risku\coding\" ; if ($?) { gcc rough.c -o rough } ; if ($?) { .\rough }
Target node not found.
Doubly Linked List: 40 <-> 30 <-> 20 <-> NULL
Doubly Linked List: 40 <-> 20 <-> NULL
PS C:\Users\risku\coding> 
```

## LEETCODE _ 725 (split linked list into parts)

```
/**

 * Definition for singly-linked list.
 * struct ListNode {
 *           int val;
 *           struct ListNode *next;
 * };
 */
/**
 * Note: The returned array must be malloced, assume caller calls
 free(). */
void append(struct ListNode **head, int val){
          struct ListNode* new=(struct ListNode*)malloc(sizeof(struct
          ListNode)); struct ListNode* prev=*head;
          new->val=val; new-
          >next=NULL;
          if(*head==NULL)
          *head=new;

          else{
          while(prev->next!=NULL)
          prev=prev->next;
          prev->next=new;
          }
}

int length(struct ListNode *head){
          struct ListNode *prev=head;
          int len=0;
          while(prev!=NULL){
          prev=prev->next;
          len++;
          }
          return len;
}


struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize) {
          struct ListNode** heads=(struct ListNode**)malloc(sizeof(struct ListNode*)*k);
          int len=length(head);
          struct ListNode* prev=head;
          for(int i=0;i<k;i++){
          struct ListNode* nhead=NULL;
          heads[i]=nhead;
          }


          int common=len/k;
          int extra=len%k;


          int iter;
          int i=0;
          while(prev!=NULL){
          for(int j=0;j<common+((extra>0)?1:0);j++){
        append(&heads[i],prev->val);
          prev=prev->next;
          }
          i++;
          extra--;
          }
          *returnSize=k;
          return heads;
}
```

## LAB Program – 8

**Write a program**

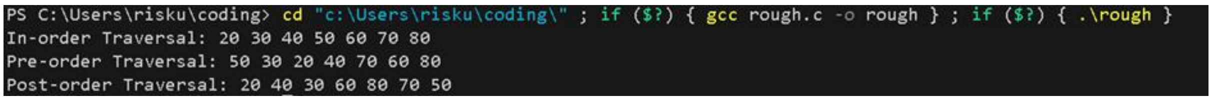
**a. To construct a binary Search tree.**

**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>


// Node structure for the binary search

tree struct Node {

        int data;
        struct Node* left;

        struct Node* right;

};


// Function to create a new node struct

Node* createNode(int value) {

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

        if (newNode == NULL) {

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

        exit(1);

        }

        newNode->data = value; newNode->left =

        newNode->right = NULL; return

        newNode;

}


// Function to insert a value into the binary search tree

struct Node* insert(struct Node* root, int value) {

        if (root == NULL) {

        return createNode(value);

        }


        if (value < root->data) {

        root->left = insert(root->left, value);

        } else if (value > root->data) {

        root->right = insert(root->right, value);

        }


        return root;

}
```

```
// Function to perform in-order traversal of the binary search tree
void inOrderTraversal(struct Node* root) {
        if (root != NULL) {
    inOrderTraversal(root->left);
        printf("%d  ",  root->data);
    inOrderTraversal(root->right);
        }
}

// Function to perform pre-order traversal of the binary search
tree void preOrderTraversal(struct Node* root) {
        if (root != NULL) {
        printf("%d ", root->data);
    preOrderTraversal(root->left);
    preOrderTraversal(root->right);
        }
}

// Function to perform post-order traversal of the binary search
tree void postOrderTraversal(struct Node* root) {
        if (root != NULL) {
    postOrderTraversal(root->left);
    postOrderTraversal(root->right);
        printf("%d ", root->data);
        }
}

// Function to free the memory allocated for the binary search
tree void freeTree(struct Node* root) {
        if (root != NULL) {
        freeTree(root->left);
        freeTree(root->right);

        free(root);

        }

}


int main() {

        struct Node* root = NULL;


        // Constructing a binary search

        tree root = insert(root, 50);

        insert(root, 30);

        insert(root,  20);

        insert(root,  40);

        insert(root,  70);

        insert(root,  60);

        insert(root, 80);


        // Displaying the elements in the tree using in-order

        traversal printf("In-order Traversal: ");

        inOrderTraversal(root);

        printf("\n");


        // Displaying the elements in the tree using pre-order

        traversal printf("Pre-order Traversal: ");

        preOrderTraversal(root);

        printf("\n");


        // Displaying the elements in the tree using post-order traversal

        printf("Post-order Traversal: "); postOrderTraversal(root);


        printf("\n");
        // Freeing the memory allocated for the binary search

        tree freeTree(root);


        return 0;

}
```



```
PS C:\Users\risku\coding> cd "c:\Users\risku\coding\" ; if ($?) { gcc rough.c -o rough } ; if ($?) { .\rough }
In-order Traversal: 20 30 40 50 60 70 80
Pre-order Traversal: 50 30 20 40 70 60 80
Post-order Traversal: 20 40 30 60 80 70 50
```

## Leetcode 61 – rotate the list

```
/**

 * Definition for singly-linked list.

 * struct ListNode {

 *          int val;

 *          struct ListNode *next;

 * };

 */

 int GetLength(struct ListNode* head)

{

                if (head == NULL)

                        return 0;


                return 1 + GetLength(head->next);

}

struct ListNode* rotateRight(struct ListNode* head, int k){

        if (head == NULL || k == 0)

                        return head;

        int length = GetLength(head);
```

```
                    if (length == 1)

                            return head;

            for(int i=0;i<k%length;i++)

            {

            struct ListNode *p=head;

        while(p->next->next!=NULL)

            {

            p=p->next;

            }

            struct ListNode *a=(struct ListNode *)malloc(sizeof(struct

        ListNode)); a->val=p->next->val;

            a->next=head;

            head=a;

            p->next=NULL;

            }

            return head;


    }
```

## <u>LAB Program – 9</u>

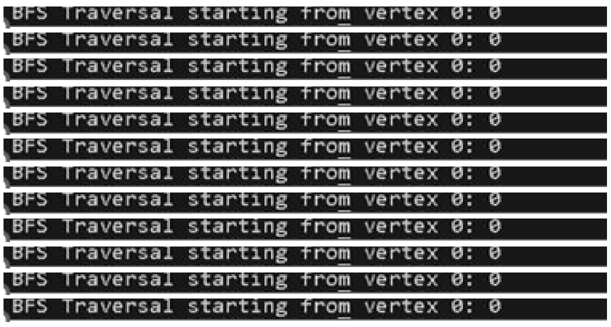
### 9a) Write a program to traverse a graph using BFS method.

```
#include <stdio.h>

#include <stdlib.h>

#include <stdbool.h>


#define MAX_VERTICES 100


// Queue structure for BFS
```

```
struct Queue {

        int front, rear;

        int capacity;

        int* array;

};


// Function to create a new queue

struct Queue* createQueue(int capacity) {

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

        if (queue == NULL) {

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

        exit(1);

        }

        queue->capacity = capacity;

        queue->front = queue->rear = -1;

        queue->array = (int*)malloc(capacity * sizeof(int));

        if (queue->array == NULL) {

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

        exit(1);

        }

        return queue;

}


// Function to check if the queue is empty

bool isEmpty(struct Queue* queue) {

        return queue->front == -1;

}


  // Function to enqueue a vertex into the queue

 void enqueue(struct Queue* queue, int vertex) {

        if (queue->rear == queue->capacity - 1) {
```

```
        printf("Queue overflow.\n");
        exit(1);
        }
        if (isEmpty(queue)) {
        queue->front = 0;
        }
        queue->rear++;
    queue->array[queue->rear] = vertex;
}

// Function to dequeue a vertex from the
queue int dequeue(struct Queue* queue) {
        if (isEmpty(queue)) {
        printf("Queue underflow.\n");
        exit(1);
        }
        int vertex = queue->array[queue->front]; if
        (queue->front == queue->rear) {
        queue->front = queue->rear = -1;
        } else {
        queue->front++;
        }
        return vertex;
}

// Function to perform BFS traversal on the graph
void BFS(int graph[MAX_VERTICES][MAX_VERTICES], int vertices, int startVertex)
        { struct Queue* queue = createQueue(vertices);
        bool visited[MAX_VERTICES] = {false};

        visited[startVertex] = true;
        enqueue(queue, startVertex);

        printf("BFS Traversal starting from vertex %d: ", startVertex);

        while (!isEmpty(queue)) {
        int currentVertex = dequeue(queue);
        printf("%d ", currentVertex);

        for (int adjacentVertex = 0; adjacentVertex < vertices; adjacentVertex++) {
        if (graph[currentVertex][adjacentVertex] == 1 && !visited[adjacentVertex]) {
        visited[adjacentVertex] = true;
        enqueue(queue, adjacentVertex);
        }
        }
        }

        printf("\n");

        free(queue->array);
        free(queue);
}

int main() {
        int vertices, edges;

        // Get the number of vertices and edges in the graph
        printf("Enter the number of vertices: ");
        scanf("%d", &vertices);
        printf("Enter the number of edges: ");
        scanf("%d", &edges);
```

```
    // Initialize the adjacency matrix with zeros
    int graph[MAX_VERTICES][MAX_VERTICES] = {0};

    // Get the edges of the graph
    printf("Enter the edges (vertex1 vertex2):\n");
    for (int i = 0; i < edges; i++) {
    int vertex1, vertex2;
    scanf("%d %d", &vertex1, &vertex2);
    graph[vertex1][vertex2] = 1;
    graph[vertex2][vertex1] = 1; // For undirected graph
    }

    // Perform BFS traversal starting from vertex 0
    BFS(graph, vertices, 0);

    return 0;
}
```



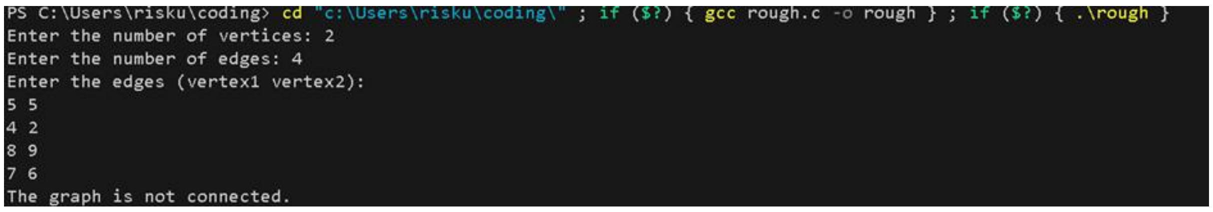
```
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
BFS Traversal starting from vertex 0: 0
```

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

```
#include <stdio.h>

#include <stdlib.h>
```

```
#include <stdbool.h>


#define MAX_VERTICES 100


// Function to perform DFS traversal on the graph

void DFS(int graph[MAX_VERTICES][MAX_VERTICES], int vertices, int startVertex,
bool visited[MAX_VERTICES]) {
        visited[startVertex] = true;


        for (int adjacentVertex = 0; adjacentVertex < vertices; adjacentVertex++)

        { if (graph[startVertex][adjacentVertex] == 1 &&

        !visited[adjacentVertex]) { DFS(graph, vertices, adjacentVertex, visited); }


        }

}


// Function to check whether the graph is connected or not

bool isConnected(int graph[MAX_VERTICES][MAX_VERTICES], int vertices)

        { bool visited[MAX_VERTICES] = {false};


        // Perform DFS traversal starting from the first vertex

        DFS(graph, vertices, 0, visited);


        // Check if all vertices are visited

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

        if (!visited[i]) {

        return false;

        }

        }


        return true;

}
```

```
int main() {
        int vertices, edges;

        // Get the number of vertices and edges in the graph
        printf("Enter the number of vertices: ");
        scanf("%d", &vertices);
        printf("Enter the number of edges: ");
        scanf("%d", &edges);

        // Initialize the adjacency matrix with zeros
        int graph[MAX_VERTICES][MAX_VERTICES] = {0};

        // Get the edges of the graph
        printf("Enter the edges (vertex1 vertex2):\n");
        for (int i = 0; i < edges; i++) {
        int vertex1, vertex2;
        scanf("%d %d", &vertex1, &vertex2);
        graph[vertex1][vertex2] = 1;
        graph[vertex2][vertex1] = 1; // For undirected graph
        }

        // Check whether the graph is connected or
        not if (isConnected(graph, vertices)) {
        printf("The graph is connected.\n");
        } else {
        printf("The graph is not connected.\n");
        }

        return 0;
}
```



```
PS C:\Users\risku\coding> cd "c:\Users\risku\coding\" ; if ($?) { gcc rough.c -o rough } ; if ($?) { .\rough }
Enter the number of vertices: 2
Enter the number of edges: 4
Enter the edges (vertex1 vertex2):
5 5
4 2
8 9
7 6
The graph is not connected.
```

## <u>LAB Program – 10</u>

**Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F.**

**Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT.**

**Let the keys in K and addresses in L are integers.**

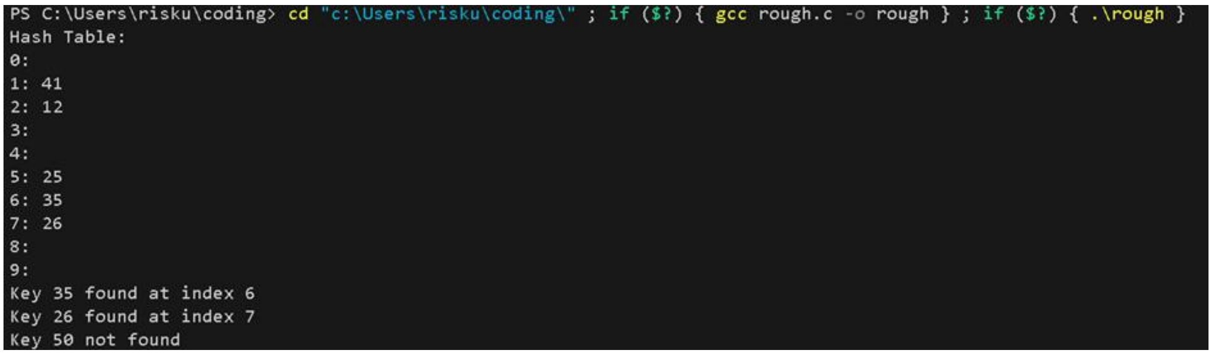
**Design and develop a Program in C that uses Hash function H: K -> L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L.**

**Resolve the collision (if any) using linear probing.**

```
#include <stdio.h>

#define TABLE_SIZE 10

int hash_table[TABLE_SIZE];

// Function to initialize hash
table void initializeHashTable() {
        for (int i = 0; i < TABLE_SIZE; i++) {
        hash_table[i] = -1; // -1 indicates empty slot
        }
}
```

```
// Function to calculate hash value using remainder

method int hash(int key) {

        return key % TABLE_SIZE;

}


// Function to insert a value into the hash table using linear

probing void insert(int key) {

        int hkey =

        hash(key); int index

        = hkey; int i = 0;


        while (hash_table[index] != -1) {

        i++;

        index = (hkey + i) % TABLE_SIZE;

        if (i == TABLE_SIZE) {

        printf("Hash table is full. Unable to insert key %d\n", key);

        return;

        }

        }


        hash_table[index] = key;

}


// Function to search for a value in the hash table using linear

probing void search(int key) {

        int hkey =

        hash(key); int index

        = hkey; int i = 0;


        while (hash_table[index] != key) {
```

```
        i++;
        index = (hkey + i) % TABLE_SIZE;
        if (hash_table[index] == -1 || i == TABLE_SIZE) {
        printf("Key %d not found\n", key);
        return;
        }
        }

        printf("Key %d found at index %d\n", key, index);
}

// Function to display the hash
table void displayHashTable() {
        printf("Hash Table:\n");
        for (int i = 0; i < TABLE_SIZE; i++)
        { printf("%d: ", i);
        if (hash_table[i] != -1) {
        printf("%d", hash_table[i]);
        }
        printf("\n");
        }
}

int main() {
        initializeHashTable();

        insert(12);
        insert(25);
        insert(35);
        insert(26);
        insert(41);
        displayHashTable();

        search(35);
        search(26);
        search(50);

        return 0;
}
```



```
PS C:\Users\risku\coding> cd "c:\Users\risku\coding\" ; if ($?) { gcc rough.c -o rough } ; if ($?) { .\rough }
Hash Table:
0:
1: 41
2: 12
3:
4:
5: 25
6: 35
7: 26
8:
9:
Key 35 found at index 6
Key 26 found at index 7
Key 50 not found
```