VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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(1BM22CS311)

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

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by TUSHAR TYAGI **(1BM22CS311)**, 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

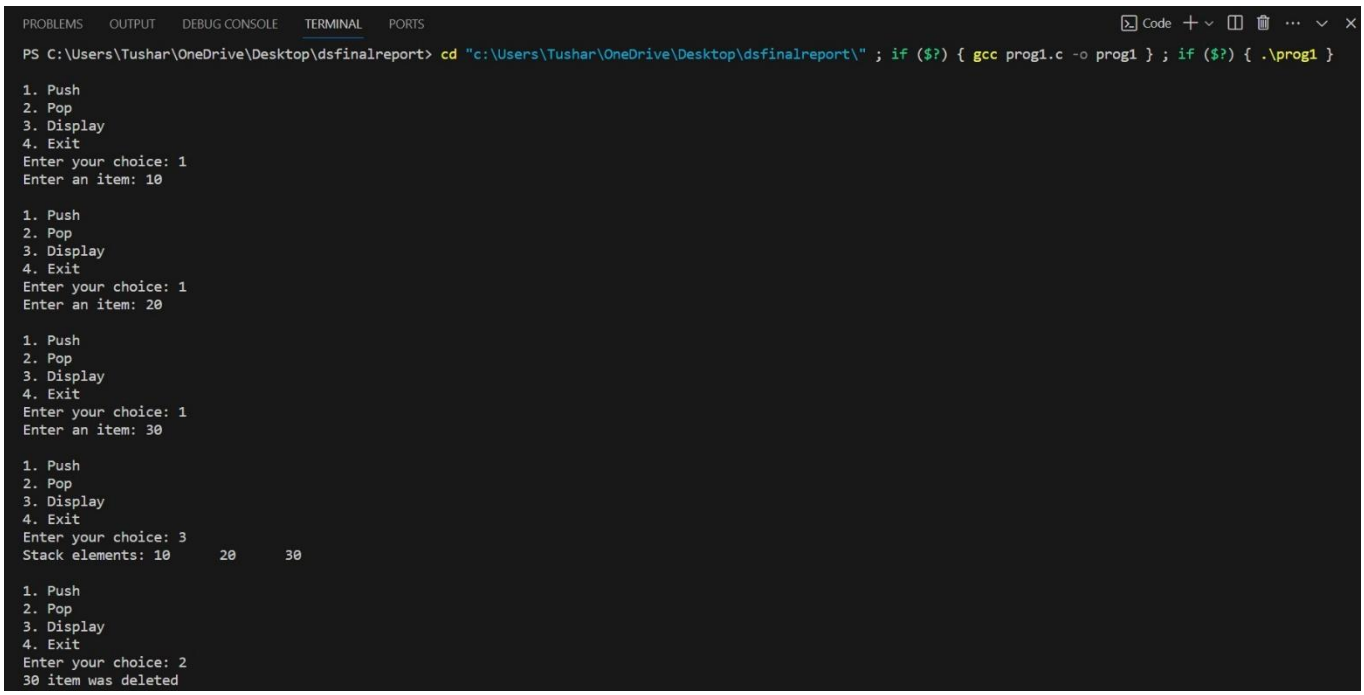
c) Display

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 {
        (*top)++;
        st[*top] = item;
    }
}

int pop(int st[], int *top) {
    int deletedItem;
    if (*top == -1) {
        printf("Stack underflow\n");
        return -1;
    } else {
        deletedItem = st[*top];
        (*top)--;
        return deletedItem;
    }
}

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

int main() {
    int st[STACK_SIZE];
    int top = -1, c, item;
```

```
    while (1) {
        printf("\n1. Push\n2. Pop\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &c);

        switch (c) {
            case 1:
                printf("Enter an item: ");
                scanf("%d", &item);
                push(st, &top, item);
                break;
            case 2:
                item = pop(st, &top);
                if (item != -1)
                    printf("%d item was deleted\n", item);
                break;
            case 3:
                display(st, &top);
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice!!!\n");
        }
    }

    return 0;
}
```

Output:



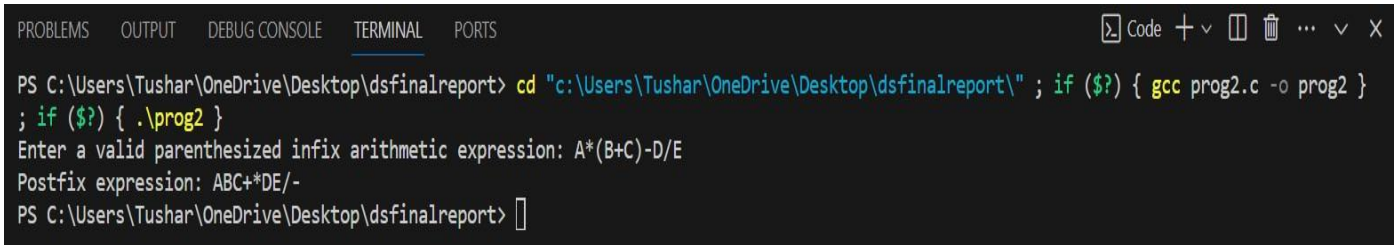
```
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
30 item was deleted

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
Stack elements: 10      20

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 4
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport>
```

LAB PROGRAM-2

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

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

#define MAX_SIZE 100

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

void initialize(Stack *s) {
    s->top = -1;
}

int isEmpty(Stack *s) {
    return s->top == -1;
}

int isFull(Stack *s) {
    return s->top == MAX_SIZE - 1;
}

void push(Stack *s, char c) {
    if (!isFull(s)) {
        s->items[++(s->top)] = c;
    }
}

char pop(Stack *s) {
    if (!isEmpty(s)) {
        return s->items[(s->top)--];
    }
    return '\0';
}

char peek(Stack *s) {
    if (!isEmpty(s)) {
        return s->items[s->top];
    }
    return '\0';
}
```

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

void infixToPostfix(char *infix, char *postfix) {
    Stack operatorStack;
    initialize(&operatorStack);
    int i, j = 0;
    for (i = 0; infix[i]; i++) {
        char token = infix[i];
        if (token == '(') {
            push(&operatorStack, token);
        } else if (token == ')') {
            while (!isEmpty(&operatorStack) && peek(&operatorStack) != '(') {
                postfix[j++] = pop(&operatorStack);
            }
            pop(&operatorStack); // Discard '('
        } else if (isOperator(token)) {
            while (!isEmpty(&operatorStack) && precedence(peek(&operatorStack)) >=
precedence(token)) {
                postfix[j++] = pop(&operatorStack);
            }
            push(&operatorStack, token);
        } else { // Operand
            postfix[j++] = token;
        }
    }
    while (!isEmpty(&operatorStack)) {
        postfix[j++] = pop(&operatorStack);
    }
    postfix[j] = '\0';
}

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

    printf("Enter a valid parenthesized infix arithmetic expression: ");
    fgets(infix, sizeof(infix), stdin);
    infix[strcspn(infix, "\n")] = '\0'; // Remove trailing newline

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

    return 0;  }
```



LAB PROGRAM-3a)

WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display The program should print appropriate messages for queue empty and queue overflow conditions

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

#define MAX_SIZE 5

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

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

int delete() {
   if (front == -1 || front > rear) {
      printf("Queue underflow\n");
      return -1; // Return some default value to indicate failure
   }
   int deletedItem = queue[front];
   front++;
   return deletedItem;
}

void display() {
   if (front == -1 || front > rear) {
```

```
        printf("Queue is empty\n");
        return;
    }
    printf("Queue elements: ");
    for (int i = front; i <= rear; i++) {
        printf("%d ", queue[i]);
    }
    printf("\n");
}

int main() {
    int choice, value;

    while (1) {
        printf("\n1. Insert\n2. Delete\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &value);
                insert(value);
                break;
            case 2:
                printf("Deleted item: %d\n", delete());
                break;
            case 3:
                display();
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice\n");
        }
    }

    return 0;
}
```

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS

PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport> cd "c:\Users\Tushar\OneDrive\Desktop\dsfinalreport\"
} ; if ($?) { .\prog3a }

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 10

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 20

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 30

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements: 10 20 30

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted item: 10

1. Insert
2. Delete
3. Display
```

```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted item: 10

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements: 20 30

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 4
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport>
```

LAB PROGRAM-3b)

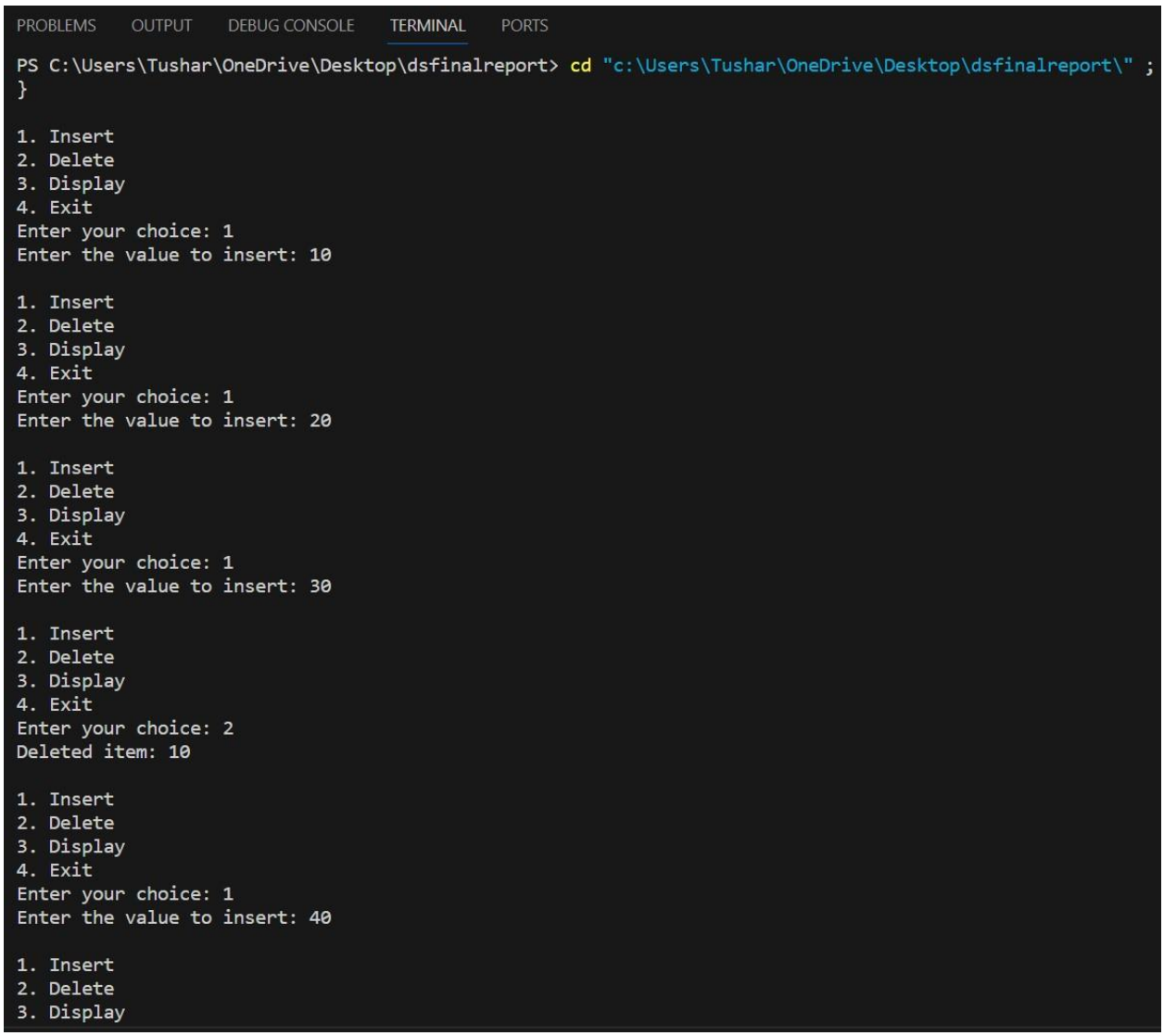
WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The program should print appropriate messages for queue empty and queue overflow conditions

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

#define MAX_SIZE 5

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

void insert(int value) {
    if ((front == 0 && rear == MAX_SIZE - 1) || (rear == (front - 1) % (MAX_SIZE - 1))) {
        printf("Queue overflow\n");
        return;
    } else if (front == -1) {
        front = rear = 0;
        queue[rear] = value;
    } else if (rear == MAX_SIZE - 1 && front != 0) {
        rear = 0;
        queue[rear] = value;
    } else {
        rear++;
        queue[rear] = value;
    }
}

int delete() {
    if (front == -1) {
        printf("Queue underflow\n");
        return -1; // Return some default value to indicate failure
    }
    int deletedItem = queue[front];
    if (front == rear) {
        front = rear = -1;
    } else if (front == MAX_SIZE - 1) {
        front = 0;
    } else {
        front++;
```

```
    }
    return deletedItem;
}

void display() {
    if (front == -1) {
        printf("Queue is empty\n");
        return;
    }
    printf("Queue elements: ");
    if (rear >= front) {
        for (int i = front; i <= rear; i++) {
            printf("%d ", queue[i]);
        }
    } else {
        for (int i = front; i < MAX_SIZE; i++) {
            printf("%d ", queue[i]);
        }
        for (int i = 0; i <= rear; i++) {
            printf("%d ", queue[i]);
        }
    }
    printf("\n");
}

int main() {
    int choice, value;

    while (1) {
        printf("\n1. Insert\n2. Delete\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &value);
                insert(value);
                break;
            case 2:
                printf("Deleted item: %d\n", delete());
                break;
```

```
            case 3:
                display();
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice\n");
        }
    }

    return 0;
}
```

OUTPUT:



```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 40

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements: 20 30 40

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 4
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport>
```

LAB PROGRAM-4

WAP to Implement Singly Linked List with following operations:
a) Create a linked list.
b) Insertion of a node at first position, at any position and at end of list.
Display the contents of the linked list.

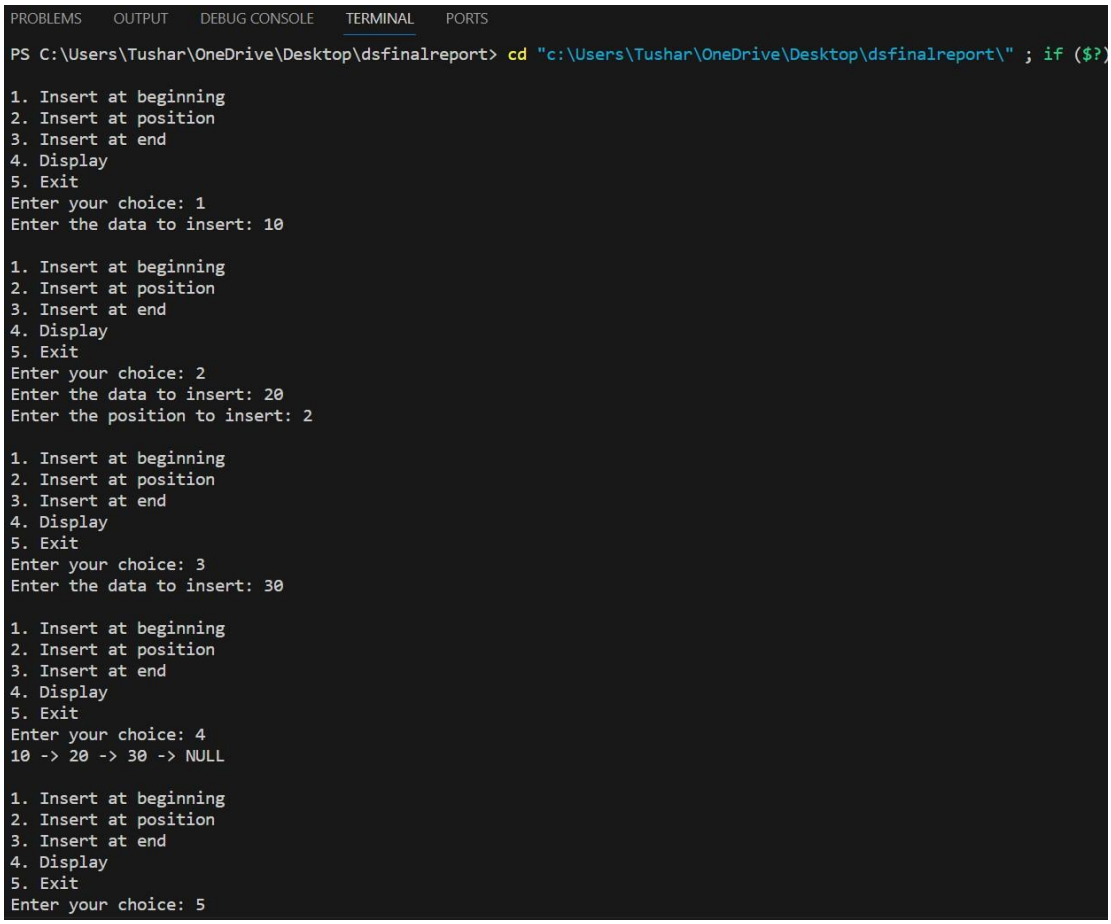
```
#include <stdio.h>
#include <stdlib.h>

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

// Function to create a new node
struct Node* createNode(int 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 display the linked list
void display(struct Node* head) {
    if (head == NULL) {
        printf("List is empty\n");
        return;
    }
    struct Node* current = head;
    while (current != NULL) {
        printf("%d -> ", current->data);
        current = current->next;
    }
    printf("NULL\n");
}

// Function to insert a node at the beginning of the list
struct Node* insertAtBeginning(struct Node* head, int data) {
    struct Node* newNode = createNode(data);
    newNode->next = head;
    return newNode;
}

// Function to insert a node at any position in the list
void insertAtPosition(struct Node* head, int data, int position) {
    if (position < 1) {
        printf("Invalid position\n");
        return;
    }
    struct Node* newNode = createNode(data);
    struct Node* current = head;
    for (int i = 1; i < position - 1 && current != NULL; i++) {
        current = current->next;
    }
    if (current == NULL) {
        printf("Position out of range\n");
        return;
    }
    newNode->next = current->next;
    current->next = newNode;
}

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

```
void insertAtEnd(struct Node* head, int data) {
    struct Node* newNode = createNode(data);
    if (head == NULL) {
        head = newNode;
        return;
    }
    struct Node* current = head;
    while (current->next != NULL) {
        current = current->next;
    }
    current->next = newNode;
}

int main() {
    struct Node* head = NULL;
    int choice, data, position;

    while (1) {
        printf("\n1. Insert at beginning\n2. Insert at position\n3. Insert at end\n4. Display\n5.
Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the data to insert: ");
                scanf("%d", &data);
                head = insertAtBeginning(head, data);
                break;
            case 2:
                printf("Enter the data to insert: ");
                scanf("%d", &data);
                printf("Enter the position to insert: ");
                scanf("%d", &position);
                insertAtPosition(head, data, position);
                break;
            case 3:
                printf("Enter the data to insert: ");
                scanf("%d", &data);
                insertAtEnd(head, data);
                break;
            case 4:
```

```
            display(head);
            break;
        case 5:
            exit(0);
        default:
            printf("Invalid choice\n");
    }
  }

  return 0;
}
```

OUTPUT:



LAB PROGRAM-5

WAP to Implement Singly Linked List with following operations :

a) Create a linked list.

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

c) Display the contents of the linked list.

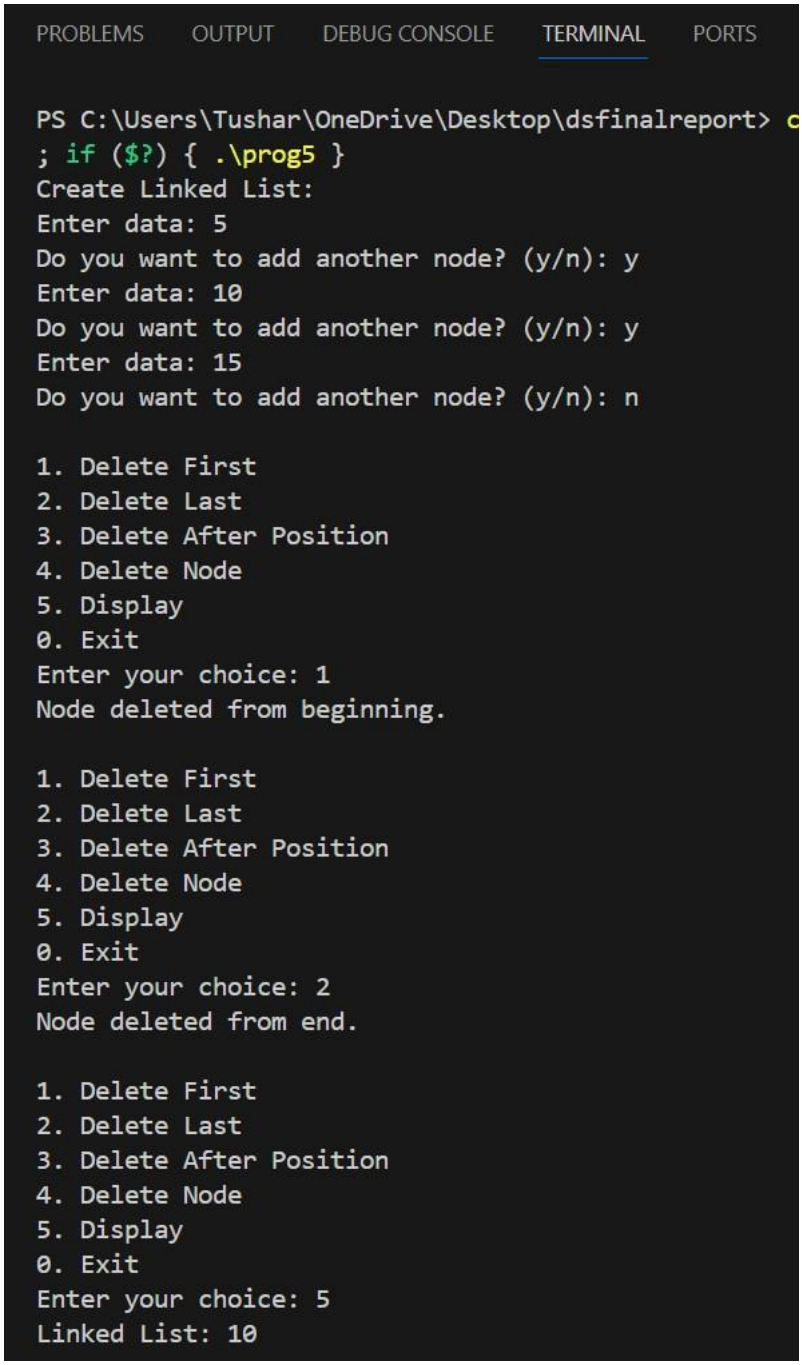
```
#include <stdio.h>
#include <stdlib.h>

struct node {
   int data;
   struct node* next;
};

struct node *create_list() {
   struct node *head = NULL;
   struct node *temp, *new_node;
   int num;
   char ch;
   do {
      printf("Enter data: ");
      scanf("%d", &num);
      new_node = (struct node *)malloc(sizeof(struct node));
      new_node->data = num;
      new_node->next = NULL;
      if (head == NULL) {
         head = new_node;
         temp = head;
      } else {
         temp->next = new_node;
         temp = new_node;
      }
      printf("Do you want to add another node? (y/n): ");
      scanf(" %c", &ch);
   } while(ch == 'y' || ch == 'Y');
   return head;
}

struct node *delete_beg(struct node *head){
   struct node *temp;
   temp=head;
```

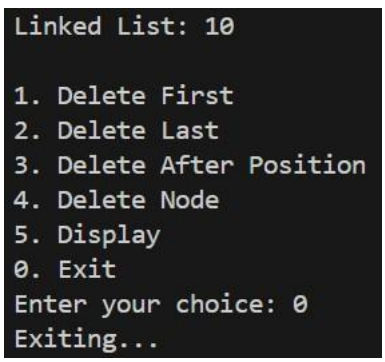
```
    head=head->next;
    free(temp);
    return head;
}

struct node *delete_end(struct node *head){
    struct node *temp, *preptr;
    preptr=temp=head;
    while(temp->next!=NULL){
        preptr=temp;
        temp=temp->next;
    }
    if(temp==head){
        head=NULL;
    }
    else{
        preptr->next=NULL;
    }
    free(temp);
    return head;
}

struct node *deleteafter_pos(struct node *head){
    struct node *preptr,*temp;
    int value;
    printf("Enter the value after which you want to delete: ");
    scanf("%d",&value);
    temp=head;
    preptr=temp;
    while(preptr->data!=value){
        preptr=temp;
        temp=temp->next;
    }
    preptr->next=temp->next;
    free(temp);
    return head;
}

struct node *deletenode(struct node *head){
    struct node *preptr,*temp;
    int value;
    printf("Enter the value you want to delete: ");
```

```
    scanf("%d",&value);
    temp=head;
    if(temp->data==value){
        head=delete_beg(head);
        return head;
    }
    else{
        while(temp->data!=value){
            preptr=temp;
            temp=temp->next;
        }
        preptr->next=temp->next;
        free(temp);
        return head;
    }
}

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

int main() {
    struct node *head = NULL;
    int choice;

    printf("Create Linked List:\n");
    head = create_list();

    do {
        printf("\n1. Delete First\n");
        printf("2. Delete Last\n");
        printf("3. Delete After Position\n");
        printf("4. Delete Node\n");
```

```
        printf("5. Display\n");
        printf("0. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                head = delete_beg(head);
                printf("Node deleted from beginning.\n");
                break;
            case 2:
                head = delete_end(head);
                printf("Node deleted from end.\n");
                break;
            case 3:
                head = deleteafter_pos(head);
                printf("Node deleted after given position.\n");
                break;
            case 4:
                head = deletenode(head);
                printf("Node deleted.\n");
                break;
            case 5:
                printf("Linked List: ");
                display(head);
                break;
            case 0:
                printf("Exiting...\n");
                break;
            default:
                printf("Invalid choice. Please try again.\n");
                break;
        }
    } while (choice != 0);

    return 0;
}
```

OUTPUT:


PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport> c
; if ($?) { .\prog5 }
Create Linked List:
Enter data: 5
Do you want to add another node? (y/n): y
Enter data: 10
Do you want to add another node? (y/n): y
Enter data: 15
Do you want to add another node? (y/n): n
1. Delete First
2. Delete Last
3. Delete After Position
4. Delete Node
5. Display
0. Exit
Enter your choice: 1
Node deleted from beginning.
1. Delete First
2. Delete Last
3. Delete After Position
4. Delete Node
5. Display
0. Exit
Enter your choice: 2
Node deleted from end.
1. Delete First
2. Delete Last
3. Delete After Position
4. Delete Node
5. Display
0. Exit
Enter your choice: 5
Linked List: 10


Linked List: 10
1. Delete First
2. Delete Last
3. Delete After Position
4. Delete Node
5. Display
0. Exit
Enter your choice: 0
Exiting...

LAB PROGRAM-6a):

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

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

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

typedef struct Node 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;
}

void append(Node** head, int data) {
    Node* newNode = createNode(data);
    if (*head == NULL) {
        *head = newNode;
        return;
    }
    Node* current = *head;
    while (current->next != NULL) {
        current = current->next;
    }
    current->next = newNode;
}

void display(Node* head) {
    while (head != NULL) {
        printf("%d -> ", head->data);
```

```
        head = head->next;
    }
    printf("NULL\n");
}

void sort(Node** head) {
    Node *current, *index;
    int temp;

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

    for (current = *head; current->next != NULL; current = current->next) {
        for (index = current->next; index != NULL; index = index->next) {
            if (current->data > index->data) {
                temp = current->data;
                current->data = index->data;
                index->data = temp;
            }
        }
    }
}

void reverse(Node** head) {
    Node *prev, *current, *next;
    prev = NULL;
    current = *head;
    while (current != NULL) {
        next = current->next;
        current->next = prev;
        prev = current;
        current = next;
    }
    *head = prev;
}

void concatenate(Node** head1, Node* head2) {
    if (*head1 == NULL) {
        *head1 = head2;
        return;
    }
```

```
    Node* current = *head1;
    while (current->next != NULL) {
        current = current->next;
    }
    current->next = head2;
}

Node* createLinkedList() {
    Node* head = NULL;
    int n, data;
    printf("Enter the number of elements: ");
    scanf("%d", &n);
    printf("Enter the elements: ");
    for (int i = 0; i < n; ++i) {
        scanf("%d", &data);
        append(&head, data);
    }
    return head;
}

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

    printf("Creating list 1:\n");
    list1 = createLinkedList();

    printf("Creating list 2:\n");
    list2 = createLinkedList();

    int choice;
    do {
        printf("\nChoose operation:\n");
        printf("1. Sort the linked list\n");
        printf("2. Reverse the linked list\n");
        printf("3. Concatenate two linked lists\n");
        printf("4. Display the linked list\n");
        printf("5. Exit\n");

        scanf("%d", &choice);

        switch (choice) {
```

```
            case 1:
                sort(&list1);
                break;
            case 2:
                reverse(&list1);
                break;
            case 3:
                concatenate(&list1, list2);
                break;
            case 4:
                display(list1);
                break;
            case 5:
                printf("Exiting...\n");
                break;
            default:
                printf("Invalid choice. Please enter a valid option.\n");
        }
    } while (choice != 5);

    return 0;
}
```

OUTPUT:

```
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport> cd "c
} ; if ($?) { .\prog6a }
Creating list 1:
Enter the number of elements: 3
Enter the elements: 5
15
25
Creating list 2:
Enter the number of elements: 3
Enter the elements: 10
20
30

Choose operation:
1. Sort the linked list
2. Reverse the linked list
3. Concatenate two linked lists
4. Display the linked list
5. Exit
2

Choose operation:
1. Sort the linked list
2. Reverse the linked list
3. Concatenate two linked lists
4. Display the linked list
5. Exit
3

Choose operation:
1. Sort the linked list
2. Reverse the linked list
3. Concatenate two linked lists
4. Display the linked list
5. Exit
4
25 -> 15 -> 5 -> 10 -> 20 -> 30 -> NULL
```

```
Choose operation:
1. Sort the linked list
2. Reverse the linked list
3. Concatenate two linked lists
4. Display the linked list
5. Exit
1

Choose operation:
1. Sort the linked list
2. Reverse the linked list
3. Concatenate two linked lists
4. Display the linked list
5. Exit
4
5 -> 10 -> 15 -> 20 -> 25 -> 30 -> NULL

Choose operation:
1. Sort the linked list
2. Reverse the linked list
3. Concatenate two linked lists
4. Display the linked list
5. Exit
5
Exiting...
```

LAB PROGRAM-6b):

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

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

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

typedef struct Node 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;
}

// Stack operations: push and pop
void push(Node** top, int data) {
    Node* newNode = createNode(data);
    newNode->next = *top;
    *top = newNode;
}

int pop(Node** top) {
    if (*top == NULL) {
        printf("Stack underflow!\n");
        exit(1);
    }
    Node* temp = *top;
    int poppedData = temp->data;
    *top = (*top)->next;
```

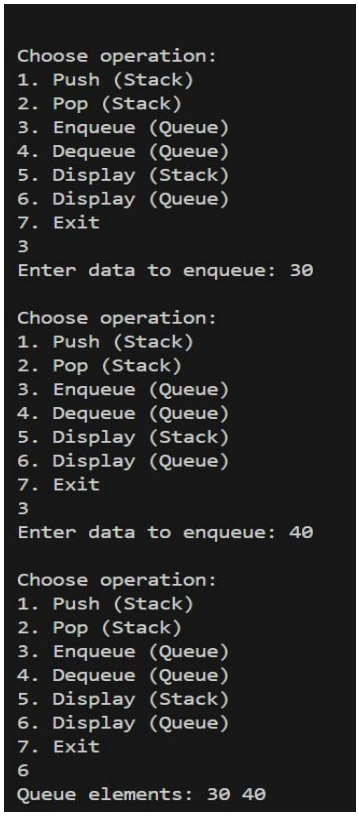
```
    free(temp);
    return poppedData;
}

// Queue operations: enqueue and dequeue
void enqueue(Node** rear, int data) {
    Node* newNode = createNode(data);
    if (*rear == NULL) {
        *rear = newNode;
    } else {
        (*rear)->next = newNode;
        *rear = newNode;
    }
}

int dequeue(Node** front) {
    if (*front == NULL) {
        printf("Queue underflow!\n");
        exit(1);
    }
    Node* temp = *front;
    int dequeuedData = temp->data;
    *front = (*front)->next;
    free(temp);
    return dequeuedData;
}

// Display the elements of the stack or queue
void display(Node* head) {
    if (head == NULL) {
        printf("Empty\n");
        return;
    }
    while (head != NULL) {
        printf("%d ", head->data);
        head = head->next;
    }
    printf("\n");
}

int main() {
    Node* stackTop = NULL;  // Initialize stack top
```

```
Node* queueFront = NULL; // Initialize queue front
Node* queueRear = NULL; // Initialize queue rear

int choice, data;
do {
    printf("\nChoose operation:\n");
    printf("1. Push (Stack)\n");
    printf("2. Pop (Stack)\n");
    printf("3. Enqueue (Queue)\n");
    printf("4. Dequeue (Queue)\n");
    printf("5. Display (Stack)\n");
    printf("6. Display (Queue)\n");
    printf("7. Exit\n");
    scanf("%d", &choice);

    switch (choice) {
        case 1:
            printf("Enter data to push: ");
            scanf("%d", &data);
            push(&stackTop, data);
            break;
        case 2:
            if (stackTop == NULL) {
                printf("Stack is empty.\n");
            } else {
                printf("Popped element: %d\n", pop(&stackTop));
            }
            break;
        case 3:
            printf("Enter data to enqueue: ");
            scanf("%d", &data);
            enqueue(&queueRear, data);
            if (queueFront == NULL) {
                queueFront = queueRear;
            }
            break;
        case 4:
            if (queueFront == NULL) {
                printf("Queue is empty.\n");
            } else {
                printf("Dequeued element: %d\n", dequeue(&queueFront));
            }
```

```
            break;
        case 5:
            printf("Stack elements: ");
            display(stackTop);
            break;
        case 6:
            printf("Queue elements: ");
            display(queueFront);
            break;
        case 7:
            printf("Exiting...\n");
            break;
        default:
            printf("Invalid choice. Please enter a valid option.\n");
      }
   } while (choice != 7);

   return 0;
}
```

OUTPUT:

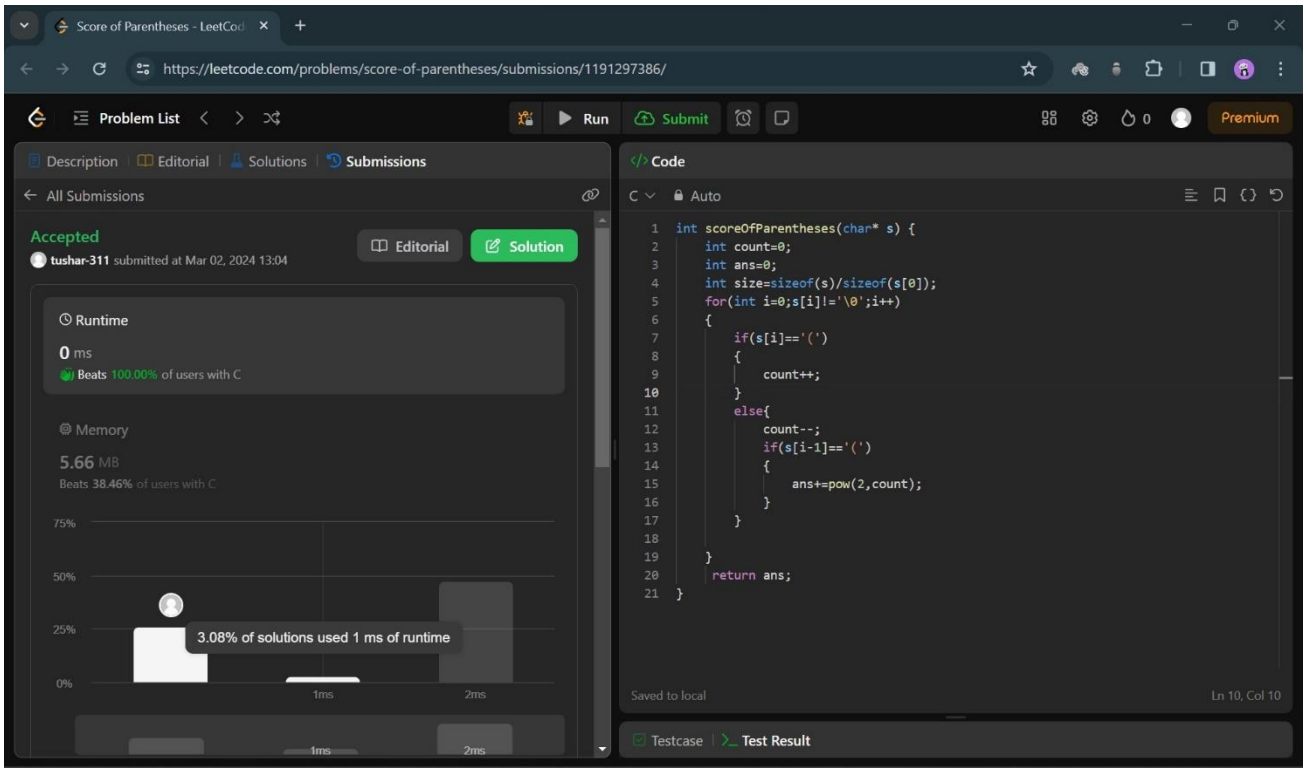
```
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport>
} ; if ($?) { .\prog6b }

Choose operation:
1. Push (Stack)
2. Pop (Stack)
3. Enqueue (Queue)
4. Dequeue (Queue)
5. Display (Stack)
6. Display (Queue)
7. Exit
1
Enter data to push: 10

Choose operation:
1. Push (Stack)
2. Pop (Stack)
3. Enqueue (Queue)
4. Dequeue (Queue)
5. Display (Stack)
6. Display (Queue)
7. Exit
1
Enter data to push: 20

Choose operation:
1. Push (Stack)
2. Pop (Stack)
3. Enqueue (Queue)
4. Dequeue (Queue)
5. Display (Stack)
6. Display (Queue)
7. Exit
5
Stack elements: 20 10

Choose operation:
```



LEETCODE PROBLEM-1:

Score of Parentheses:

```
int scoreOfParentheses(char* s) {
    int count=0;
    int ans=0;
    int size=sizeof(s)/sizeof(s[0]);
    for(int i=0;s[i]!='\0';i++)
    {
        if(s[i]=='(')
        {
            count++;
        }
        else{
            count--;
            if(s[i-1]=='(')
            {
                ans+=pow(2,count);
            }
        }

    }
     return ans;
}
```



LAB PROGRAM-7:

WAP to Implement doubly link list with primitive operations:

a) Create a doubly linked list.

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

c) Delete the node based on a specific value

d) Display the contents of the list

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

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

typedef struct Node 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->prev = NULL;
    newNode->next = NULL;
    return newNode;
}

// Function to insert a new node to the left of a specified node
void insertLeft(Node** head, int value, int newValue) {
    Node* newNode = createNode(newValue);
    Node* current = *head;
    while (current != NULL && current->data != value) {
        current = current->next;
    }
    if (current == NULL) {
        printf("Node with value %d not found. New node not inserted.\n", value);
        free(newNode);
        return;
    }
    newNode->next = current;
    newNode->prev = current->prev;
    if (current->prev != NULL) {
        current->prev->next = newNode;
    }
    current->prev = newNode;
    if (current == *head) {
        *head = newNode;
    }
}

// Function to delete a node based on a specific value
void deleteNode(Node** head, int value) {
    Node* current = *head;
    while (current != NULL && current->data != value) {
        current = current->next;
    }
    if (current == NULL) {
```

```
        printf("Node with value %d not found.\n", value);
        return;
    }
    if (current->prev != NULL) {
        current->prev->next = current->next;
    }
    if (current->next != NULL) {
        current->next->prev = current->prev;
    }
    if (current == *head) {
        *head = current->next;
    }
    free(current);
}

// Function to display the contents of the list
void display(Node* head) {
    if (head == NULL) {
        printf("List is empty.\n");
        return;
    }
    while (head != NULL) {
        printf("%d <-> ", head->data);
        head = head->next;
    }
    printf("NULL\n");
}

int main() {
    Node* head = createNode(1);
    head->next = createNode(2);
    head->next->prev = head;
    head->next->next = createNode(3);
    head->next->next->prev = head->next;

    int choice, value, newValue;

    do {
        printf("\nChoose operation:\n");
        printf("1. Insert a new node to the left of a specified node\n");
        printf("2. Delete a node based on a specific value\n");
        printf("3. Display the contents of the list\n");
```

```
        printf("4. Exit\n");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value of the existing node: ");
                scanf("%d", &value);
                printf("Enter the value of the new node: ");
                scanf("%d", &newValue);
                insertLeft(&head, value, newValue);
                break;
            case 2:
                printf("Enter the value of the node to delete: ");
                scanf("%d", &value);
                deleteNode(&head, value);
                break;
            case 3:
                printf("List contents:\n");
                display(head);
                break;
            case 4:
                printf("Exiting...\n");
                break;
            default:
                printf("Invalid choice. Please enter a valid option.\n");
        }
    } while (choice != 4);

    return 0;
}
```

OUTPUT:

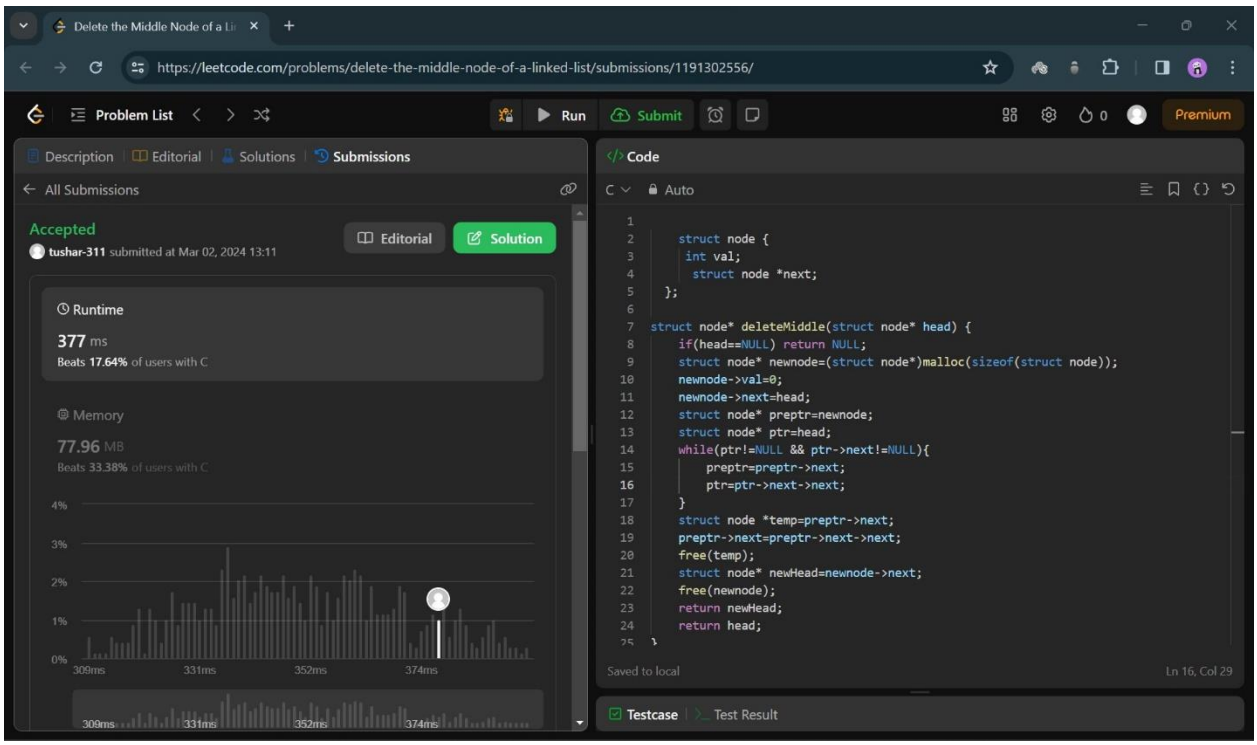
```
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport> cd "c:
; if ($?) { .\prog7 }

Choose operation:
1. Insert a new node to the left of a specified node
2. Delete a node based on a specific value
3. Display the contents of the list
4. Exit
1
Enter the value of the existing node: 1
Enter the value of the new node: 0

Choose operation:
1. Insert a new node to the left of a specified node
2. Delete a node based on a specific value
3. Display the contents of the list
4. Exit
3
List contents:
0 <-> 1 <-> 2 <-> 3 <-> NULL

Choose operation:
1. Insert a new node to the left of a specified node
2. Delete a node based on a specific value
3. Display the contents of the list
4. Exit
2
Enter the value of the node to delete: 2

Choose operation:
1. Insert a new node to the left of a specified node
2. Delete a node based on a specific value
3. Display the contents of the list
4. Exit
3
List contents:
0 <-> 1 <-> 3 <-> NULL
```

LEETCODE PROBLEM-2:

Delete the Middle Node of the Linked List

```
    struct node {
     int val;
      struct node *next;
  };

struct node* deleteMiddle(struct node* head) {
    if(head==NULL) return NULL;
    struct node* newnode=(struct node*)malloc(sizeof(struct node));
    newnode->val=0;
    newnode->next=head;
    struct node* preptr=newnode;
    struct node* ptr=head;
    while(ptr!=NULL && ptr->next!=NULL){
        preptr=preptr->next;
```

```
        ptr=ptr->next->next;
    }
    struct node *temp=preptr->next;
    preptr->next=preptr->next->next;
    free(temp);
    struct node* newHead=newnode->next;
    free(newnode);
    return newHead;
    return head;
}
```

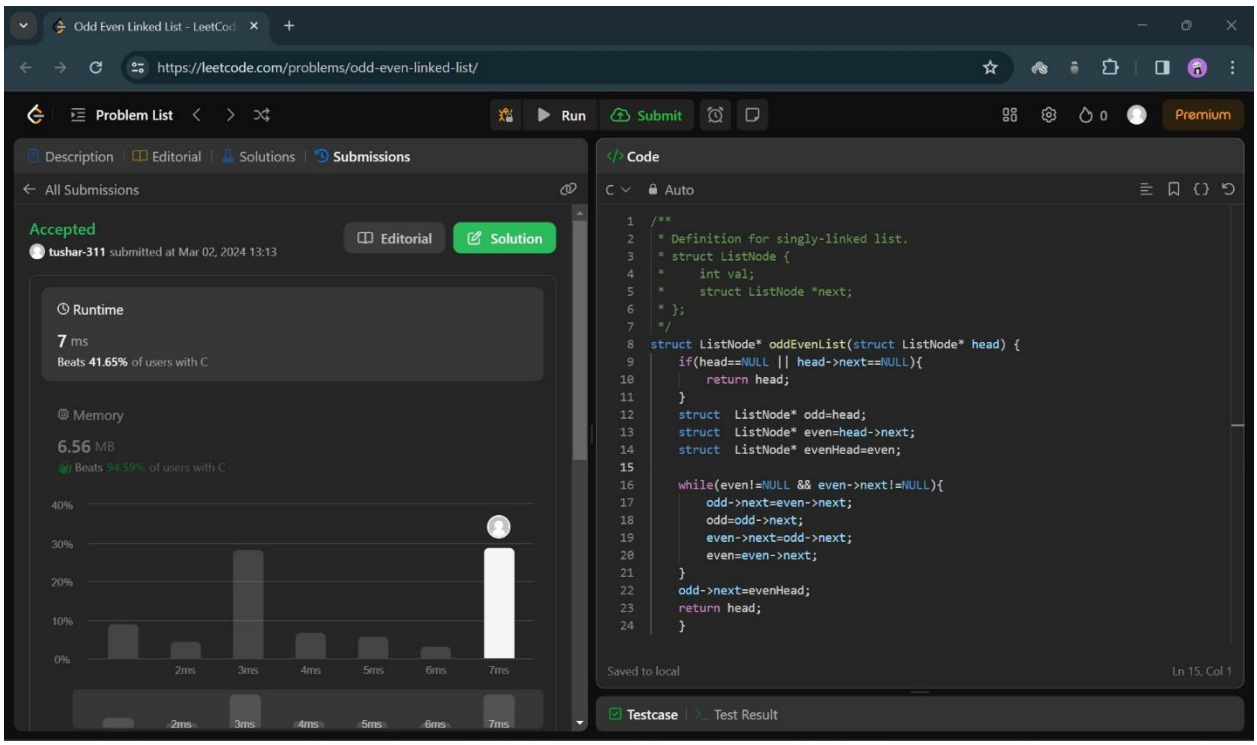


LEETCODE PROBLEM-3:

Odd Even Linked List

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
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-8:

Write a program

a) To construct a binary Search tree.

b) To traverse the tree using all the methods i.e., in-order, preorder and post order

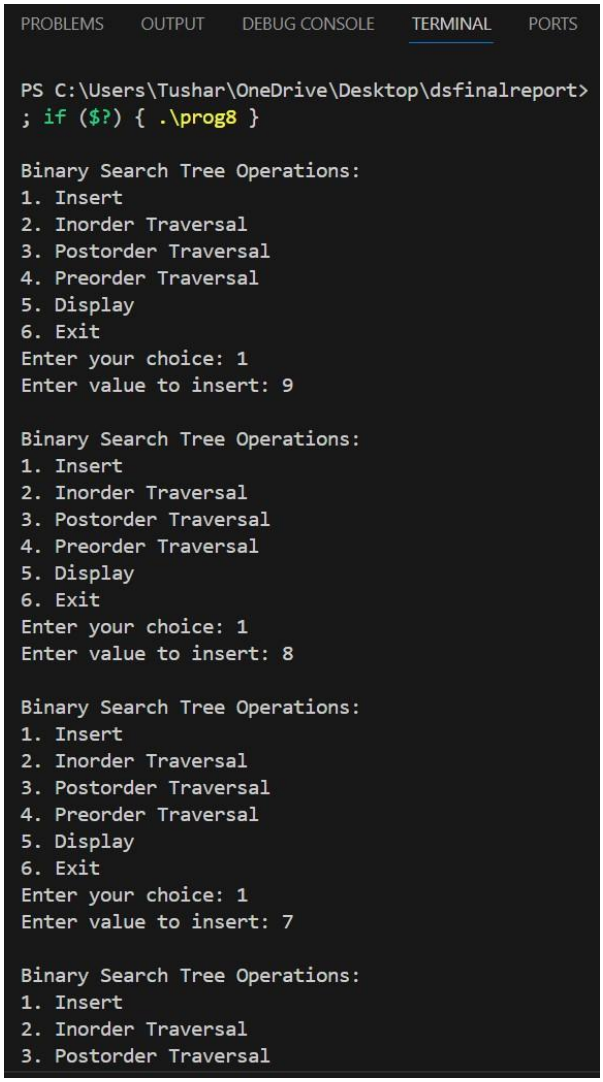
c) To display the elements in the tree.

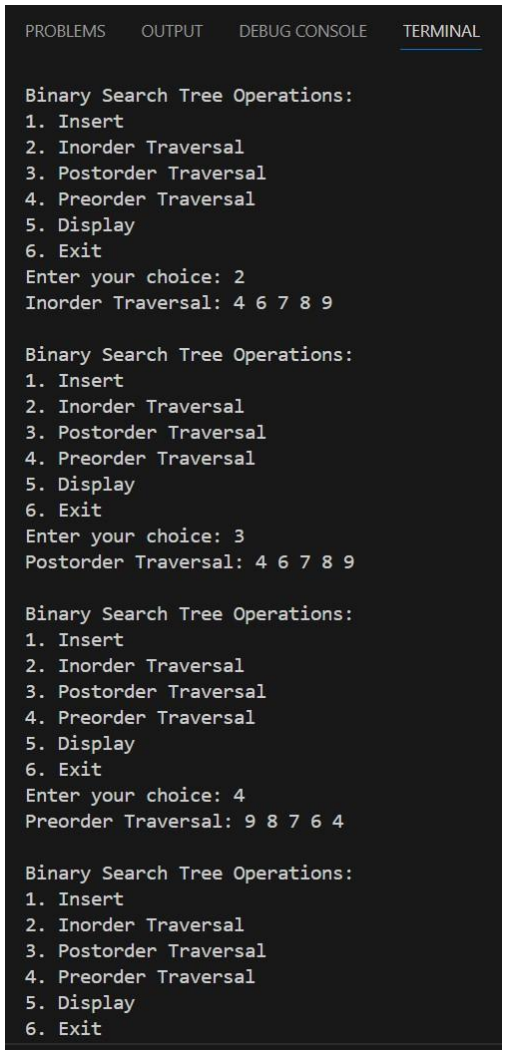
```
#include <stdio.h>
#include <stdlib.h>

// Structure for a node of the binary search tree
struct Node {
    int data;
    struct Node* left;
    struct Node* right;
};

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

// Function to insert a new node into the binary search tree
struct Node* insert(struct Node* root, int value) {
    if (root == NULL) {
        return createNode(value);
    }

    if (value < root->data) {
        root->left = insert(root->left, value);
    } else if (value > root->data) {
        root->right = insert(root->right, value);
    }

    return root;
}

// Function to traverse the binary search tree using inorder traversal
void inorderTraversal(struct Node* root) {
    if (root != NULL) {
        inorderTraversal(root->left);
        printf("%d ", root->data);
        inorderTraversal(root->right);
    }
}

// Function to traverse the binary search tree using postorder traversal
void postorderTraversal(struct Node* root) {
    if (root != NULL) {
        postorderTraversal(root->left);
        postorderTraversal(root->right);
        printf("%d ", root->data);
    }
}

// Function to traverse the binary search tree using preorder traversal
void preorderTraversal(struct Node* root) {
    if (root != NULL) {
        printf("%d ", root->data);
        preorderTraversal(root->left);
```

```
        preorderTraversal(root->right);
    }
}

// Function to display the elements in the binary search tree
void display(struct Node* root) {
    printf("Elements in the tree: ");
    inorderTraversal(root);
    printf("\n");
}

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

    do {
        printf("\nBinary Search Tree Operations:\n");
        printf("1. Insert\n");
        printf("2. Inorder Traversal\n");
        printf("3. Postorder Traversal\n");
        printf("4. Preorder Traversal\n");
        printf("5. Display\n");
        printf("6. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert: ");
                scanf("%d", &value);
                root = insert(root, value);
                break;
            case 2:
                printf("Inorder Traversal: ");
                inorderTraversal(root);
                printf("\n");
                break;
            case 3:
                printf("Postorder Traversal: ");
                postorderTraversal(root);
                printf("\n");
                break;
            case 4:
                printf("Preorder Traversal: ");
                preorderTraversal(root);
                printf("\n");
                break;
            case 5:
                display(root);
                break;
            case 6:
                printf("Exiting...\n");
                break;
            default:
                printf("Invalid choice! Please enter a valid option.\n");
        }
```

```
    } while (choice != 6);

    return 0;
}
```

OUTPUT:



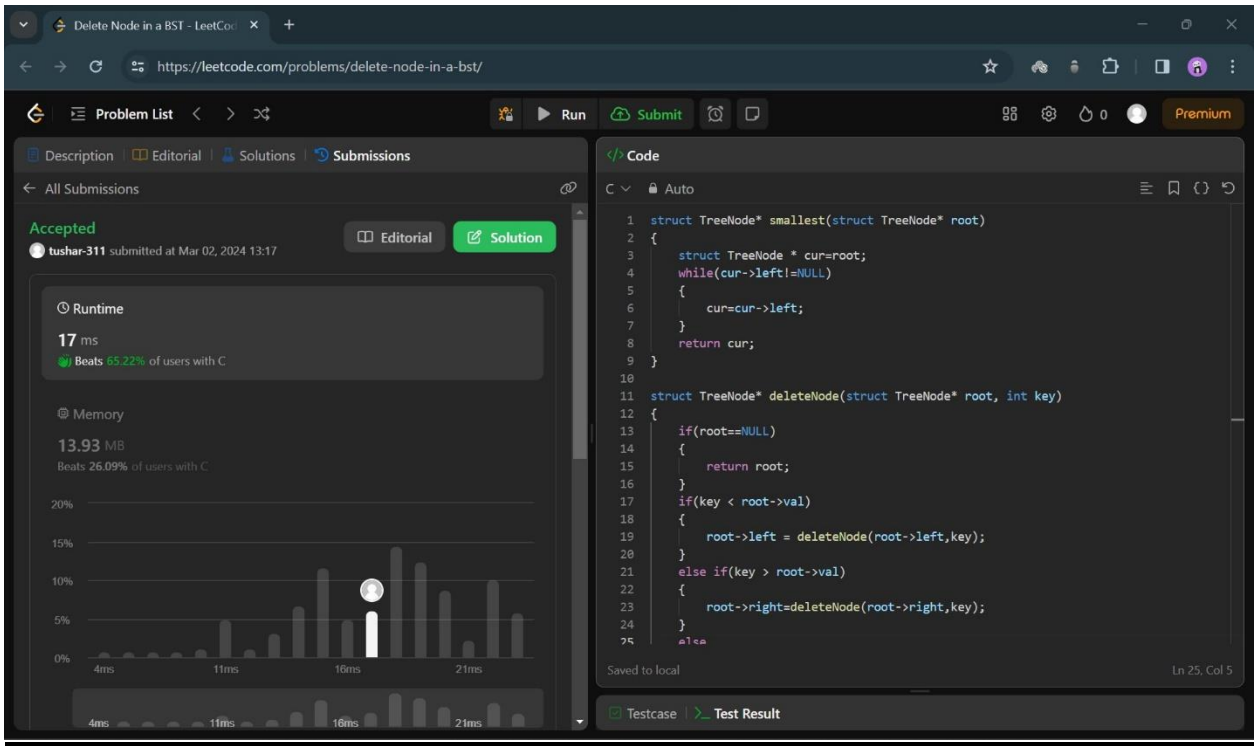


LEETCODE PROBLEM-4:

Delete a node in BST

```
struct TreeNode* smallest(struct TreeNode* root)
{
   struct TreeNode * cur=root;
   while(cur->left!=NULL)
   {
      cur=cur->left;
   }
   return cur;
}

struct TreeNode* deleteNode(struct TreeNode* root, int key)
{

         // base case
   if(root==NULL)
```

```
    {
        return root;
    }
    if(key < root->val)
    {
        root->left = deleteNode(root->left,key);
    }
    else if(key > root->val)
    {
        root->right=deleteNode(root->right,key);
    }
  else
    {

        if (root->left == NULL)
        {
            struct TreeNode *temp = root->right;
            free(root);
            return temp;
        }
        else if (root->right == NULL)
        {
            struct TreeNode *temp = root->left;
            free(root);
            return temp;
        }
        struct TreeNode *temp = smallest(root->right);
        root->val = temp->val;
        root->right = deleteNode(root->right, root->val);
    }

    return root;
}
```

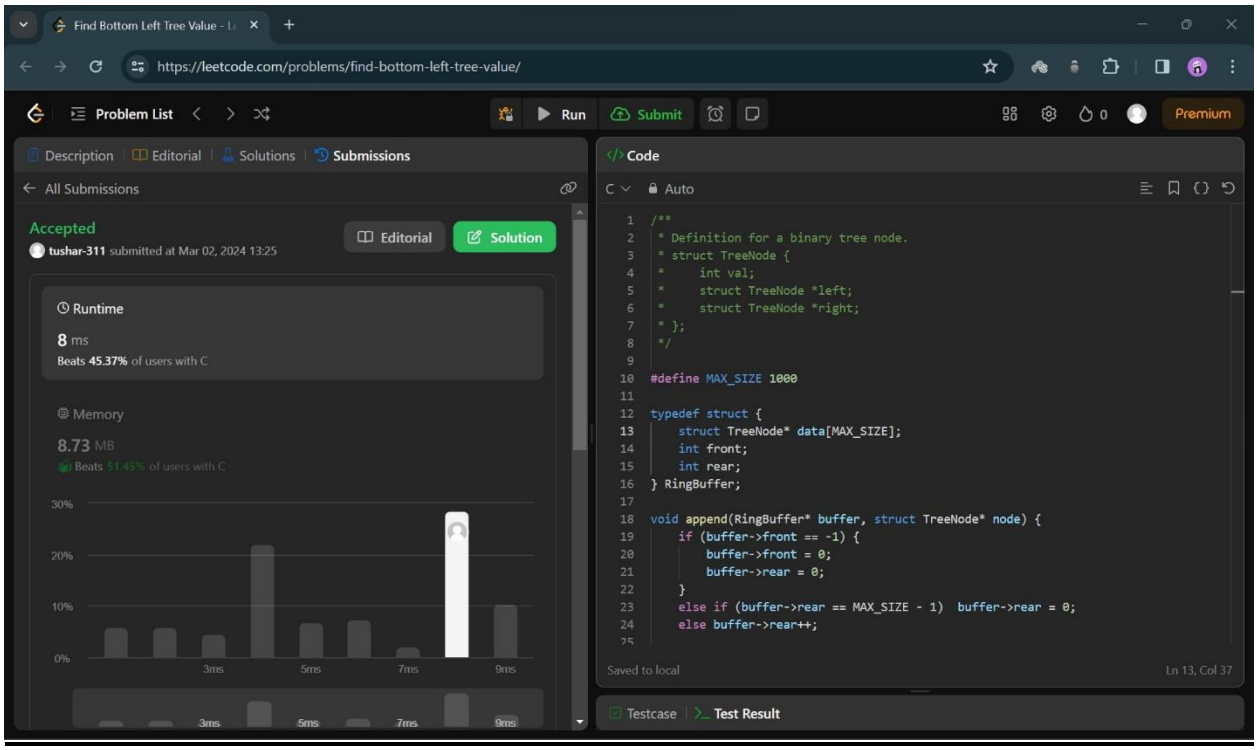


LEETCODE PROBLEM-5:

Find bottom left tree value

```
/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     struct TreeNode *left;
 *     struct TreeNode *right;
 * };
 */

#define MAX_SIZE 1000

typedef struct {
    struct TreeNode* data[MAX_SIZE];
    int front;
    int rear;
} RingBuffer;

void append(RingBuffer* buffer, struct TreeNode* node) {
    if (buffer->front == -1) {
```

```
        buffer->front = 0;
        buffer->rear = 0;
    }
    else if (buffer->rear == MAX_SIZE - 1)  buffer->rear = 0;
    else buffer->rear++;

    buffer->data[buffer->rear] = node;
}

struct TreeNode* popleft(RingBuffer* buffer) {
    struct TreeNode* node = buffer->data[buffer->front];
    if (buffer->front == buffer->rear) {
        buffer->front = -1;
        buffer->rear = -1;
    }
    else if (buffer->front == MAX_SIZE - 1)  buffer->front = 0;
    else     buffer->front++;

    return node;
}

int findBottomLeftValue(struct TreeNode* root) {
    if (root == NULL)  return -1;
    RingBuffer buffer = {
        .front = -1,
        .rear = -1
    };
    append(&buffer, root);

    struct TreeNode* node;
    while( buffer.front != -1 ){
        node = popleft(&buffer);
        if (node->right) append(&buffer, node->right);
        if (node->left)  append(&buffer, node->left);
    }

    return node->val;
}
```



LAB PROGRAM-9a):

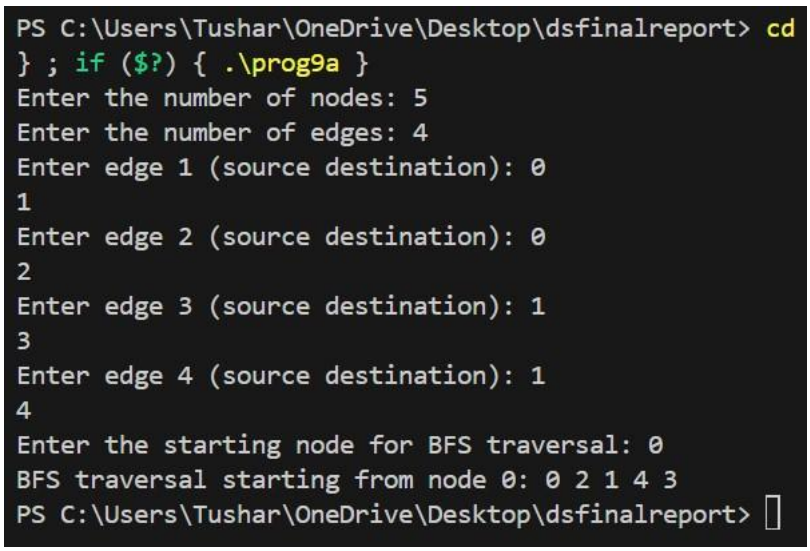
Write a program to traverse a graph using BFS method.

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

#define MAX_NODES 100

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

// Define a structure for the graph
struct Graph {
    int numNodes;
    struct Node* adjLists[MAX_NODES];
    int visited[MAX_NODES];
};
```

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

// Function to create a graph with n nodes
struct Graph* createGraph(int n) {
    struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
    graph->numNodes = n;
    for (int i = 0; i < n; i++) {
        graph->adjLists[i] = NULL;
        graph->visited[i] = 0;
    }
    return graph;
}

// 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->adjLists[src];
    graph->adjLists[src] = newNode;

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

// Function to perform Breadth First Search
void BFS(struct Graph* graph, int startNode) {
    // Create a queue for BFS
    int queue[MAX_NODES];
    int front = 0, rear = 0;

    // Mark the current node as visited and enqueue it
    graph->visited[startNode] = 1;
    queue[rear++] = startNode;

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

        // Get all adjacent vertices of the dequeued vertex current
        // If an adjacent has not been visited, then mark it visited and enqueue it
        struct Node* temp = graph->adjLists[current];
        while (temp) {
```

```
            int adjNode = temp->data;
            if (!graph->visited[adjNode]) {
                graph->visited[adjNode] = 1;
                queue[rear++] = adjNode;
            }
            temp = temp->next;
        }
    }
}

int main() {
    // Get the number of nodes from the user
    int numNodes;
    printf("Enter the number of nodes: ");
    scanf("%d", &numNodes);

    // Create a graph with the specified number of nodes
    struct Graph* graph = createGraph(numNodes);

    // Get the number of edges from the user
    int numEdges;
    printf("Enter the number of edges: ");
    scanf("%d", &numEdges);

    // Add edges
    for (int i = 0; i < numEdges; i++) {
        int src, dest;
        printf("Enter edge %d (source destination): ", i + 1);
        scanf("%d %d", &src, &dest);
        addEdge(graph, src, dest);
    }

    // Print BFS traversal
    int startNode;
    printf("Enter the starting node for BFS traversal: ");
    scanf("%d", &startNode);
    printf("BFS traversal starting from node %d: ", startNode);
    BFS(graph, startNode);

    return 0;
}
```

OUTPUT:



LAB PROGRAM-9b):

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

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

#define MAX_NODES 100

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

// Define a structure for the graph
struct Graph {
    int numNodes;
    struct Node* adjLists[MAX_NODES];
    int visited[MAX_NODES];
};

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

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

// Function to create a graph with n nodes
struct Graph* createGraph(int n) {
    struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
    graph->numNodes = n;
    for (int i = 0; i < n; i++) {
        graph->adjLists[i] = NULL;
        graph->visited[i] = 0;
    }
    return graph;
}

// 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->adjLists[src];
    graph->adjLists[src] = newNode;

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

// Function to perform Depth First Search
void DFS(struct Graph* graph, int startNode) {
    // Mark the current node as visited
    graph->visited[startNode] = 1;
    printf("%d ", startNode);

    // Get all adjacent vertices of the current node
    struct Node* temp = graph->adjLists[startNode];
    while (temp) {
        int adjNode = temp->data;
        if (!graph->visited[adjNode]) {
            DFS(graph, adjNode);
        }
        temp = temp->next;
    }
}

int main() {
    // Get the number of nodes from the user
    int numNodes;
    printf("Enter the number of nodes: ");
    scanf("%d", &numNodes);
```

```
    // Create a graph with the specified number of nodes
    struct Graph* graph = createGraph(numNodes);

    // Get the number of edges from the user
    int numEdges;
    printf("Enter the number of edges: ");
    scanf("%d", &numEdges);

    // Add edges
    for (int i = 0; i < numEdges; i++) {
        int src, dest;
        printf("Enter edge %d (source destination): ", i + 1);
        scanf("%d %d", &src, &dest);
        addEdge(graph, src, dest);
    }

    // Print DFS traversal
    int startNode;
    printf("Enter the starting node for DFS traversal: ");
    scanf("%d", &startNode);
    printf("DFS traversal starting from node %d: ", startNode);
    DFS(graph, startNode);

    return 0;
}
```

OUTPUT:

```
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport> cd "c:
} ; if ($?) { .\prog9b }
Enter the number of nodes: 5
Enter the number of edges: 4
Enter edge 1 (source destination): 0
1
Enter edge 2 (source destination): 0
2
Enter edge 3 (source destination): 2
4
Enter edge 4 (source destination): 2
3
Enter the starting node for DFS traversal: 0
DFS traversal starting from node 0: 0 2 3 4 1
PS C:\Users\Tushar\OneDrive\Desktop\dsfinalreport>
```

LAB PROGRAM-10:

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

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

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

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

Resolve the collision (if any) using linear probing.

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

#define SIZE 10 // Size of the hash table

// Employee structure
struct Employee {
    int key; // 4-digit key
    int data; // Data associated with the employee
};

typedef struct Employee Employee;

// Hash table structure
struct HashTable {
    Employee* table[SIZE];
};

typedef struct HashTable HashTable;

// Function to initialize the hash table
void initializeHashTable(HashTable* ht) {
    for (int i = 0; i < SIZE; i++) {
        ht->table[i] = NULL;
    }
}

// Hash function: H(K) = K mod m (remainder method)
int hashFunction(int key) {
    return key % SIZE;
}

// Function to insert a record into the hash table
void insert(HashTable* ht, int key, int data) {
    int index = hashFunction(key);
```

```
    while (ht->table[index] != NULL) {
        index = (index + 1) % SIZE; // Linear probing
    }
    Employee* newEmployee = (Employee*)malloc(sizeof(Employee));
    newEmployee->key = key;
    newEmployee->data = data;
    ht->table[index] = newEmployee;
}

// Function to display the contents of the hash table
void displayHashTable(HashTable* ht) {
    printf("Hash Table Contents:\n");
    printf("Index\tKey\tData\n");
    for (int i = 0; i < SIZE; i++) {
        if (ht->table[i] != NULL) {
            printf("%d\t%d\t%d\n", i, ht->table[i]->key, ht->table[i]->data);
        } else {
            printf("%d\tEmpty\n", i);
        }
    }
}

int main() {
    HashTable ht;
    initializeHashTable(&ht);

    int key, data;
    char choice;
    do {
        printf("Enter employee key (4-digit): ");
        scanf("%d", &key);
        printf("Enter employee data: ");
        scanf("%d", &data);
        insert(&ht, key, data);

        printf("Do you want to enter another employee record? (y/n): ");
        scanf(" %c", &choice);
    } while (choice == 'y' || choice == 'Y');

    // Displaying the contents of the hash table
    displayHashTable(&ht);
```

```
    return 0;
}
```

OUTPUT: