VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
Dec 2023- March 2024

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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **“DATA STRUCTURES”** carried out by TARANG **(1BM22CS305)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 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

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!!!
```

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)

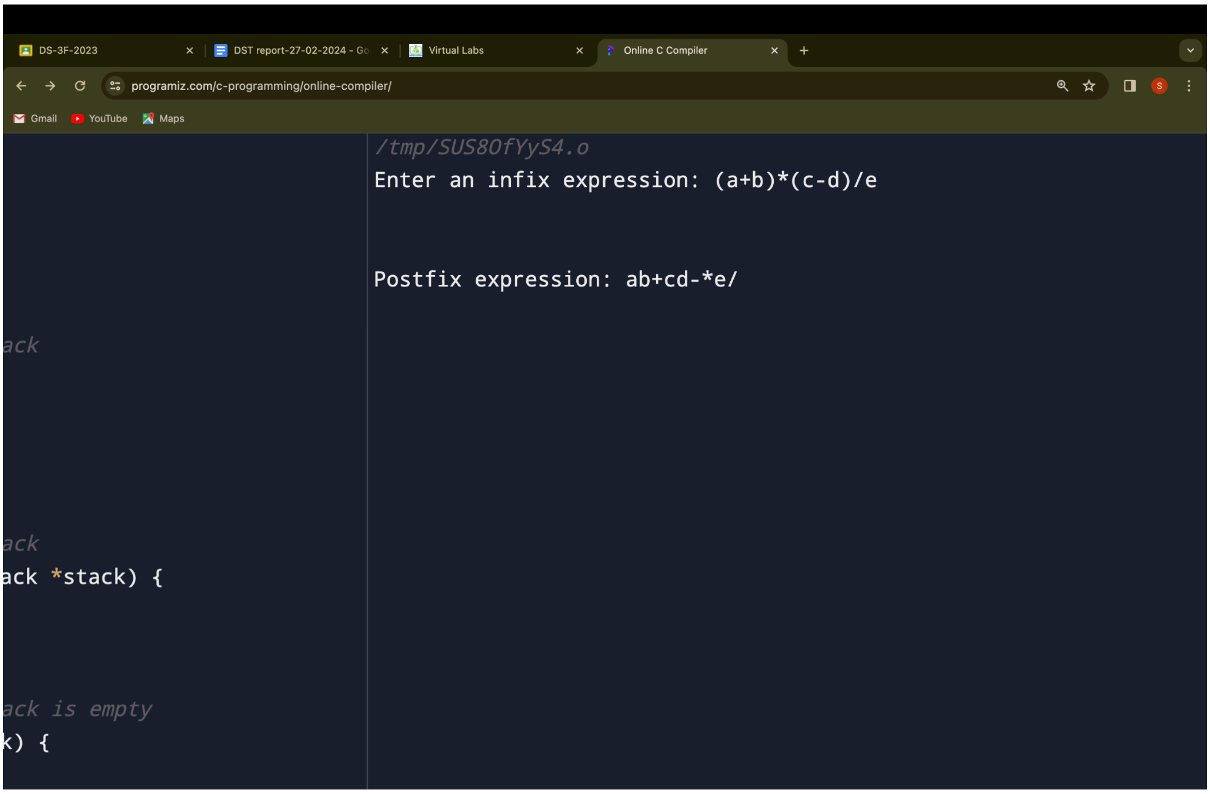
and /(divide)

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

#define MAX_SIZE 100

// Structure to represent a stack
struct Stack {
    int top;
    char items[MAX_SIZE];
};

// Function to initialize a stack
void initializeStack(struct Stack *stack) {
    stack->top = -1;
}

// Function to check if the stack is empty
int isEmpty(struct Stack *stack) {
    return stack->top == -1;
}

// Function to push an element onto the stack
void push(struct Stack *stack, char value) {
    if (stack->top < MAX_SIZE - 1) {
        stack->items[++(stack->top)] = value;
    } else {
        printf("Stack overflow\n");
        exit(EXIT_FAILURE);
    }
}
```

```
// Function to pop an element from the stack
char pop(struct Stack *stack) {
  if (!isEmpty(stack)) {
    return stack->items[(stack->top)--];
  } else {
    printf("Stack underflow\n");
    exit(EXIT_FAILURE);
  }
}

// Function to get the precedence of an operator
int getPrecedence(char operator) {
  switch (operator) {
    case '+':
    case '-':
      return 1;
    case '*':
    case '/':
      return 2;
    default:
      return -1; // Unknown operator
  }
}

// Function to convert infix expression to postfix expression
void infixToPostfix(char infix[], char postfix[]) {
  struct Stack operatorStack;
  initializeStack(&operatorStack);

  int i, j;
  i = j = 0;
```

```
    while (infix[i] != '\0') {
        if ((infix[i] >= 'a' && infix[i] <= 'z') || (infix[i] >= 'A' && infix[i] <= 'Z')) {
            postfix[j++] = infix[i++];
        } else if (infix[i] == '(') {
            push(&operatorStack, infix[i++]);
        } else if (infix[i] == ')') {
            while (!isEmpty(&operatorStack) && operatorStack.items[operatorStack.top] != '(') {
                postfix[j++] = pop(&operatorStack);
            }
            if (!isEmpty(&operatorStack) && operatorStack.items[operatorStack.top] == '(') {
                pop(&operatorStack); // Discard '('
                i++;
            } else {
                printf("Invalid expression: Mismatched parentheses\n");
                exit(EXIT_FAILURE);
            }
        } else {
            while (!isEmpty(&operatorStack) && getPrecedence(infix[i]) <=
getPrecedence(operatorStack.items[operatorStack.top])) {
                postfix[j++] = pop(&operatorStack);
            }
            push(&operatorStack, infix[i++]);
        }
    }

    while (!isEmpty(&operatorStack)) {
        postfix[j++] = pop(&operatorStack);
    }

    postfix[j] = '\0'; // Null-terminate the postfix expression
}
```

```c
int main() {
    char infix[MAX_SIZE];
    char postfix[MAX_SIZE];

    printf("Enter an infix expression: ");
    scanf("%s", infix);

    infixToPostfix(infix, postfix);

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

    return 0;
}
```



Lab program 3:

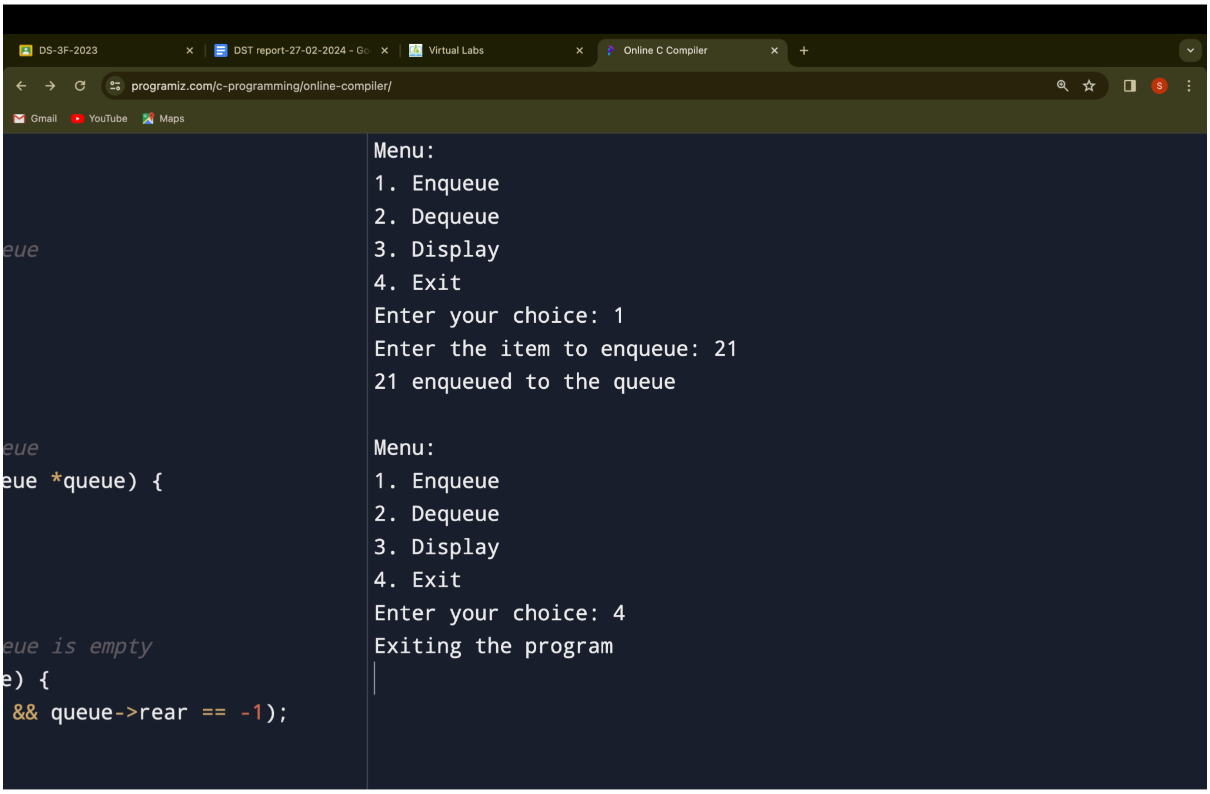
write a program to simulate the working of the queue of integers using an array. Provide the following operations: Insert, delete, display. The program should print appropriate message for overflow and underflow condition.

```
#include <stdio.h>

#include <stdlib.h>


#define MAX_SIZE 5


// Structure to represent a queue

struct Queue {

   int front, rear;

   int items[MAX_SIZE];

};


// Function to initialize a queue

void initializeQueue(struct Queue *queue) {

   queue->front = -1;

   queue->rear = -1;

}


// Function to check if the queue is empty

int isEmpty(struct Queue *queue) {

   return (queue->front == -1 && queue->rear == -1);

}


// Function to check if the queue is full

int isFull(struct Queue *queue) {

   return ((queue->rear + 1) % MAX_SIZE == queue->front);

}


// Function to insert an element into the queue
```

```
void enqueue(struct Queue *queue, int item) {
    if (isFull(queue)) {
        printf("Queue overflow. Cannot enqueue %d\n", item);
        return;
    }

    if (isEmpty(queue)) {
        queue->front = queue->rear = 0;
    } else {
        queue->rear = (queue->rear + 1) % MAX_SIZE;
    }

    queue->items[queue->rear] = item;
    printf("%d enqueued to the queue\n", item);
}

// Function to delete an element from the queue
int dequeue(struct Queue *queue) {
    int item;

    if (isEmpty(queue)) {
        printf("Queue underflow. Cannot dequeue.\n");
        return -1; // Return a special value to indicate underflow
    }

    item = queue->items[queue->front];

    if (queue->front == queue->rear) {
        // Reset front and rear as it's the last element in the queue
        queue->front = queue->rear = -1;
    } else {
        queue->front = (queue->front + 1) % MAX_SIZE;
```

```
    }

    return item;
}

// Function to display the elements of the queue
void display(struct Queue *queue) {
    if (isEmpty(queue)) {
        printf("Queue is empty\n");
        return;
    }

    printf("Queue elements: ");
    int i = queue->front;
    do {
        printf("%d ", queue->items[i]);
        i = (i + 1) % MAX_SIZE;
    } while (i != (queue->rear + 1) % MAX_SIZE);

    printf("\n");
}

int main() {
    struct Queue myQueue;
    initializeQueue(&myQueue);

    int choice, item;

    do {
        printf("\nMenu:\n");
        printf("1. Enqueue\n");
        printf("2. Dequeue\n");
```

```
        printf("3. Display\n");
        printf("4. Exit\n");

        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the item to enqueue: ");
                scanf("%d", &item);
                enqueue(&myQueue, item);
                break;
            case 2:
                item = dequeue(&myQueue);
                if (item != -1) {
                    printf("Dequeued item: %d\n", item);
                }
                break;
            case 3:
                display(&myQueue);
                break;
            case 4:
                printf("Exiting the program\n");
                break;
            default:
                printf("Invalid choice. Please enter a valid option.\n");
        }

    } while (choice != 4);

    return 0;
}
```



Lab program 4:

write a program to simulate the working of a circular queue using an array. Provide the following operations: insert, delete& display. The program should print appropriate message for queue empty and queue overflow conditions.

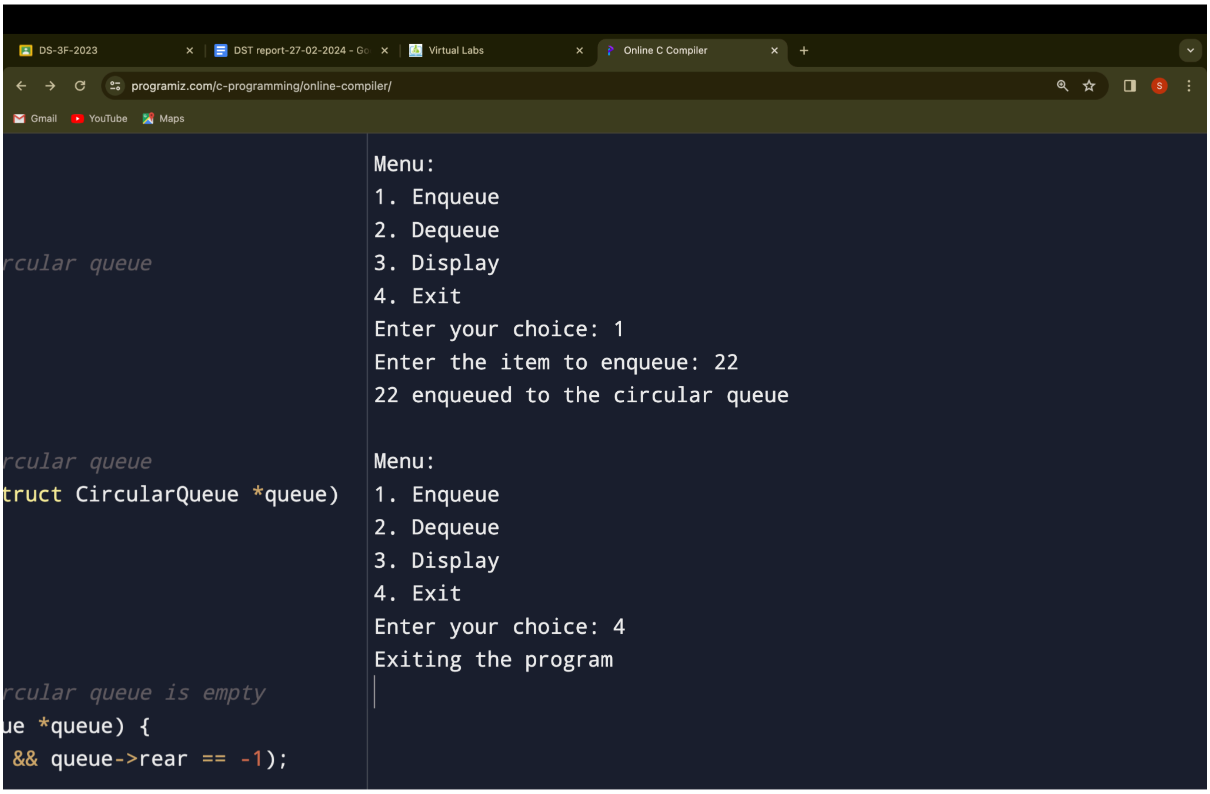
```
#include <stdio.h>

#include <stdlib.h>



#define MAX_SIZE 5



// Structure to represent a circular queue

struct CircularQueue {

    int front, rear;

    int items[MAX_SIZE];

};



// Function to initialize a circular queue

void initializeCircularQueue(struct CircularQueue *queue) {

    queue->front = -1;
```

```
    queue->rear = -1;
}

// Function to check if the circular queue is empty
int isEmpty(struct CircularQueue *queue) {
    return (queue->front == -1 && queue->rear == -1);
}

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

// Function to insert an element into the circular queue
void enqueue(struct CircularQueue *queue, int item) {
    if (isFull(queue)) {
        printf("Queue overflow. Cannot enqueue %d\n", item);
        return;
    }

    if (isEmpty(queue)) {
        queue->front = queue->rear = 0;
    } else {
        queue->rear = (queue->rear + 1) % MAX_SIZE;
    }

    queue->items[queue->rear] = item;
    printf("%d enqueued to the circular queue\n", item);
}

// Function to delete an element from the circular queue
int dequeue(struct CircularQueue *queue) {
```

```
    int item;

    if (isEmpty(queue)) {
        printf("Queue underflow. Cannot dequeue.\n");
        return -1; // Return a special value to indicate underflow
    }

    item = queue->items[queue->front];

    if (queue->front == queue->rear) {
        // Reset front and rear as it's the last element in the circular queue
        queue->front = queue->rear = -1;
    } else {
        queue->front = (queue->front + 1) % MAX_SIZE;
    }

    return item;
}

// Function to display the elements of the circular queue
void display(struct CircularQueue *queue) {
    if (isEmpty(queue)) {
        printf("Circular queue is empty\n");
        return;
    }

    printf("Circular Queue elements: ");
    int i = queue->front;
    do {
        printf("%d ", queue->items[i]);
        i = (i + 1) % MAX_SIZE;
    } while (i != (queue->rear + 1) % MAX_SIZE);
```

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

int main() {
    struct CircularQueue myCircularQueue;
    initializeCircularQueue(&myCircularQueue);

    int choice, item;

    do {
        printf("\nMenu:\n");
        printf("1. Enqueue\n");
        printf("2. Dequeue\n");
        printf("3. Display\n");
        printf("4. Exit\n");

        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the item to enqueue: ");
                scanf("%d", &item);
                enqueue(&myCircularQueue, item);
                break;
            case 2:
                item = dequeue(&myCircularQueue);
                if (item != -1) {
                    printf("Dequeued item: %d\n", item);
                }
                break;
```

```
            case 3:
                display(&myCircularQueue);
                break;
            case 4:
                printf("Exiting the program\n");
                break;
            default:
                printf("Invalid choice. Please enter a valid option.\n");
        }

    } while (choice != 4);

    return 0;
}
```



Lab program 5:

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

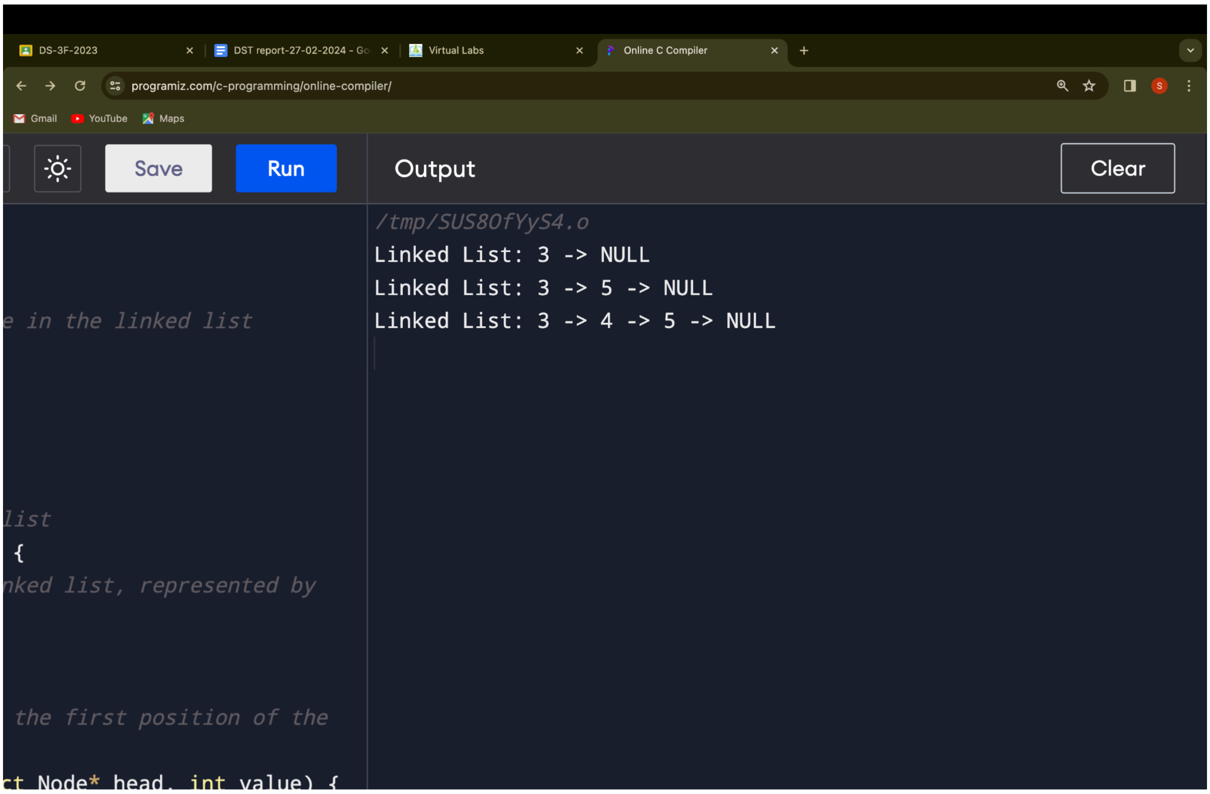
list.

```
#include <stdio.h>

#include <stdlib.h>

// Structure to represent a node in the linked list

struct Node {

   int data;

   struct Node* next;

};

// Function to create a linked list

struct Node* createLinkedList() {

   return NULL; // An empty linked list, represented by NULL

}

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

```c
struct Node* insertAtFirst(struct Node* head, int value) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = 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 = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = 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. Cannot insert at position %d\n", position);
      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* insertAtEnd(struct Node* head, int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = value;
    newNode->next = NULL;

    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 displayLinkedList(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* linkedList = createLinkedList();
```

```
    // Insert at first position
    linkedList = insertAtFirst(linkedList, 3);
    displayLinkedList(linkedList);

    // Insert at end
    linkedList = insertAtEnd(linkedList, 5);
    displayLinkedList(linkedList);

    // Insert at any position
    linkedList = insertAtPosition(linkedList, 4, 2);
    displayLinkedList(linkedList);

    return 0;
}
```



Lab program 6:

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.

Display the contents of the linked

list.

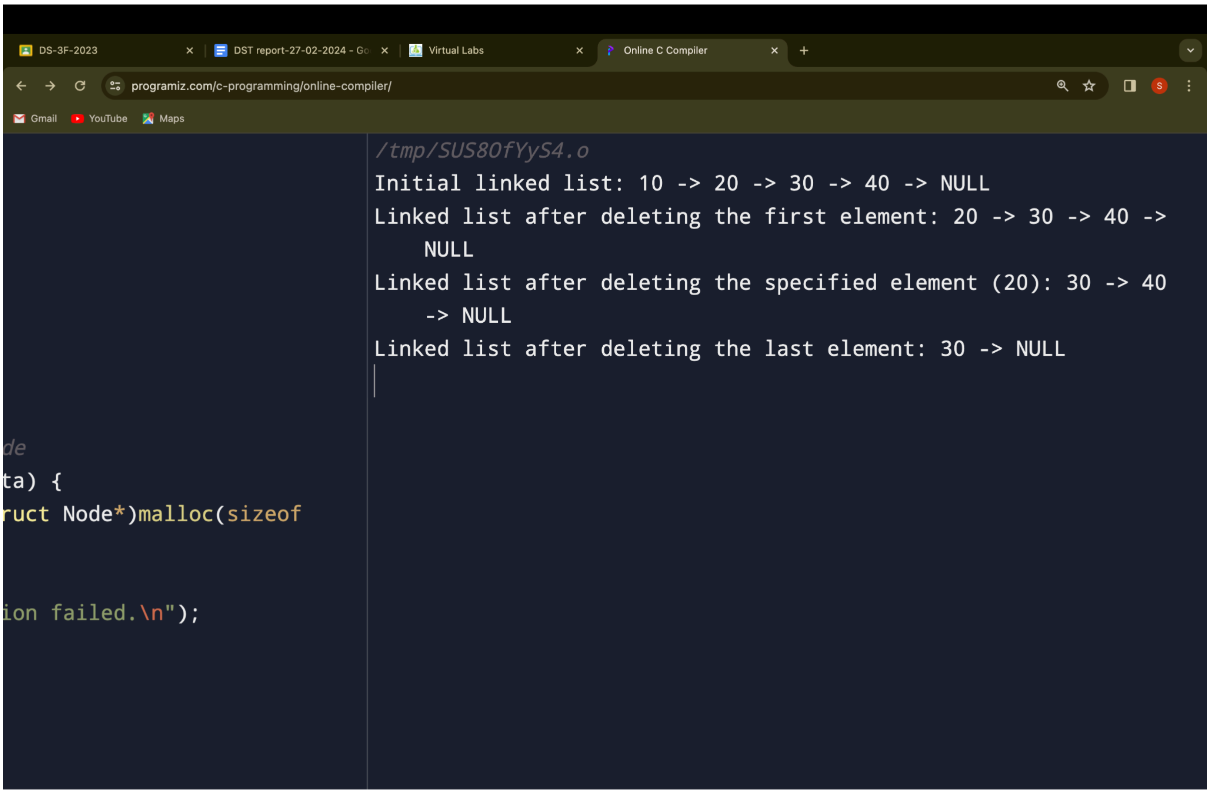
```
#include <stdio.h>

#include <stdlib.h>


// Node structure

struct Node {

    int data;

    struct Node* next;

};


// Function to create a new node

struct Node* createNode(int data) {

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

    if (newNode == NULL) {

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

        exit(1);

    }
```

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

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

// Function to delete the first node in the list
void deleteFirst(struct Node** head) {
    if (*head == NULL) {
        printf("List is empty. Cannot delete.\n");
        return;
    }
    struct Node* temp = *head;
    *head = (*head)->next;
    free(temp);
}
```

```
// Function to delete a specified node in the list
void deleteNode(struct Node** head, int key) {
    if (*head == NULL) {
        printf("List is empty. Cannot delete.\n");
        return;
    }
    struct Node* temp = *head;
    struct Node* prev = NULL;
    while (temp != NULL && temp->data != key) {
        prev = temp;
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Element not found in the list.\n");
        return;
    }
    if (prev == NULL) {
        *head = temp->next;
    } else {
        prev->next = temp->next;
    }
    free(temp);
}

// Function to delete the last node in the list
void deleteLast(struct Node** head) {
    if (*head == NULL) {
        printf("List is empty. Cannot delete.\n");
```

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

// Function to display the contents of the linked list
void displayList(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;
```

```
    // Create a linked list
    insertEnd(&head, 10);
    insertEnd(&head, 20);
    insertEnd(&head, 30);
    insertEnd(&head, 40);

    // Display the initial list
    printf("Initial linked list: ");
    displayList(head);

    // Delete the first element
    deleteFirst(&head);
    printf("Linked list after deleting the first element: ");
    displayList(head);

    // Delete a specified element (e.g., 20)
    deleteNode(&head, 20);
    printf("Linked list after deleting the specified element (20): ");
    displayList(head);

    // Delete the last element
    deleteLast(&head);
    printf("Linked list after deleting the last element: ");
    displayList(head);

    return 0;
}
```



Lab program 7:

sll-sort,reverse,concatination

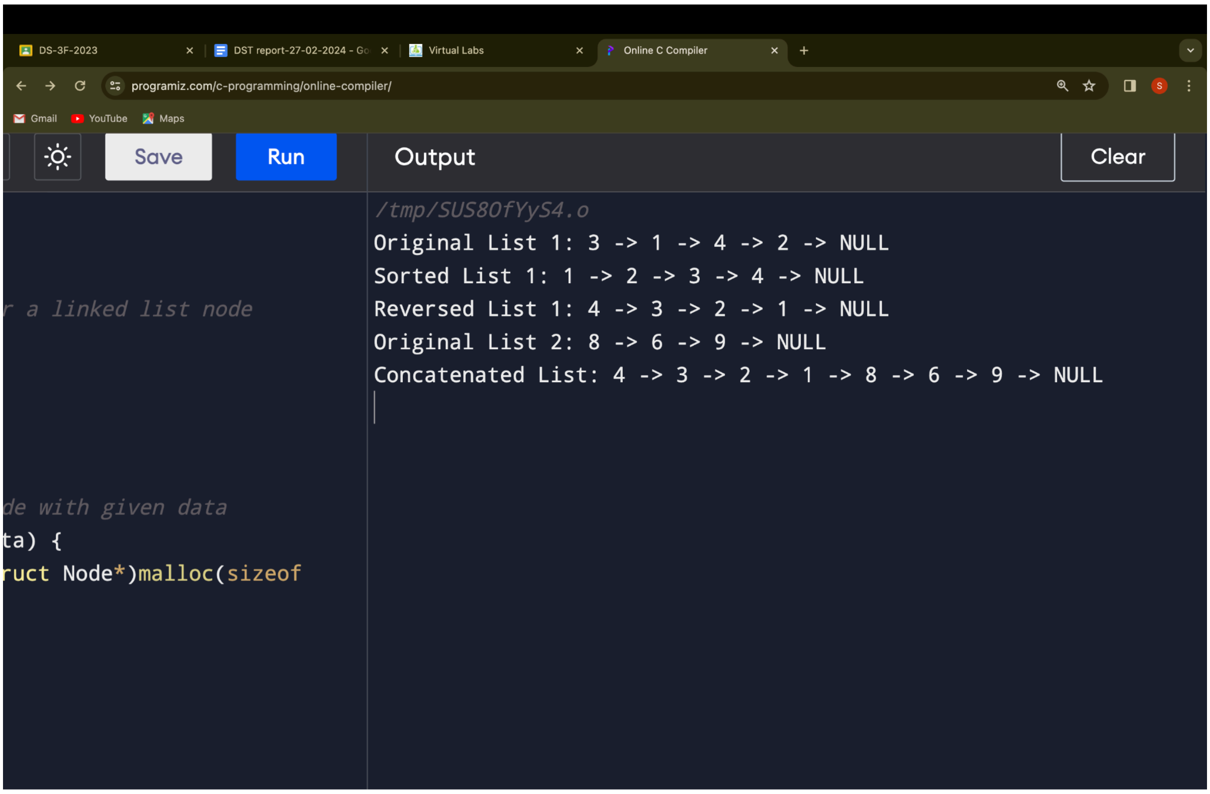
```
#include <stdio.h>

#include <stdlib.h>


// Define a basic structure for a linked list node

struct Node {

    int data;

    struct Node* next;

};


// Function to create a new node with given data

struct Node* createNode(int data) {

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

    newNode->data = data;

    newNode->next = NULL;

    return newNode;
```

```c
}

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

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

// Function to reverse the linked list
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 merge two linked lists
struct Node* concatenateLists(struct Node* list1, struct Node* list2) {
    if (list1 == NULL) {
        return list2;
    }

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

    temp->next = list2;
    return list1;
}

// Function to perform a bubble sort on the linked list
void bubbleSort(struct Node* head) {
    int swapped;
    struct Node* ptr1;
    struct Node* lptr = NULL;

    // Checking for empty list
```

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

    do {
        swapped = 0;
        ptr1 = head;

        while (ptr1->next != lptr) {
            if (ptr1->data > ptr1->next->data) {
                // Swap the data of the nodes
                int temp = ptr1->data;
                ptr1->data = ptr1->next->data;
                ptr1->next->data = temp;

                swapped = 1;
            }
            ptr1 = ptr1->next;
        }
        lptr = ptr1;
    } while (swapped);
}

int main() {
    // Creating and displaying the first linked list
    struct Node* list1 = NULL;
    insertAtEnd(&list1, 3);
    insertAtEnd(&list1, 1);
    insertAtEnd(&list1, 4);
    insertAtEnd(&list1, 2);
    printf("Original List 1: ");
    printList(list1);
```

```
    // Sorting the first linked list
    bubbleSort(list1);
    printf("Sorted List 1: ");
    printList(list1);

    // Reversing the first linked list
    list1 = reverseList(list1);
    printf("Reversed List 1: ");
    printList(list1);

    // Creating and displaying the second linked list
    struct Node* list2 = NULL;
    insertAtEnd(&list2, 8);
    insertAtEnd(&list2, 6);
    insertAtEnd(&list2, 9);
    printf("Original List 2: ");
    printList(list2);

    // Concatenating the two linked lists
    list1 = concatenateLists(list1, list2);
    printf("Concatenated List: ");
    printList(list1);

    return 0;
}
```



Lab program 8:

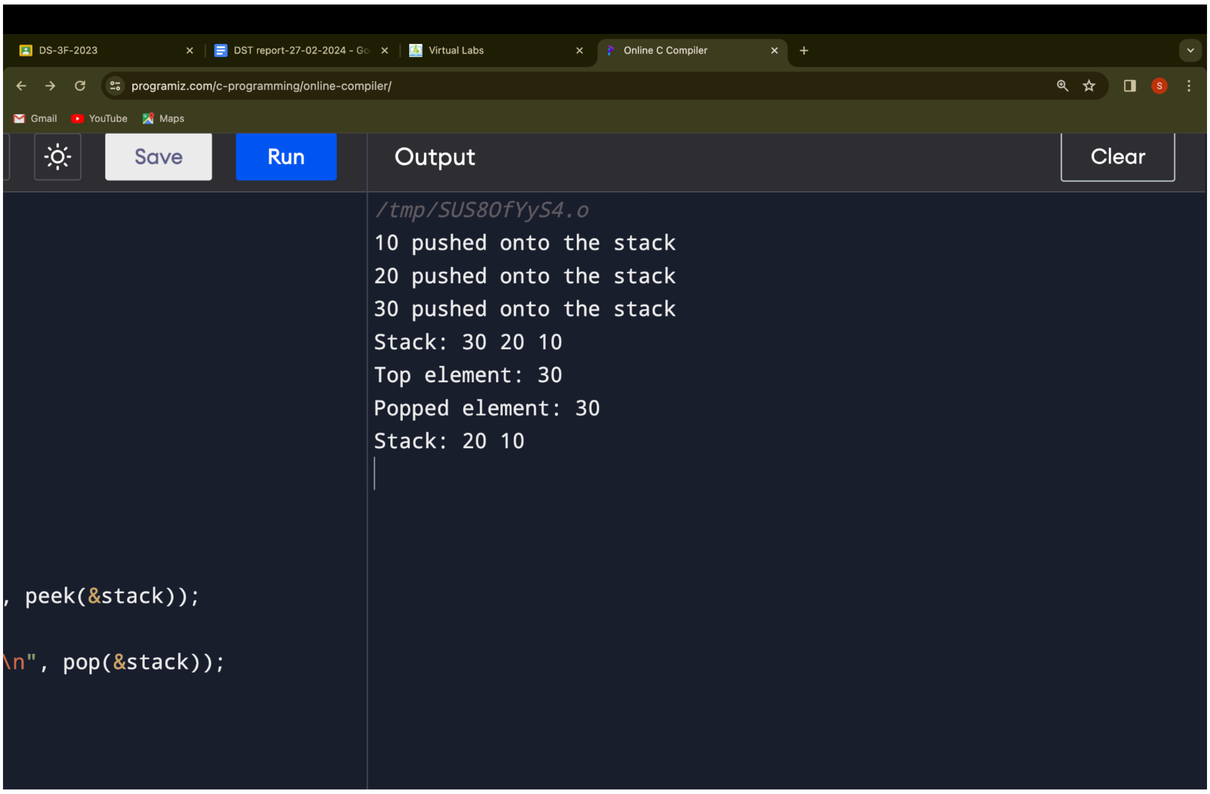
.Stack implementation using single linked list

```
#include <stdio.h>

#include <stdlib.h>


// Node structure for the linked list

typedef struct Node {

    int data;

    struct Node* next;

} Node;


// Stack structure

typedef struct Stack {

    Node* top;

} Stack;


// Function to initialize an empty stack

void initialize(Stack* stack) {
```

```
    stack->top = NULL;
}

// Function to check if the stack is empty
int isEmpty(Stack* stack) {
    return (stack->top == NULL);
}

// Function to push an element onto the stack
void push(Stack* stack, int data) {
    Node* newNode = (Node*)malloc(sizeof(Node));
    if (newNode == NULL) {
        printf("Memory allocation failed\n");
        return;
    }

    newNode->data = data;
    newNode->next = stack->top;
    stack->top = newNode;

    printf("%d pushed onto the stack\n", data);
}

// Function to pop an element from the stack
int pop(Stack* stack) {
    if (isEmpty(stack)) {
        printf("Stack underflow\n");
        return -1; // Return an invalid value indicating stack underflow
    }

    Node* temp = stack->top;
    int poppedData = temp->data;
```

```
    stack->top = temp->next;
    free(temp);

    return poppedData;
}

// Function to get the top element of the stack without removing it
int peek(Stack* stack) {
    if (isEmpty(stack)) {
        printf("Stack is empty\n");
        return -1; // Return an invalid value indicating an empty stack
    }

    return stack->top->data;
}

// Function to display the elements of the stack
void display(Stack* stack) {
    if (isEmpty(stack)) {
        printf("Stack is empty\n");
        return;
    }

    Node* current = stack->top;
    printf("Stack: ");
    while (current != NULL) {
        printf("%d ", current->data);
        current = current->next;
    }
    printf("\n");
}
```

```c
// Function to free the memory used by the stack
void destroy(Stack* stack) {
    while (!isEmpty(stack)) {
        pop(stack);
    }
}

int main() {
    Stack stack;
    initialize(&stack);

    push(&stack, 10);
    push(&stack, 20);
    push(&stack, 30);

    display(&stack);

    printf("Top element: %d\n", peek(&stack));

    printf("Popped element: %d\n", pop(&stack));
    display(&stack);

    destroy(&stack);

    return 0;
}
```



Lab program 9:

.Queue implementation using single linked list

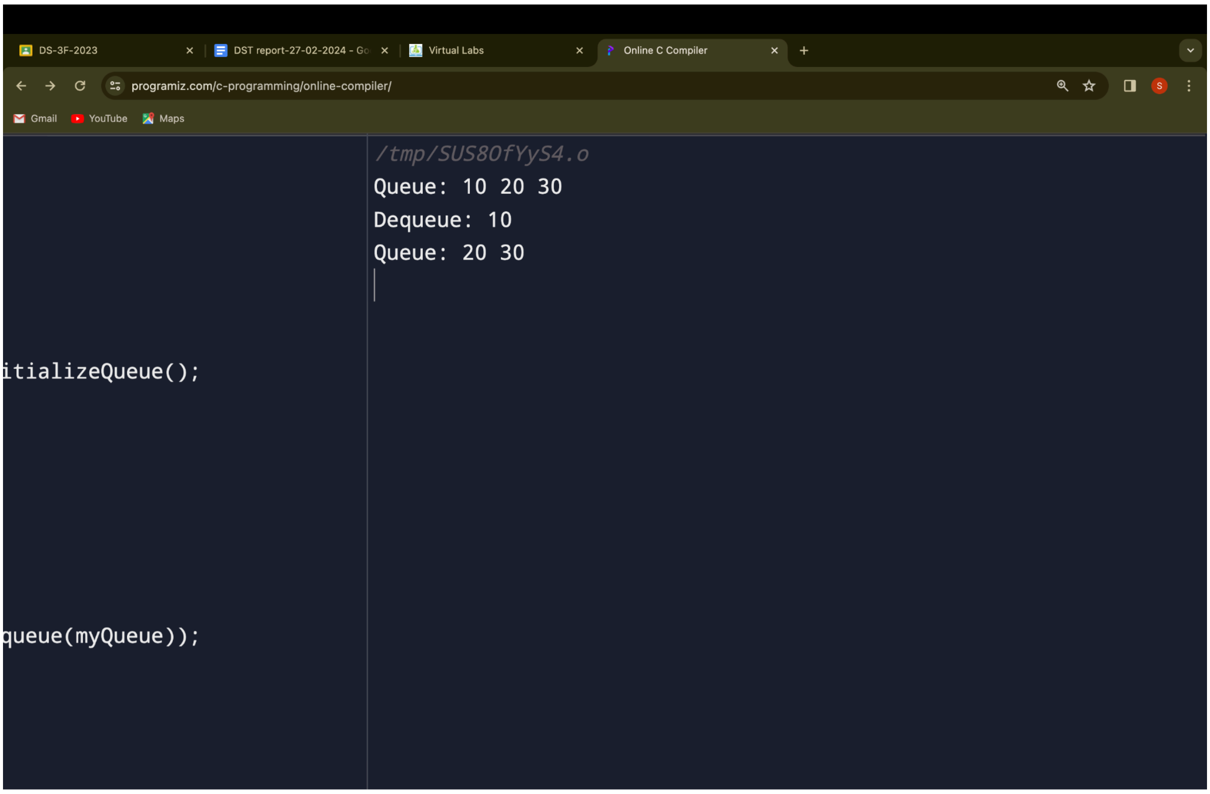
```
#include <stdio.h>

#include <stdlib.h>


// Node structure

struct Node {

    int data;

    struct Node* next;

};


// Queue structure

struct Queue {

    struct Node* front;

    struct Node* rear;

};


// 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(EXIT_FAILURE);
    }
    newNode->data = value;
    newNode->next = NULL;
    return newNode;
}

// Function to initialize a queue
struct Queue* initializeQueue() {
    struct Queue* queue = (struct Queue*)malloc(sizeof(struct Queue));
    if (queue == NULL) {
        printf("Memory allocation failed.\n");
        exit(EXIT_FAILURE);
    }
    queue->front = queue->rear = NULL;
    return queue;
}

// Function to check if the queue is empty
int isEmpty(struct Queue* queue) {
    return (queue->front == NULL);
}

// Function to enqueue (insert) an element into the queue
void enqueue(struct Queue* queue, int value) {
    struct Node* newNode = createNode(value);
    if (isEmpty(queue)) {
        queue->front = queue->rear = newNode;
```

```
  } else {
    queue->rear->next = newNode;
    queue->rear = newNode;
  }
}

// Function to dequeue (remove) an element from the queue
int dequeue(struct Queue* queue) {
  if (isEmpty(queue)) {
    printf("Queue is empty. Cannot dequeue.\n");
    exit(EXIT_FAILURE);
  }

  struct Node* temp = queue->front;
  int value = temp->data;

  queue->front = temp->next;
  free(temp);

  if (queue->front == NULL) {
    queue->rear = NULL; // If the last element is dequeued, update the rear pointer
  }

  return value;
}

// Function to display the elements in the queue
void displayQueue(struct Queue* queue) {
  if (isEmpty(queue)) {
    printf("Queue is empty.\n");
    return;
  }
```

```
    struct Node* current = queue->front;
    printf("Queue: ");
    while (current != NULL) {
        printf("%d ", current->data);
        current = current->next;
    }
    printf("\n");
}

// Function to free the allocated memory for the queue
void freeQueue(struct Queue* queue) {
    while (!isEmpty(queue)) {
        dequeue(queue);
    }
    free(queue);
}

int main() {
    struct Queue* myQueue = initializeQueue();

    enqueue(myQueue, 10);
    enqueue(myQueue, 20);
    enqueue(myQueue, 30);

    displayQueue(myQueue);

    printf("Dequeue: %d\n", dequeue(myQueue));

    displayQueue(myQueue);

    freeQueue(myQueue);
```

```
    return 0;
}
```



Lab program 10:

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**

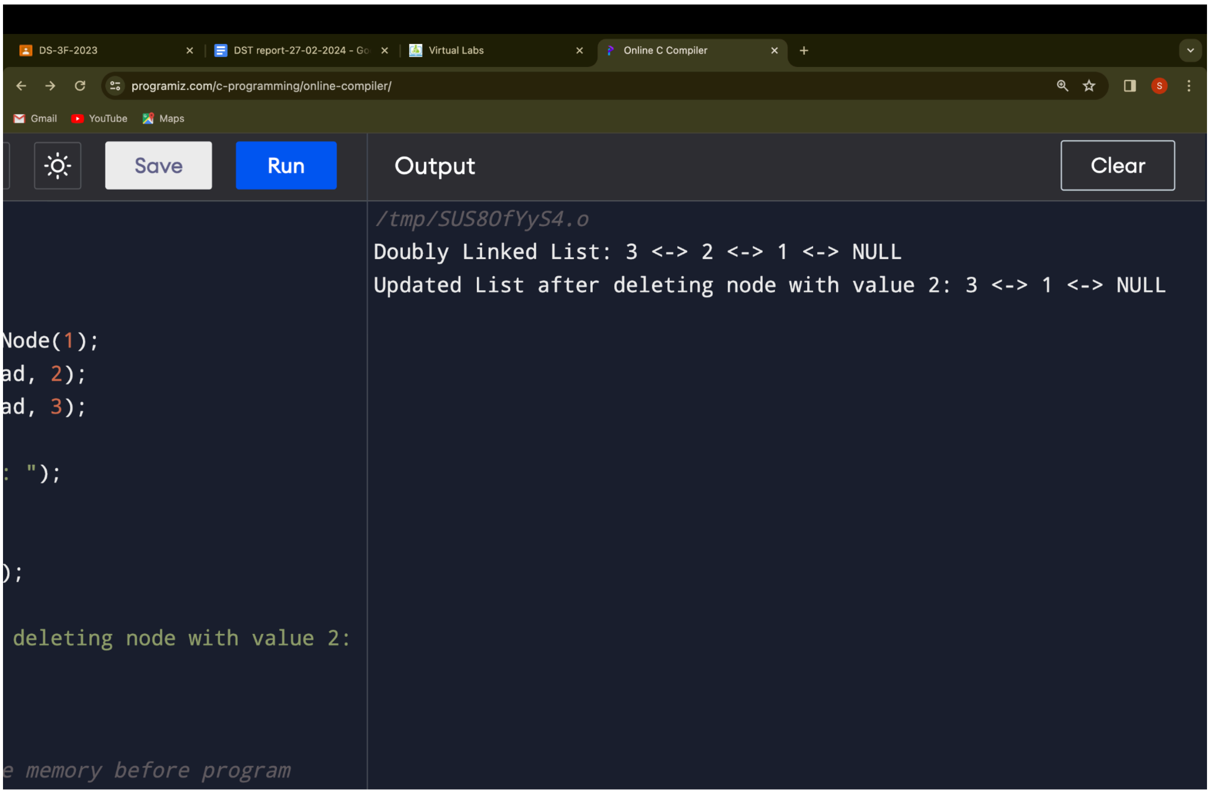
```
#include <stdio.h>
#include <stdlib.h>

// Node structure for doubly linked list
struct Node {
    int data;
    struct Node* prev;
```

```c
    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 new node to the left of the given node
void insertNodeToLeft(struct Node** head, struct Node* target, int data) {
    struct Node* newNode = createNode(data);

    // If the target node is the head
    if (*head == target) {
        newNode->next = *head;
        (*head)->prev = newNode;
        *head = newNode;
    } else {
        newNode->next = target;
        newNode->prev = target->prev;
        target->prev->next = newNode;
        target->prev = newNode;
    }
}
```

```
// Function to delete a node based on a specific value
void deleteNodeByValue(struct Node** head, int value) {
  struct Node* current = *head;

  // Traverse the list to find the node with the given value
  while (current != NULL && current->data != value) {
    current = current->next;
  }

  // If the node with the given value is found
  if (current != NULL) {
    // If the node is the head
    if (current->prev == NULL) {
      *head = current->next;
      if (*head != NULL) {
        (*head)->prev = NULL;
      }
    } else {
      current->prev->next = current->next;
      if (current->next != NULL) {
        current->next->prev = current->prev;
      }
    }

    // Free the memory occupied by the deleted node
    free(current);
  } else {
    printf("Node with value %d not found.\n", value);
  }
}
```

```
// Function to print the doubly linked list
void printList(struct Node* head) {
    while (head != NULL) {
        printf("%d <-> ", head->data);
        head = head->next;
    }
    printf("NULL\n");
}

// Function to free the memory occupied by the doubly linked list
void freeList(struct Node* head) {
    struct Node* temp;
    while (head != NULL) {
        temp = head;
        head = head->next;
        free(temp);
    }
}

int main() {
    struct Node* head = createNode(1);
    insertNodeToLeft(&head, head, 2);
    insertNodeToLeft(&head, head, 3);

    printf("Doubly Linked List: ");
    printList(head);

    deleteNodeByValue(&head, 2);

    printf("Updated List after deleting node with value 2: ");
    printList(head);
```

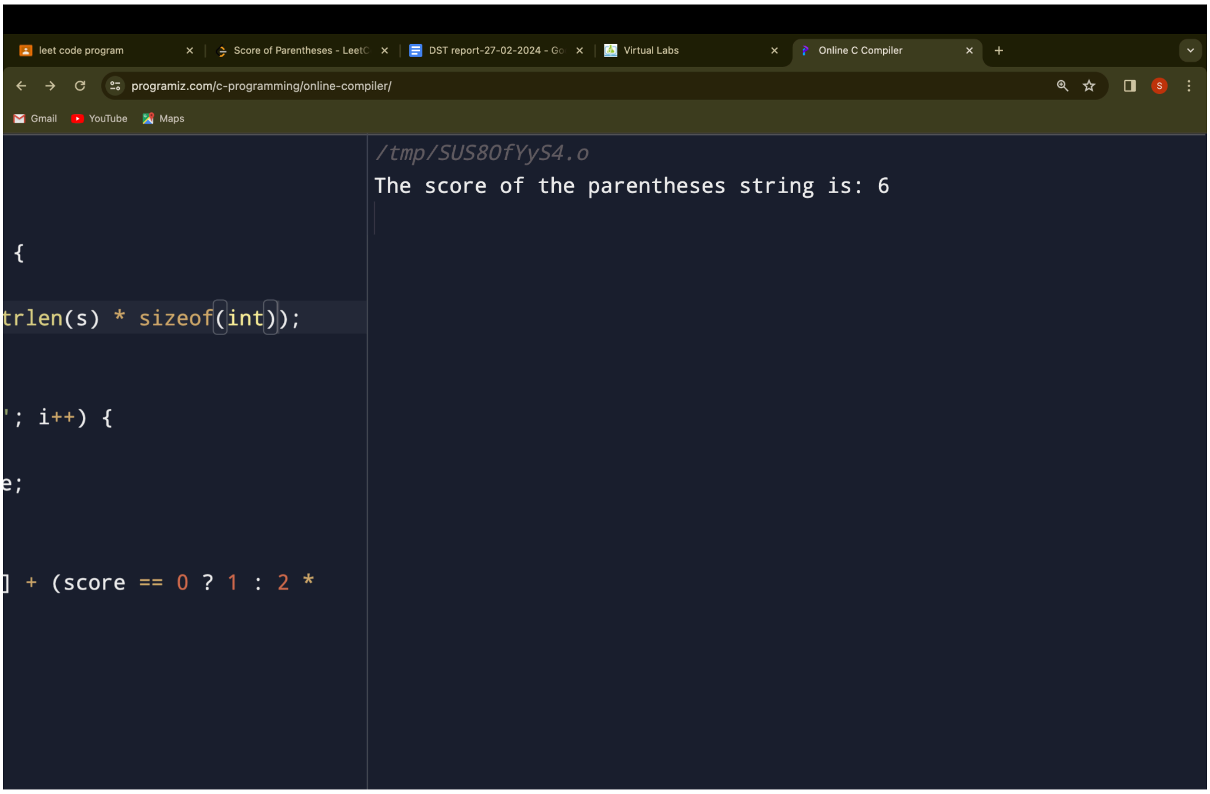
```
    freeList(head); // Free the memory before program termination

    return 0;

}
```



Lab program 11:

```
#include <stdio.h>
#include <stdlib.h>
int scoreOfParentheses(char* s) {
    int score = 0;
    int* stack = (int*)malloc(strlen(s) * sizeof(int));
    int top = -1;
    for (int i = 0; s[i] != '\0'; i++) {
        if (s[i] == '(') {
            stack[++top] = score;
            score = 0;
        } else {
            score = stack[top--] + (score == 0 ? 1 : 2
* score);
        }
    }
```

```
    free(stack);
    return score;
}
int main() {
    char input[] = "(()(()))";
    int result = scoreOfParentheses(input);
    printf("The score of the parentheses string is:
%d\n", result);
    return 0;
}
```



Lab program 12:

```
struct ListNode* oddEvenList(struct ListNode* head) {
   if (head == NULL || head->next == NULL) {
      return head;
   }

   struct ListNode* odd = head;
   struct ListNode* even = head->next;
```

```
    struct ListNode* evenHead = even;

    while (even != NULL && even->next != NULL) {
        odd->next = even->next;
        odd = odd->next;
        even->next = odd->next;
        even = even->next;
    }

    odd->next = evenHead;

    return head;
}
```

Lab program 13:

```
struct ListNode* deleteMiddle(struct ListNode* head) {
    struct ListNode *ptr,*temp;
    int count=0,n=0;
    ptr=head;
    while(ptr!=NULL){
        n++;
        ptr=ptr->next;
    }
    ptr=head;
    if(n==1) {
        return 0;
    }
    while(count!=n/2) {
        temp=ptr;
        count++;
```

```
        ptr=ptr->next;
    }
    temp->next=ptr->next;
    ptr=NULL;
    free(ptr);
    return head;

}
```

Lab program 14:

Write a program.

a. To construct Binary Search tree

b. Traverse the tree using inorder , postorder, preorder.

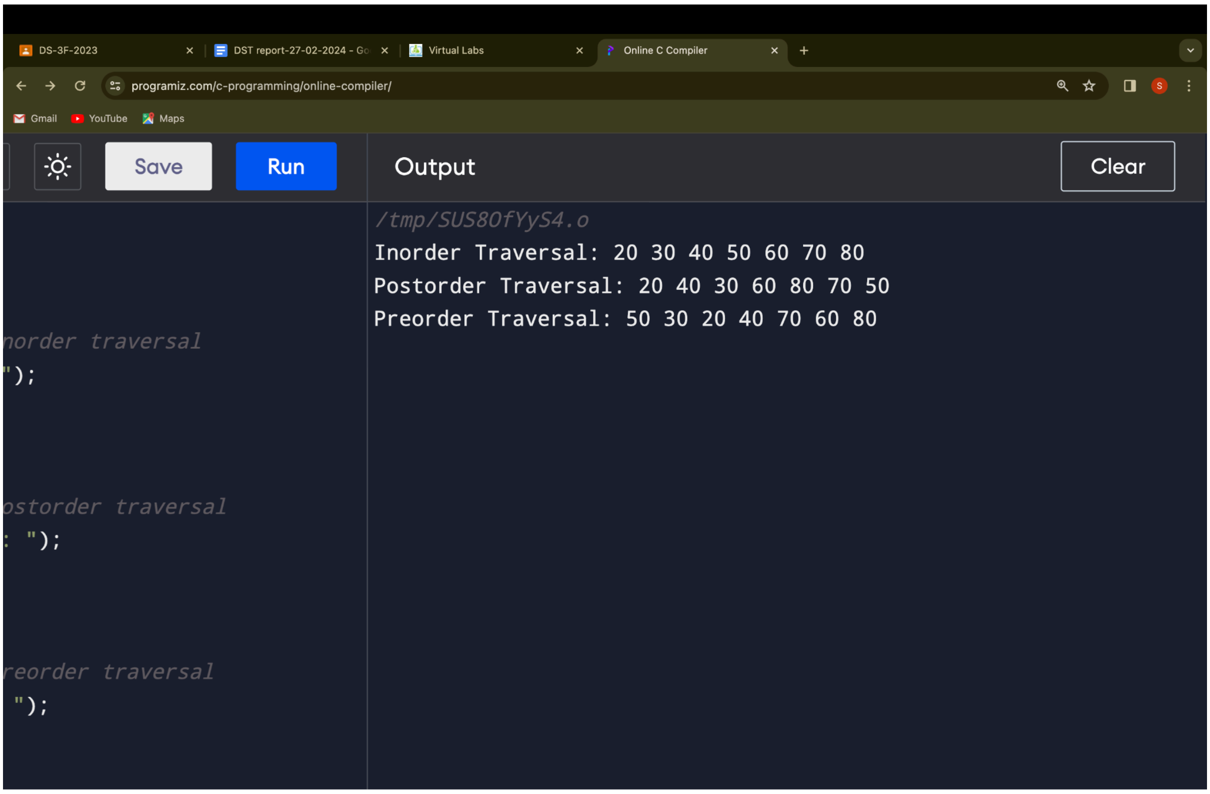
c. Display the elements in the tree.

```
#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 with given data
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->left = newNode->right = NULL;
    return newNode;
}
```

```c
// Function to insert a new node into the Binary Search Tree
struct Node* insertNode(struct Node* root, int data) {
   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;
}

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

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

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

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

  // Insert elements into the BST
  root = insertNode(root, 50);
  insertNode(root, 30);
  insertNode(root, 20);
  insertNode(root, 40);
  insertNode(root, 70);
  insertNode(root, 60);
  insertNode(root, 80);

  // Display elements using inorder traversal
  printf("Inorder Traversal: ");
  inorderTraversal(root);
  printf("\n");

  // Display elements using postorder traversal
  printf("Postorder Traversal: ");
  postorderTraversal(root);
  printf("\n");

  // Display elements using preorder traversal
```

```
    printf("Preorder Traversal: ");
    preorderTraversal(root);
    printf("\n");

    return 0;
}
```



Lab program 15:

1.BFS

2.DFS

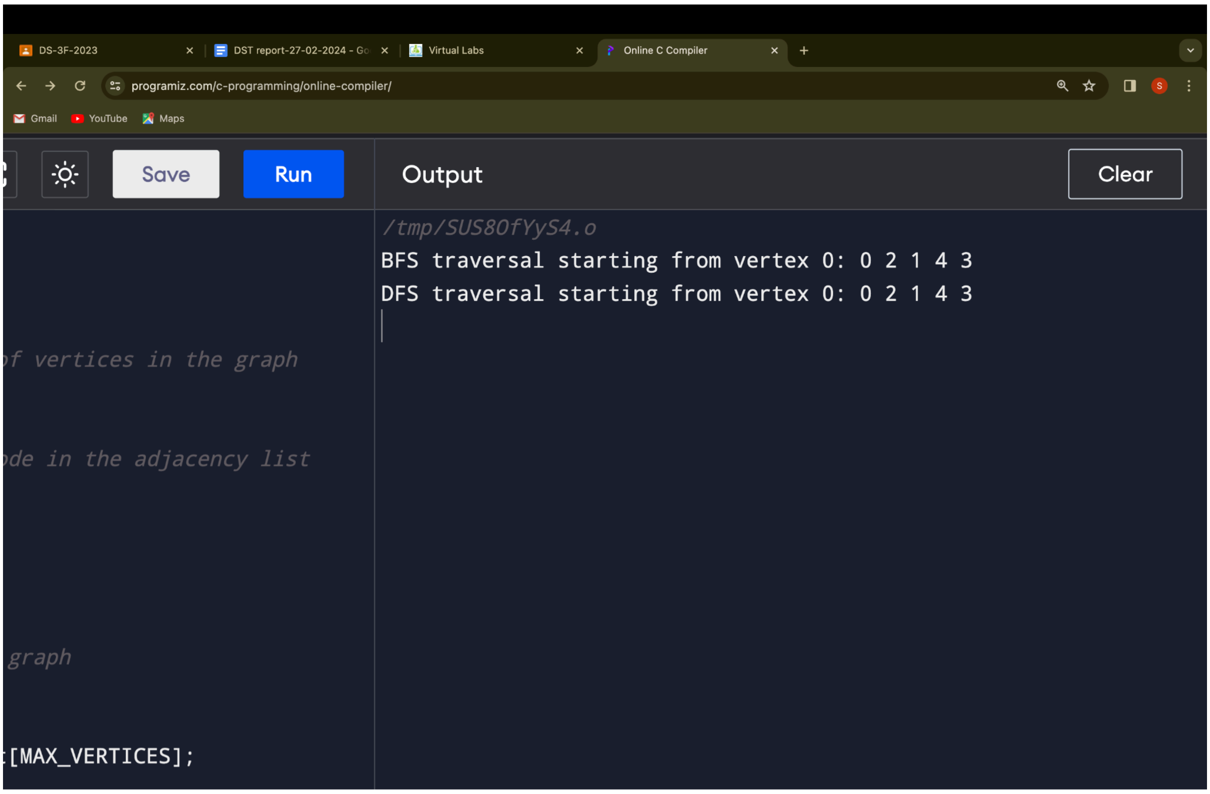
```
#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>

// Define the maximum number of vertices in the graph
#define MAX_VERTICES 100

// Structure to represent a node in the adjacency list
```

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

// Structure to represent the graph
struct Graph {
    int numVertices;
    struct Node* adjacencyList[MAX_VERTICES];
};

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

// Function to create a graph with the given number of vertices
struct Graph* createGraph(int numVertices) {
    struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
    graph->numVertices = numVertices;

    // Initialize adjacency list
    for (int i = 0; i < numVertices; ++i) {
        graph->adjacencyList[i] = NULL;
    }

    return graph;
}
```

```c
// Function to add an edge to the graph
void addEdge(struct Graph* graph, int src, int dest) {
   // Add edge from src to dest
   struct Node* newNode = createNode(dest);
   newNode->next = graph->adjacencyList[src];
   graph->adjacencyList[src] = newNode;

   // Add edge from dest to src (assuming undirected graph)
   newNode = createNode(src);
   newNode->next = graph->adjacencyList[dest];
   graph->adjacencyList[dest] = newNode;
}

// BFS traversal of the graph
void BFS(struct Graph* graph, int startVertex) {
   // Array to keep track of visited vertices
   bool visited[MAX_VERTICES] = {false};

   // Queue for BFS
   int queue[MAX_VERTICES];
   int front = 0, rear = 0;

   // Mark the start vertex as visited and enqueue it
   visited[startVertex] = true;
   queue[rear++] = startVertex;

   // BFS loop
   while (front < rear) {
      // Dequeue a vertex from the queue and print it
      int currentVertex = queue[front++];
      printf("%d ", currentVertex);
```

```
        // Explore adjacent vertices
        struct Node* temp = graph->adjacencyList[currentVertex];
        while (temp != NULL) {
            int adjVertex = temp->data;
            if (!visited[adjVertex]) {
                visited[adjVertex] = true;
                queue[rear++] = adjVertex;
            }
            temp = temp->next;
        }
    }
}

// DFS traversal of the graph
void DFSUtil(struct Graph* graph, int currentVertex, bool visited[]) {
    // Mark the current vertex as visited and print it
    visited[currentVertex] = true;
    printf("%d ", currentVertex);

    // Recur for all the adjacent vertices
    struct Node* temp = graph->adjacencyList[currentVertex];
    while (temp != NULL) {
        int adjVertex = temp->data;
        if (!visited[adjVertex]) {
            DFSUtil(graph, adjVertex, visited);
        }
        temp = temp->next;
    }
}

void DFS(struct Graph* graph, int startVertex) {
    // Array to keep track of visited vertices
```

```
    bool visited[MAX_VERTICES] = {false};

    // Call the DFS utility function
    DFSUtil(graph, startVertex, visited);
}

// Driver program
int main() {
    // Create a graph with 5 vertices
    struct Graph* graph = createGraph(5);

    // Add edges
    addEdge(graph, 0, 1);
    addEdge(graph, 0, 2);
    addEdge(graph, 1, 3);
    addEdge(graph, 1, 4);

    // Print BFS traversal starting from vertex 0
    printf("BFS traversal starting from vertex 0: ");
    BFS(graph, 0);
    printf("\n");

    // Reset visited array for DFS
    bool visited[MAX_VERTICES] = {false};

    // Print DFS traversal starting from vertex 0
    printf("DFS traversal starting from vertex 0: ");
    DFS(graph, 0);
    printf("\n");

    return 0;
}
```



Lab program 15:

Leetcode -Delete a node in BST

```
struct TreeNode* findMinValueNode(struct TreeNode* node) {
    while (node->left != NULL) {
        node = node->left;
    }
    return node;
}

struct TreeNode* deleteNode(struct TreeNode* root, int key) {
    struct TreeNode* current = root;
    struct TreeNode* parent = NULL;

    // Find the node to be deleted and its parent
    while (current != NULL && current->val != key) {
        parent = current;
        if (key < current->val) {
            current = current->left;
```

```
    } else {
        current = current->right;
    }
}

// If the key is not found
if (current == NULL) {
    return root;
}

// Case 1: Node with only one child or no child
if (current->left == NULL) {
    struct TreeNode* temp = current->right;
    if (parent == NULL) {
        // If the node to be deleted is the root
        free(current);
        return temp;
    } else {
        // Adjust the parent's pointer
        if (parent->left == current) {
            parent->left = temp;
        } else {
            parent->right = temp;
        }
        free(current);
        return root;
    }
} else if (current->right == NULL) {
    struct TreeNode* temp = current->left;
    if (parent == NULL) {
        // If the node to be deleted is the root
        free(current);
```

```
        return temp;
    } else {
        // Adjust the parent's pointer
        if (parent->left == current) {
            parent->left = temp;
        } else {
            parent->right = temp;
        }
        free(current);
        return root;
    }
}

// Case 3: Node with two children
struct TreeNode* minValueNode = findMinValueNode(current->right);
current->val = minValueNode->val;

// Delete the in-order successor
current->right = deleteNode(current->right, minValueNode->val);

return root;
}
```

Lab program 16:

```
void findBottomLeftValueHelper(struct TreeNode* root, int depth, int* maxDepth, int* result) {
    if (root == NULL) {
        return;
    }

    // Check if the current node is at a deeper level
    if (depth > *maxDepth) {
```

```
        *maxDepth = depth;
        *result = root->val;
    }

    // Recursive calls for the left and right subtrees
    findBottomLeftValueHelper(root->left, depth + 1, maxDepth, result);
    findBottomLeftValueHelper(root->right, depth + 1, maxDepth, result);
}

int findBottomLeftValue(struct TreeNode* root) {
   if (root == NULL) {
        return 0; // Or any suitable default value indicating an empty tree
    }

    int maxDepth = 0;
    int result = 0;

    findBottomLeftValueHelper(root, 1, &maxDepth, &result);

    return result;
}
```