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
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This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by SULAIMAN AHMED **(1BM22CS295)**, 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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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>

```c
#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);
    }
}
```

```c
// 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;
```

```c
    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;
}
```



```
/tmp/SUS80fYyS4.o
Enter an infix expression: (a+b)*(c-d)/e


Postfix expression: ab+cd-*e/
```

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.

```c
#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
```

```c
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;
```

```c
    }

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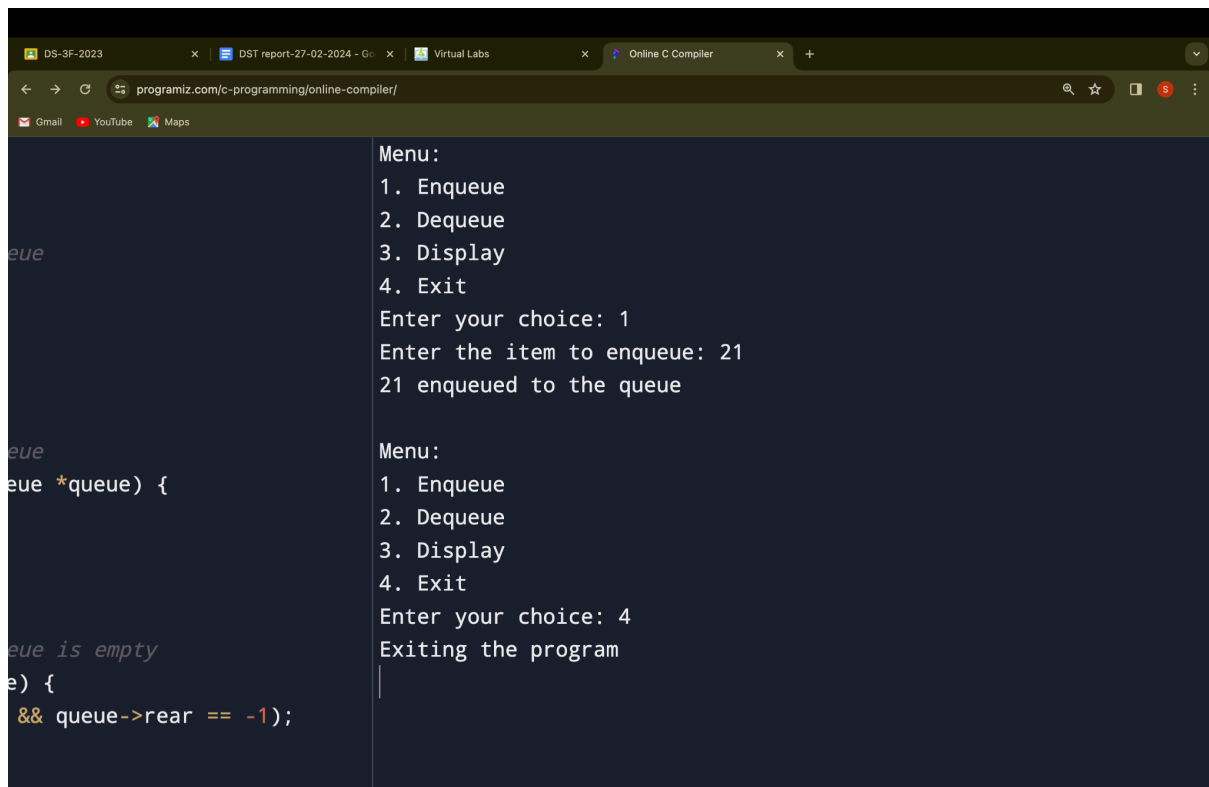
```c
        printf("3. Display\n");
        printf("4. Exit\n");

        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;
}
```

```
Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the item to enqueue: 21
21 enqueued to the queue

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 4
Exiting the program
```

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;

```c
    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) {
```

```c
    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);
```

```c
        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;
```

```c
        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.

```c
#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;

}
```

```c
// 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();
```

```c
// 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.

```c
#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);
    }
}
```

```c
    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);

}
```

```c
// 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");
```

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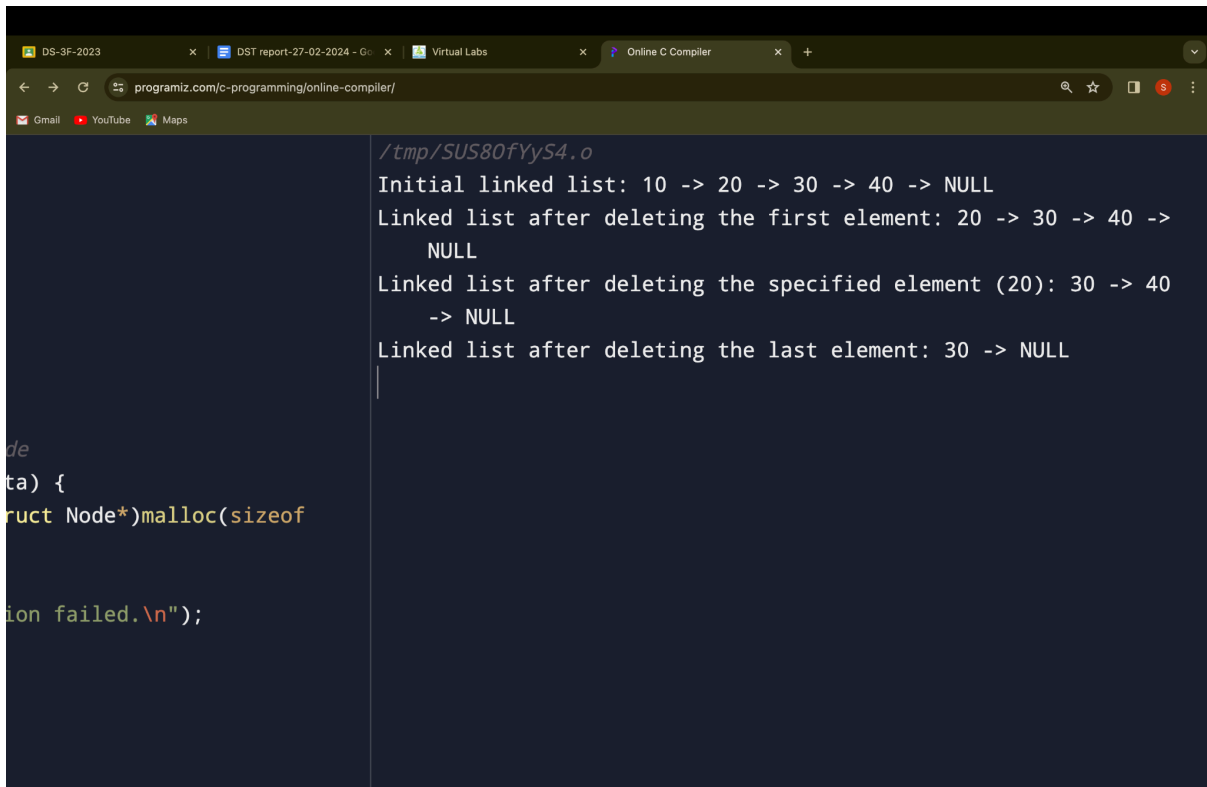
```c
    // Create a linked list
    insertEnd(&head, 10);
    insertEnd(&head, 20);
    insertEnd(&head, 30);
    insertEnd(&head, 40);

    // 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;
}
```

```
/tmp/SUS8OfYyS4.o
Initial linked list: 10 -> 20 -> 30 -> 40 -> NULL
Linked list after deleting the first element: 20 -> 30 -> 40 ->
    NULL
Linked list after deleting the specified element (20): 30 -> 40
    -> NULL
Linked list after deleting the last element: 30 -> NULL
```

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;
```

```c
    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
```

```c
    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);
```

```c
    // 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;
}
```
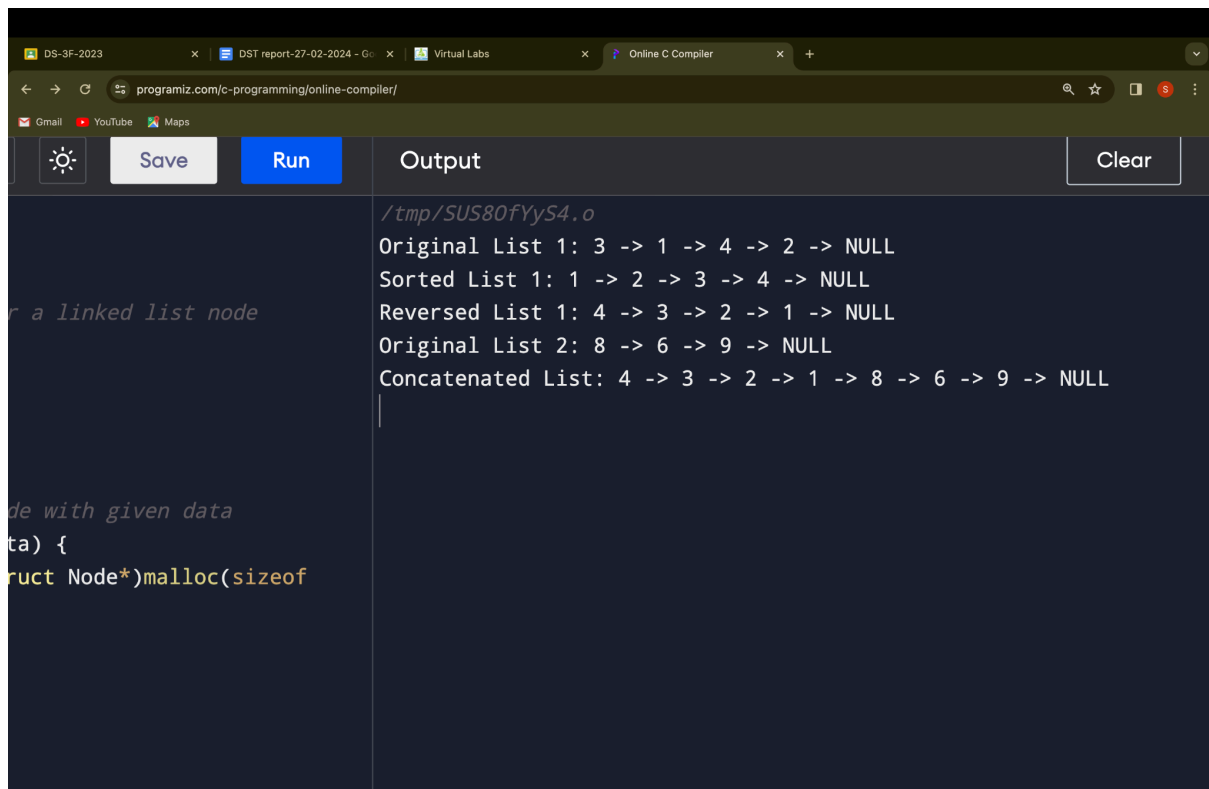
```
/tmp/SUS80fYyS4.o
Original List 1: 3 -> 1 -> 4 -> 2 -> NULL
Sorted List 1: 1 -> 2 -> 3 -> 4 -> NULL
Reversed List 1: 4 -> 3 -> 2 -> 1 -> NULL
Original List 2: 8 -> 6 -> 9 -> NULL
Concatenated List: 4 -> 3 -> 2 -> 1 -> 8 -> 6 -> 9 -> NULL
```

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) {

```c
    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;
```

```c
        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;
}
```

```
/tmp/SUS80fYyS4.o
10 pushed onto the stack
20 pushed onto the stack
30 pushed onto the stack
Stack: 30 20 10
Top element: 30
Popped element: 30
Stack: 20 10
```

```
, peek(&stack));

\n", pop(&stack));
```

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

```c
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;
```

```c
    } 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;
    }
```

```c
    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;
    }
}
```

```c
// 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);
    }
}
```

```c
// 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:

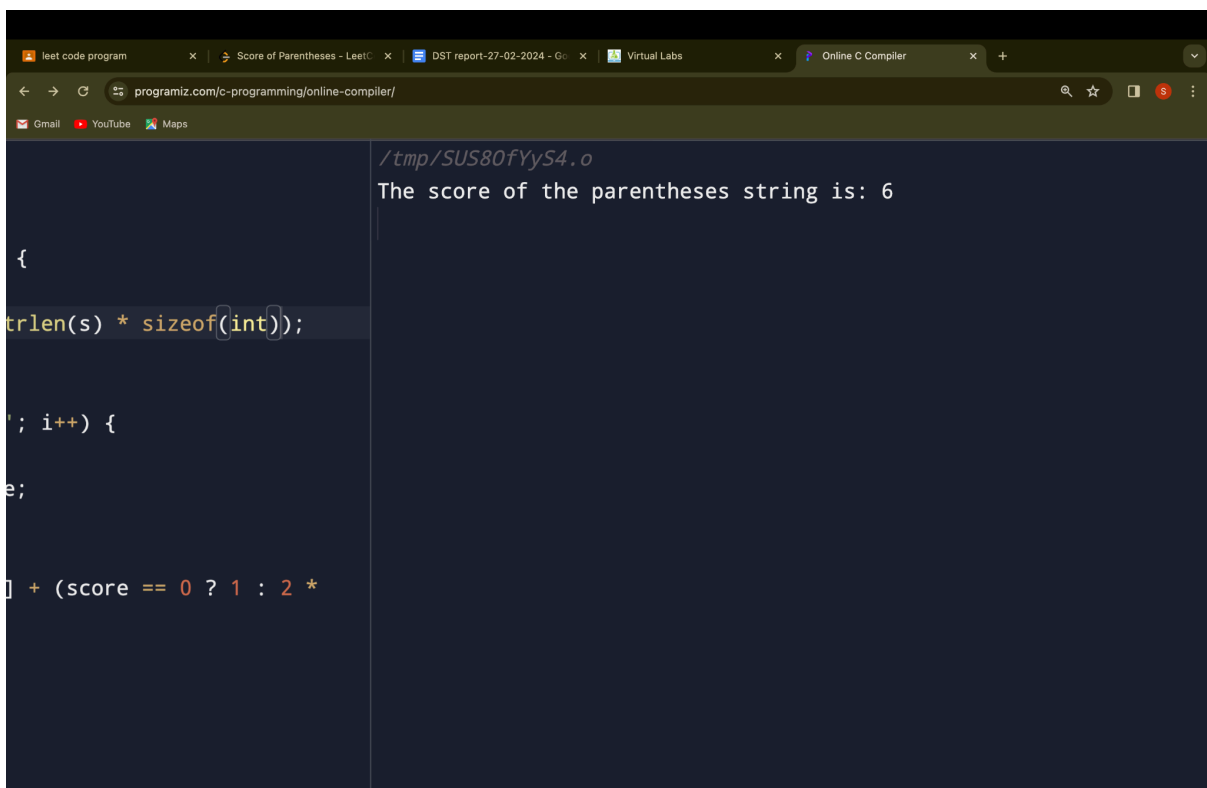```c
#include <stdio.h>
#include <stdlib.h>
int scoreOfParentheses(char* s) {
    int score = 0;
    int* stack = (int*)malloc(strlen(s) * sizeof(int));
    int top = -1;
    for (int i = 0; s[i] != '\0'; i++) {
        if (s[i] == '(') {
            stack[++top] = score;
            score = 0;
    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

```c
        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.

```c
#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);
    }
}
```

```c
// 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
```

```c
    printf("Preorder Traversal: ");

    preorderTraversal(root);

    printf("\n");


    return 0;
}
```


Lab program 15:

1.BFS

2.DFS

```c
#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);
```

```c
        // 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
```

```c
    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;
}
```
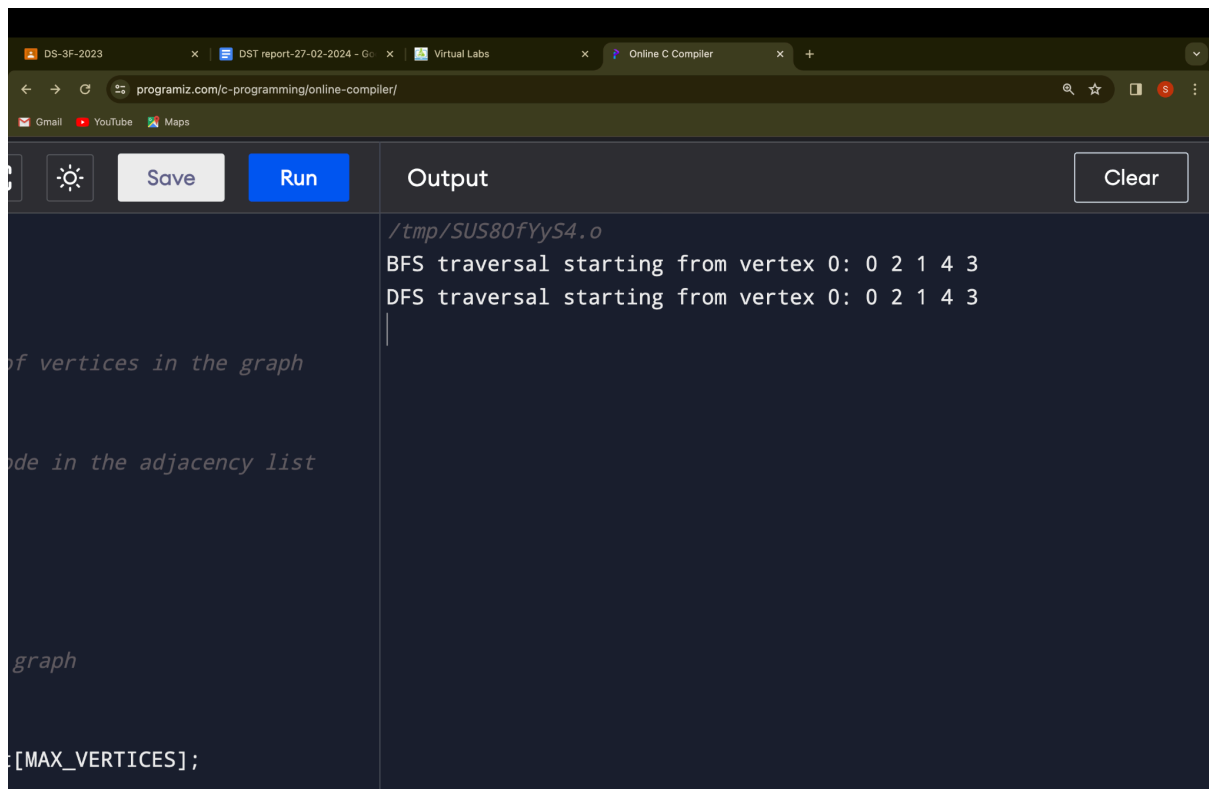
```
/tmp/SUS8OfYyS4.o
BFS traversal starting from vertex 0: 0 2 1 4 3
DFS traversal starting from vertex 0: 0 2 1 4 3
```

Lab program 15:

Leetcode -Delete a node in BST

```c
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;
```

```c
        } 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);
```

```c
        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:

```c
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) {
```

```c
        *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;

}
```