VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by NAME **(USN)**, 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	Swapping Using Pointers, Dynamic Memory Allocation, Stack Implementation	4
2	Infix to Postfix conversion AND Evaluation of Postfix Expression	7
3	Queue Implementation and Circular Queue Implementation	9
4	Singly Linked List Insert and display Implementation(LeetCode)	13
5	Singly Linked List delete and display Implementation (LeetCodes)	17
6	Sort the linked list, Reverse the linked list, Concatenation of two linked lists. Implement Single Linked List to simulate Stack & Queue Operations	17
7	Implement doubly link list with primitive operations (LeetCode)	26
8	To construct a binary Search Tree, To traverse the tree using all the methods i.e., in-order, preorder and postorder and To display the elements in the tree.	34
9	Write a program to traverse a graph using BFS method.Write a program to check whether given graph is connected or not using DFS method. (HackerRank)	42
10	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.	48

Course outcomes:

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

Lab program 1:

Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c) Display
The program should print appropriate messages for stack overflow, stack underflow.

```
#include <stdio.h>
#include<stdlib.h>
#define STACK_SIZE 5
void push(int st[],int *top)
{
        int item;
        if(*top==STACK_SIZE-1)
                printf("Stack overflow\n");
        else
        {
                printf("\nEnter an item :");
                scanf("%d",&item);
                (*top)++;
                st[*top]=item;
        }
}
void pop(int st[],int *top)
{
        if(*top==-1)
                printf("Stack underflow\n");
        else
        {
                printf("\n%d item was deleted",st[(*top)--]);
        }
}
void display(int st[],int *top)
{
        int i;
        if(*top==-1)
                printf("Stack is empty\n");
        for(i=0;i<=*top;i++)
                printf("%d\t",st[i]);
}
void main()
{
        int st[10],top=-1, c,val_del;
        while(1)
        {
                printf("\n1. Push\n2. Pop\n3. Display\n");
                printf("\nEnter your choice :");
                scanf("%d",&c);
```

```
                switch(c)
                {
                        case 1: push(st,&top);
                                break;
                        case 2: pop(st,&top);
                                break;
                        case 3: display(st,&top);
                                break;
                        default: printf("\nInvalid choice!!!");
                                exit(0);
                }
        }
}
```

Output:

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL

PS D:\jyothika\DST> cd "d:\jyothika\DST\" ; if ($?) { gcc 1.c -o 1 } ; if ($?) { .\1 }

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :12

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :65

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :45

1. Push
2. Pop
3. Display

Enter your choice :1
Stack overflow
```

```
1. Push
2. Pop
3. Display

Enter your choice :2

45 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2

65 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :3
12
1. Push
2. Pop
3. Display

Enter your choice :2

12 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2
Stack underflow

1. Push
2. Pop
3. Display

Enter your choice :4

Invalid choice!!!
```

NOTE: SIMILARLY INCLUDE FOR ALL THE LAB PROGRAMS (ALL 10). LEETCODE AND HACKERRANK PROGRAMS ALSO TO BE INCLUDED.

LAB 2

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

#define MAX_SIZE 100

typedef struct {
    char items[MAX_SIZE];
    int top;
} Stack;

void push(Stack *s, char item) {
    if (s->top == MAX_SIZE - 1) {
        printf("Stack Overflow\n");
        exit(1);
    }
    s->items[++(s->top)] = item;
}

char pop(Stack *s) {
    if (s->top == -1) {
        printf("Stack Underflow\n");
        exit(1);
    }
    return s->items[(s->top)--];
}

int is_operator(char c) {
    return (c == '+' || c == '-' || c == '*' || c == '/');
```

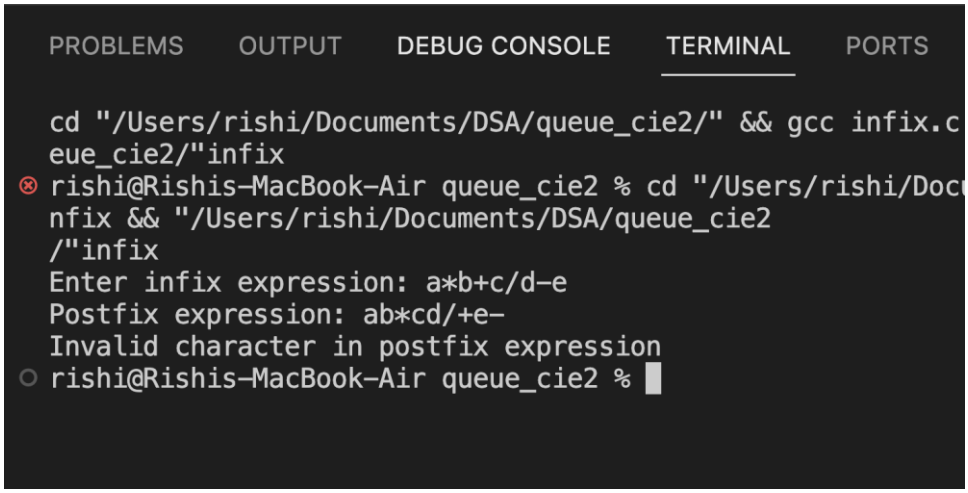
```
}

int precedence(char c) {
    if (c == '+' || c == '-')
        return 1;
    else if (c == '*' || c == '/')
        return 2;
    return 0;
}

void infix_to_postfix(char infix[], char postfix[]) {
    Stack s;
    s.top = -1;
    int i = 0, j = 0;

    while (infix[i] != '\0') {
        if (isdigit(infix[i]) || isalpha(infix[i]))
            postfix[j++] = infix[i];
        else if (infix[i] == '(')
            push(&s, '(');
        else if (infix[i] == ')') {
            while (s.top != -1 && s.items[s.top] != '(')
                postfix[j++] = pop(&s);
            if (s.top == -1) {
                printf("Invalid expression: Unmatched parenthesis\n");
                exit(1);
            }
            pop(&s); // Discard '('
        }
        else if (is_operator(infix[i])) {
            while (s.top != -1 && precedence(s.items[s.top]) >= precedence(infix[i]))
                postfix[j++] = pop(&s);
```

```
            push(&s, infix[i]);
        }
        else {
            printf("Invalid character in infix expression\n");
            exit(1);
        }
        i++;
    }

    while (s.top != -1) {
        if (s.items[s.top] == '(') {
            printf("Invalid expression: Unmatched parenthesis\n");
            exit(1);
        }
        postfix[j++] = pop(&s);
    }
    postfix[j] = '\0';
}

int evaluate_postfix(char postfix[]) {
    Stack s;
    s.top = -1;
    int i = 0, operand1, operand2, result;

    while (postfix[i] != '\0') {
        if (isdigit(postfix[i])) {
            push(&s, postfix[i] - '0');
        }
        else if (is_operator(postfix[i])) {
            operand2 = pop(&s);
            operand1 = pop(&s);
            switch (postfix[i]) {
```

```
            case '+':
                push(&s, operand1 + operand2);
                break;
            case '-':
                push(&s, operand1 - operand2);
                break;
            case '*':
                push(&s, operand1 * operand2);
                break;
            case '/':
                if (operand2 == 0) {
                    printf("Division by zero\n");
                    exit(1);
                }
                push(&s, operand1 / operand2);
                break;
        }
    }
    else {
        printf("Invalid character in postfix expression\n");
        exit(1);
    }
    i++;
}

result = pop(&s);
if (s.top != -1) {
    printf("Invalid expression: Too many operands\n");
    exit(1);
}
return result;
}
```

```
int main() {
    char infix[MAX_SIZE], postfix[MAX_SIZE];
    printf("Enter infix expression: ");
    scanf("%s", infix);

    infix_to_postfix(infix, postfix);
    printf("Postfix expression: %s\n", postfix);

    int result = evaluate_postfix(postfix);
    printf("Result of evaluation: %d\n", result);

    return 0;
}
```

OUTPUT:


PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
cd "/Users/rishi/Documents/DSA/queue_cie2/" && gcc infix.c
eue_cie2/"infix
rishi@Rishis-MacBook-Air queue_cie2 % cd "/Users/rishi/Doc
nfix && "/Users/rishi/Documents/DSA/queue_cie2
/"infix
Enter infix expression: a*b+c/d-e
Postfix expression: ab*cd/+e-
Invalid character in postfix expression
rishi@Rishis-MacBook-Air queue_cie2 %

LAB 3

A)

QUEUE IMPLEMENTATION

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_SIZE 100

typedef struct {
    int items[MAX_SIZE];
    int front;
    int rear;
} Queue;

void initQueue(Queue *q) {
    q->front = -1;
    q->rear = -1;
}

int isEmpty(Queue *q) {
    return q->front == -1;
}

int isFull(Queue *q) {
    return (q->rear + 1) % MAX_SIZE == q->front;
}

void enqueue(Queue *q, int data) {
    if (isFull(q)) {
        printf("Queue is full\n");
        return;
    }
    if (isEmpty(q)) {
        q->front = 0;
        q->rear = 0;
```

```
    } else {
        q->rear = (q->rear + 1) % MAX_SIZE;
    }
    q->items[q->rear] = data;
}

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

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

    enqueue(&q, 1);
    enqueue(&q, 2);
    enqueue(&q, 3);
    enqueue(&q, 4);

    printf("Dequeued: %d\n", dequeue(&q));
    printf("Dequeued: %d\n", dequeue(&q));
    printf("Dequeued: %d\n", dequeue(&q));
    printf("Dequeued: %d\n", dequeue(&q));
```

```
    return 0;
}
```

OUTPUT:

B)

Circular Queue Implementation

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

#define MAX_SIZE 5

typedef struct {
    int items[MAX_SIZE];
    int front;
    int rear;
} CircularQueue;
```

```
void initCircularQueue(CircularQueue *cq) {
    cq->front = -1;
    cq->rear = -1;
}

int isEmptyCircularQueue(CircularQueue *cq) {
    return cq->front == -1;
}

int isFullCircularQueue(CircularQueue *cq) {
    return (cq->rear + 1) % MAX_SIZE == cq->front;
}

void enqueueCircularQueue(CircularQueue *cq, int data) {
    if (isFullCircularQueue(cq)) {
        printf("Queue is full\n");
        return;
    }
    if (isEmptyCircularQueue(cq)) {
        cq->front = 0;
    }
    cq->rear = (cq->rear + 1) % MAX_SIZE;
    cq->items[cq->rear] = data;
}

int dequeueCircularQueue(CircularQueue *cq) {
    if (isEmptyCircularQueue(cq)) {
        printf("Queue is empty\n");
        exit(1);
    }
    int data = cq->items[cq->front];
```

```
    if (cq->front == cq->rear) {
        cq->front = -1;
        cq->rear = -1;
    } else {
        cq->front = (cq->front + 1) % MAX_SIZE;
    }
    return data;
}

int main() {
    CircularQueue cq;
    initCircularQueue(&cq);

    enqueueCircularQueue(&cq, 1);
    enqueueCircularQueue(&cq, 2);
    enqueueCircularQueue(&cq, 3);
    enqueueCircularQueue(&cq, 4);

    printf("Dequeued: %d\n", dequeueCircularQueue(&cq));
    printf("Dequeued: %d\n", dequeueCircularQueue(&cq));

    enqueueCircularQueue(&cq, 5);
    enqueueCircularQueue(&cq, 6);

    printf("Dequeued: %d\n", dequeueCircularQueue(&cq));
    printf("Dequeued: %d\n", dequeueCircularQueue(&cq));
    printf("Dequeued: %d\n", dequeueCircularQueue(&cq));

    return 0;
}
```

OUTPUT:

LAB 4

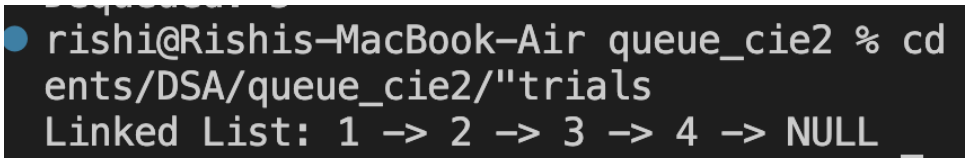
Singly Linked List insertion

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

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

// Function to create a new node
Node* createNode(int data) {
    Node* newNode = (Node*)malloc(sizeof(Node));
    if (newNode == NULL) {
        printf("Memory allocation failed\n");
```

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

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

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

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

int main() {
    Node* head = NULL;

    // Insert some elements at the end of the linked list
    insertEnd(&head, 1);
    insertEnd(&head, 2);
    insertEnd(&head, 3);
    insertEnd(&head, 4);

    // Display the linked list
    display(head);

    return 0;
}
```

OUTPUT:



LAB 5

Singly Linked List deletion

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

struct node *head = NULL;
void pop() {
    if (head == NULL) {
        printf("EMPTY LIST");
        return;
    }
```

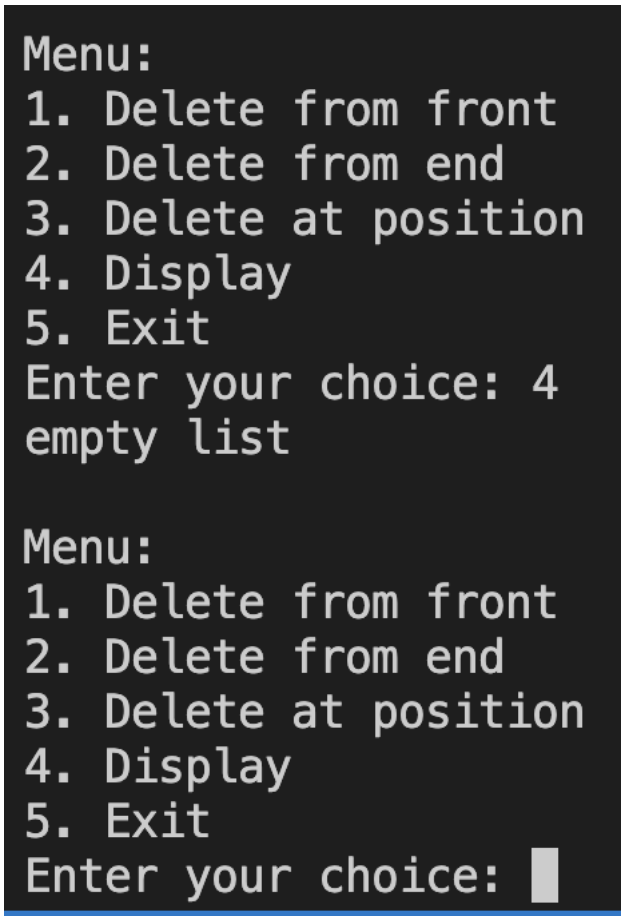
```
    struct node *ptr = head;
    head = head->next;
    free(ptr);
    printf("node deleted\n");
}

void end_delete() {
    if (head == NULL) {
        printf("list is empty\n");
        return;
    }
    if (head->next == NULL) {
        free(head);
        head = NULL;
        printf("node deleted from end\n");
        return;
    }

    struct node *ptr = head;
    struct node *ptr1 = NULL;

    while (ptr->next != NULL) {
        ptr1 = ptr;
        ptr = ptr->next;
    }

    ptr1->next = NULL;
    free(ptr);
    printf("node deleted from end\n");
}
```

```
void delete_at_pos(int position) {
    struct node *ptr = head;
    struct node *ptr1 = NULL;
    if (head == NULL) {
        printf("EMPTY LIST\n");
        return;
    }

for (int i = 1; ptr != NULL && i < position; i++) {
    ptr1 = ptr;
    ptr = ptr->next;
}

    if (ptr == NULL) {
        printf("there are fewer elements\n");
        return;
    }

    if (ptr1 == NULL) {
        head = ptr->next;
    } else {
        ptr1->next = ptr->next;
    }

    free(ptr);
    printf("node deleted from position\n");
}

void display() {
    if (head == NULL) {
        printf("empty list\n");
```

```
        return;
    }
    struct node *current = head;
    printf("linked list: ");
    while (current != NULL) {
        printf("%d ", current->data);
        current = current->next;
    }
    printf("\n");
}

int main() {
    int choice;

    do {
        printf("\nMenu:\n");
        printf("1. Delete from front\n");
        printf("2. Delete from end\n");
        printf("3. Delete at position\n");
        printf("4. Display\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                pop();
                break;
            case 2:
                end_delete();
                break;
```

```
            case 3: {
                int position;
                printf("Enter the position from where you want to delete: ");
                scanf("%d", &position);
                delete_at_pos(position);
                break;
            }
            case 4:
                display();
                break;
            case 5:
                printf("Exiting program.\n");
                break;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    } while (choice != 5);

    return 0;
}
```

OUTPUT:


Menu:
1. Delete from front
2. Delete from end
3. Delete at position
4. Display
5. Exit
Enter your choice: 4
empty list
Menu:
1. Delete from front
2. Delete from end
3. Delete at position
4. Display
5. Exit
Enter your choice:

LAB 6

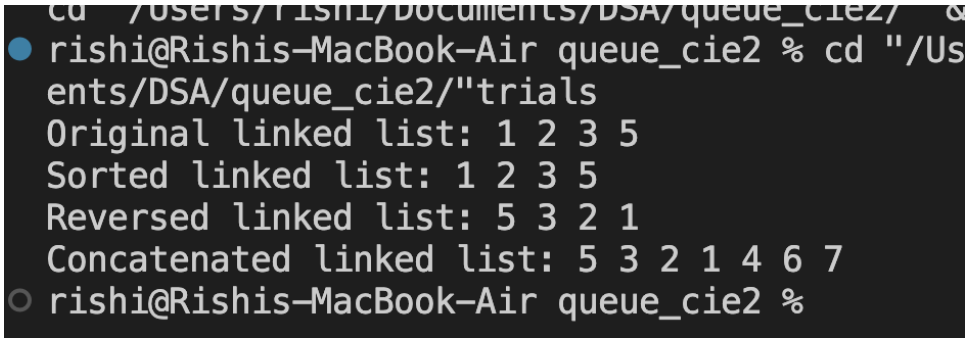
```
#include <stdio.h>
#include <stdlib.h>
// Node structure
struct Node {
int data;
struct Node *next;
};
// Function to create a new node
struct Node *newNode(int data) {
struct Node *node = (struct Node *)malloc(sizeof(struct Node));
node->data = data;
node->next = NULL;
return node;
}
// Function to insert a node at the beginning of the linked list
void insertAtBeginning(struct Node **head, int data) {
struct Node *node = newNode(data);
node->next = *head;
*head = node;
}
// Function to print the linked list
void printLinkedList(struct Node *head) {
struct Node *temp = head;
while (temp != NULL) {
printf("%d ", temp->data);
temp = temp->next;
}
printf("\n");
}
// Function to sort the linked list using the bubble sort algorithm
void sortLinkedList(struct Node **head) {
struct Node *current = *head;
struct Node *next = NULL;
int swapped;
do {
```

```
swapped = 0;
current = *head;
while (current->next != NULL) {
next = current->next;
if (current->data > next->data) {
int temp = current->data;
current->data = next->data;
next->data = temp;
swapped = 1;
}
current = current->next;
}
} while (swapped);
}
// Function to reverse the linked list
void reverseLinkedList(struct Node **head) {
struct Node *previous = NULL;
struct Node *current = *head;
struct Node *next = NULL;
while (current != NULL) {
next = current->next;
current->next = previous;
previous = current;
current = next;
}
*head = previous;
}
// Function to concatenate two linked lists
struct Node *concatenateLinkedLists(struct Node *head1, struct Node
*head2) {
struct Node *temp = head1;
while (temp->next != NULL) {
temp = temp->next;
}
temp->next = head2;
return head1;
}
// Function to implement a stack using a singly linked list
void push(struct Node **head, int data) {
```

```
insertAtBeginning(head, data);
}
int pop(struct Node **head) {
if (*head == NULL) {
printf("Stack is empty\n");
return -1;
}
int data = (*head)->data;
*head = (*head)->next;
return data;
}
// Function to implement a queue using a singly linked list
void enqueue(struct Node **head, int data) {
insertAtBeginning(head, data);
}
int dequeue(struct Node **head) {
if (*head == NULL) {
printf("Queue is empty\n");
return -1;
}
struct Node *temp = *head;
while (temp->next != NULL) {
temp = temp->next;
}
int data = temp->data;
free(temp);
return data;
}
// Main function
int main() {
// Create a linked list
struct Node *head = NULL;
insertAtBeginning(&head, 5);
insertAtBeginning(&head, 3);
insertAtBeginning(&head, 2);
insertAtBeginning(&head, 1);
// Print the linked list
printLinkedList(head);
// Sort the linked list
```

```
sortLinkedList(&head);
// Print the sorted linked list
printLinkedList(head);
// Reverse the linked list
reverseLinkedList(&head);
// Print the reversed linked list
printLinkedList(head);
// Concatenate two linked lists
struct Node *head2 = NULL;
insertAtBeginning(&head2, 7);
insertAtBeginning(&head2, 6);
insertAtBeginning(&head2, 4);
head = concatenateLinkedLists(head, head2);
```

OUTPUT:



LAB 7

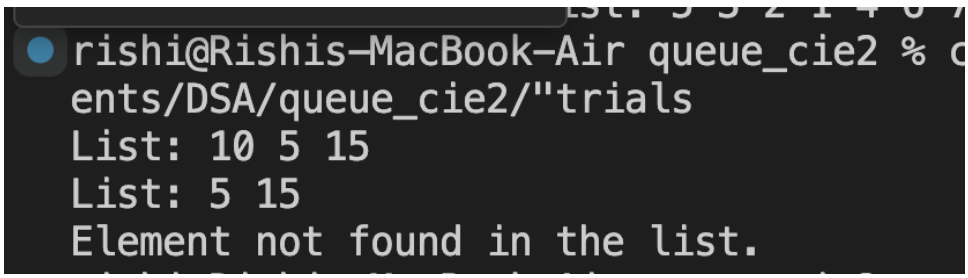
```
#include <stdio.h>
#include <stdlib.h>

// Define a structure for a node
struct Node {
    int data;
    struct Node* prev;
    struct Node* next;
};

// Function to create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (newNode == NULL) {
        printf("Memory allocation failed.\n");
        exit(1);
    }
    newNode->data = data;
    newNode->prev = NULL;
    newNode->next = NULL;
    return newNode;
}

// Function to insert a node at the beginning
void insertAtBeginning(struct Node** head, int data) {
    struct Node* newNode = createNode(data);
    if (*head == NULL) {
        *head = newNode;
    } else {
```

```
        newNode->next = *head;
        (*head)->prev = newNode;
        *head = newNode;
    }
}

// Function to insert a node at the end
void insertAtEnd(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;
        newNode->prev = temp;
    }
}

// Function to delete a node by value
void deleteNode(struct Node** head, int data) {
    struct Node* temp = *head;
    if (temp == NULL) {
        printf("List is empty.\n");
        return;
    }
    if (temp->data == data) {
        *head = temp->next;
        if (*head != NULL)
```

```
            (*head)->prev = NULL;
        free(temp);
        return;
    }
    while (temp != NULL && temp->data != data) {
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Element not found in the list.\n");
        return;
    }
    if (temp->prev != NULL)
        temp->prev->next = temp->next;
    if (temp->next != NULL)
        temp->next->prev = temp->prev;
    free(temp);
}

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

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

```
    insertAtBeginning(&head, 5);
    insertAtBeginning(&head, 10);
    insertAtEnd(&head, 15);
    displayList(head);

    deleteNode(&head, 10);
    displayList(head);

    deleteNode(&head, 20);

    return 0;
}
```

OUTPUT:



LAB 8

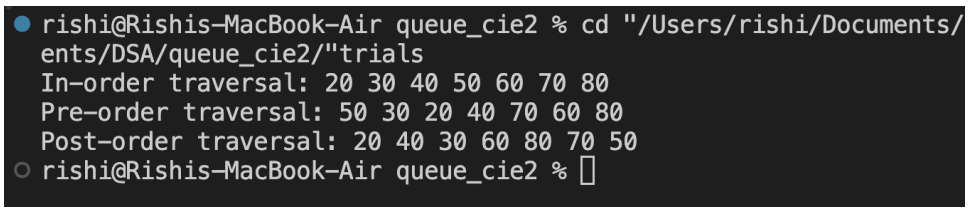
```
#include <stdio.h>
#include <stdlib.h>
```

```
// Define a structure for a binary search tree node
struct TreeNode {
    int data;
    struct TreeNode *left;
    struct TreeNode *right;
};

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

// Function to insert a value into a BST
struct TreeNode *insert(struct TreeNode *root, int value) {
    // If the tree is empty, create a new node and return it
    if (root == NULL) {
        return createNode(value);
    }

    // Otherwise, recur down the tree
    if (value < root->data) {
        root->left = insert(root->left, value);
    } else if (value > root->data) {
        root->right = insert(root->right, value);
    }

    // Return the (unchanged) node pointer
```

```
    return root;
}

// Function to perform in-order traversal of BST
void inorderTraversal(struct TreeNode *root) {
    if (root != NULL) {
        inorderTraversal(root->left);
        printf("%d ", root->data);
        inorderTraversal(root->right);
    }
}

// Function to perform pre-order traversal of BST
void preorderTraversal(struct TreeNode *root) {
    if (root != NULL) {
        printf("%d ", root->data);
        preorderTraversal(root->left);
        preorderTraversal(root->right);
    }
}

// Function to perform post-order traversal of BST
void postorderTraversal(struct TreeNode *root) {
    if (root != NULL) {
        postorderTraversal(root->left);
        postorderTraversal(root->right);
        printf("%d ", root->data);
    }
}

// Function to display the elements of the BST
```

```
void display(struct TreeNode *root) {
    printf("In-order traversal: ");
    inorderTraversal(root);
    printf("\n");

    printf("Pre-order traversal: ");
    preorderTraversal(root);
    printf("\n");

    printf("Post-order traversal: ");
    postorderTraversal(root);
    printf("\n");
}

int main() {
    struct TreeNode *root = NULL;

    // Insert elements into the binary search tree
    root = insert(root, 50);
    root = insert(root, 30);
    root = insert(root, 20);
    root = insert(root, 40);
    root = insert(root, 70);
    root = insert(root, 60);
    root = insert(root, 80);

    // Display the elements of the binary search tree
    display(root);

    return 0;
}
```

OUTPUT:



LAB 9

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

#define MAX_VERTICES 100

int graph[MAX_VERTICES][MAX_VERTICES];
```

```
int visited[MAX_VERTICES];
int queue[MAX_VERTICES];
int front = -1, rear = -1;
int vertices, edges;

// Function to add an edge to the graph
void addEdge(int v1, int v2) {
    graph[v1][v2] = 1;
    graph[v2][v1] = 1; // Assuming undirected graph
}

// Function to perform Breadth First Search traversal of the graph
void BFS(int start) {
    printf("BFS traversal starting from vertex %d: ", start);
    visited[start] = true;
    enqueue(start);

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

        for (int i = 0; i < vertices; i++) {
            if (graph[currentVertex][i] && !visited[i]) {
                visited[i] = true;
                enqueue(i);
            }
        }
    }
    printf("\n");
}
```

```
// Function to add an element to the queue
void enqueue(int vertex) {
    if (rear == MAX_VERTICES - 1)
        printf("Queue Overflow\n");
    else {
        if (front == -1)
            front = 0;
        rear++;
        queue[rear] = vertex;
    }
}

// Function to remove an element from the queue
int dequeue() {
    int deletedVertex;
    if (front == -1)
        printf("Queue Underflow\n");
    else {
        deletedVertex = queue[front];
        front++;
        if (front > rear)
            front = rear = -1;
        return deletedVertex;
    }
}

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

```
// Function to perform Depth First Search traversal of the graph
void DFS(int vertex) {
    visited[vertex] = true;
    for (int i = 0; i < vertices; i++) {
        if (graph[vertex][i] && !visited[i]) {
            DFS(i);
        }
    }
}

// Function to check if the given graph is connected or not using DFS
bool isConnected() {
    for (int i = 0; i < vertices; i++)
        visited[i] = false;

    DFS(0); // Start DFS from vertex 0

    for (int i = 0; i < vertices; i++) {
        if (!visited[i]) {
            return false;
        }
    }
    return true;
}

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

    printf("Enter the edges (vertex pairs):\n");
    for (int i = 0; i < edges; i++) {
```

```
        int v1, v2;
        scanf("%d %d", &v1, &v2);
        addEdge(v1, v2);
    }

    if (isConnected())
        printf("The graph is connected.\n");
    else
        printf("The graph is not connected.\n");

    printf("BFS traversal of the graph:\n");
    for (int i = 0; i < vertices; i++) {
        if (!visited[i])
            BFS(i);
    }

    return 0;
}
```

OUTPUT:

```
Enter the number of vertices and edges: 5 4
Enter the edges (vertex pairs):
0 1
0 2
1 3
3 4
The graph is connected.
BFS traversal of the graph:
BFS traversal starting from vertex 0: 0 1 2 3 4
```

LAB 10

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

#define SIZE 10 // Size of the hash table

int hash_table[SIZE];

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

```
// Function to calculate hash value using remainder method
int hash(int key) {
    return key % SIZE;
}

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

    // If slot is empty, insert key
    if (hash_table[index] == -1) {
        hash_table[index] = key;
    } else {
        // Collision occurred, find next empty slot using linear probing
        while (hash_table[index] != -1) {
            index = (index + 1) % SIZE;
        }
        hash_table[index] = key;
    }
}

// Function to search for a key in the hash table
int search(int key) {
    int index = hash(key);

    // Search until an empty slot is found or key is found
    while (hash_table[index] != -1) {
        if (hash_table[index] == key) {
            return index; // Key found
        }
        index = (index + 1) % SIZE; // Move to next slot
```

```
    }

    return -1; // Key not found
}

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

int main() {
    initializeHashTable();

    // Insert keys into the hash table
    insert(12);
    insert(25);
    insert(35);
    insert(26);
    insert(41);
    insert(15);
    insert(76);

    displayHashTable();
```

```
    // Search for a key
    int key_to_search = 26;
    int index = search(key_to_search);
    if (index != -1) {
        printf("Key %d found at index %d\n", key_to_search, index);
    } else {
        printf("Key %d not found\n", key_to_search);
    }

    return 0;
}
```

OUTPUT: