# VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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

**LAB REPORT**
**On**

**DATA STRUCTURES (23CS3PCDST)**

**Submitted by**

**R BHUVAN ADITYA (1BM23CS254)**

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

**B.M.S. COLLEGE OF ENGINEERING**
**(Autonomous Institution under VTU)**
**BENGALURU-560019**
**September 2024-January 2025**

**B. M. S. College of Engineering,**
**Bull Temple Road, Bangalore 560019**
**(Affiliated To Visvesvaraya Technological University, Belgaum)**
**Department of Computer Science and Engineering**

This is to certify that the Lab work entitled **“DATA STRUCTURES”** carried out by **R Bhuvan Aditya (1BM23CS254)**, 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 2024-25. 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:**

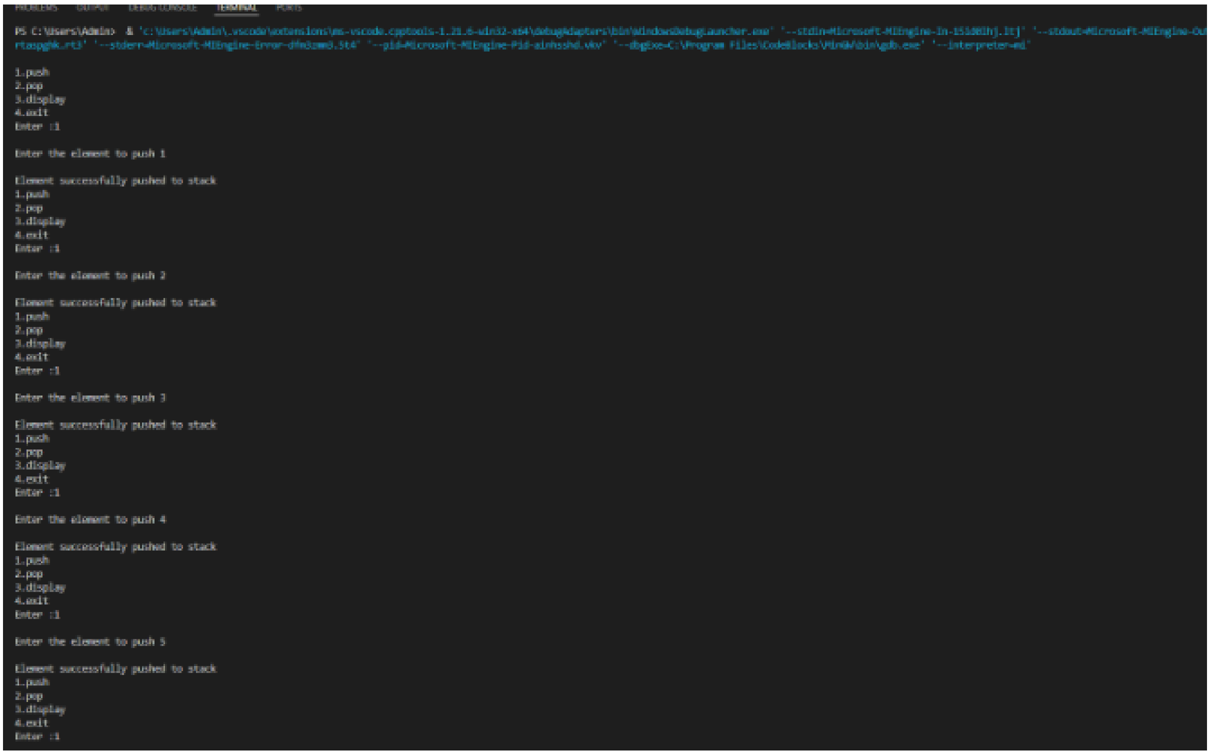
| | |
|---|---|
| CO1 | Apply the concept of linear and nonlinear data structures. |
| CO2 | Analyze data structure operations for a given problem |
| CO3 | Design and develop solutions using the operations of linear and nonlinear data structure for a given specification. |
| CO4 | Conduct practical 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 SIZE 5
int stack[SIZE];
int top=-1;

void push(int a)
{
  if(top==SIZE-1)
  {
    printf("\nStack is full,overflow condition");
  }
  else
  {
    top++;
    stack[top]=a;
    printf("\nElement successfully pushed to stack");
  }
}
void pop()
{
  if(top==-1)
  {
    printf("\nStack is empty,underflow condition");
  }
  else
  {
    int ele = stack[top];
    printf("\nElement %d has been successfully popped",ele);
    top--;
  }
}
void display()
{
  if(top==-1)
  {
    printf("\nstack is empty,underflow condition");
  }
  else
  {
    for(int i=top;i>-1;i--)
    {
      printf("%d ",stack[i]);
    }
  }
}
```

```
void main()
{
   int c,e;
   while(1)
   {
      printf("\n\n1.push\n2.pop\n3.display\n4.exit\nEnter :");
      scanf("%d",&c);
      switch (c)
      {
         case 1: printf("\nEnter the element to push ");
               scanf("%d",&e);
               push(e);
               break;
         case 2: pop();
               break;
         case 3: display();
               break;
         case 4: exit(1);
         default : printf("\nInvalid input");
      }
   }
}
```



```
Enter the element to push 6

Stack is full,overflow condition
1.push
2.pop
3.display
4.exit
Enter :2

Element 5 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Element 4 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Element 3 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Element 2 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Element 1 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Stack is empty,underflow condition
1.push
2.pop
3.display
4.exit
Enter :1

Enter the element to push 1
```

```
Element successfully pushed to stack
1.push
2.pop
3.display
4.exit
Enter :1

Enter the element to push 2

Element successfully pushed to stack
1.push
2.pop
3.display
4.exit
Enter :1

Enter the element to push 3

Element successfully pushed to stack
1.push
2.pop
3.display
4.exit
Enter :1

Enter the element to push 4

Element successfully pushed to stack
1.push
2.pop
3.display
4.exit
Enter :1

Enter the element to push 5

Element successfully pushed to stack
1.push
2.pop
3.display
4.exit
Enter :1

Enter the element to push 6

Stack is full,overflow condition
1.push
2.pop
3.display
4.exit
Enter :3
54321
1.push
2.pop
```

```
Element 5 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Element 4 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Element 3 has been successfully popped
1.push
2.pop
3.display
4.exit
Enter :2

Element 2 has been successfully popped
1.push
1.push
2.pop
3.display
4.exit
Enter :2

4.exit
Enter :2

Enter :2

Element 1 has been successfully popped
1.push
1.push
2.pop
3.display
4.exit
Enter :2

Stack is empty,underflow condition
1.push
2.pop
3.display
4.exit
Enter :3
3.display
4.exit
Enter :1
Enter :3
```

```
PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL   PORTS
4.exit
Enter :2

Enter :2

Element 1 has been successfully popped
1.push
1.push
2.pop
3.display
4.exit
Enter :2

Stack is empty,underflow condition
1.push
2.pop
3.display
4.exit
Enter :3
3.display
4.exit
Enter :3
Enter :3


stack is empty,underflow condition
1.push
2.pop
3.display
4.exit
Enter :5

Invalid input
1.push
2.pop
3.display
4.exit
Enter :4
PS C:\Users\Admin> []
```

**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 <string.h>

int index1 = 0, pos = 0, top = -1, length;
char symbol, temp, infix[20], postfix[20], stack[20];
void infixToPostfix();
void push(char symbol);
char pop();
int pred(char symbol);
int main() {
    printf("Enter infix expression:\n");
    scanf("%s", infix);
    infixToPostfix();
    printf("\nInfix expression: %s", infix);
    printf("\nPostfix expression: %s\n", postfix);
    return 0;
}
void infixToPostfix() {
    length = strlen(infix);
    push('#'); // Push an initial dummy character to the stack
    while (index1 < length) {
        symbol = infix[index1];
        switch (symbol) {
            case '(':
                push(symbol);
                break;
            case ')':
                temp = pop();
                while (temp != '(') {
                    postfix[pos++] = temp;
                    temp = pop();
                }
                break;
            case '+':
            case '-':
            case '*':
            case '/':
            case '^':
                while (pred(stack[top]) >= pred(symbol)) {
                    temp = pop();
                    postfix[pos++] = temp;
                }
                push(symbol);
                break;
            default:
                postfix[pos++] = symbol;
        }
        index1++;
    }
    while (top > 0) {
        temp = pop();
        postfix[pos++] = temp;
    }
    postfix[pos] = '\0';
}

void push(char symbol) {
    top = top + 1;
    stack[top] = symbol;
```

```
}

char pop() {
    char symb;
    symb = stack[top];
    top = top - 1;
    return symb;
}

int pred(char symbol) {
    int p;
    switch (symbol) {
        case '^':
            p = 3;
            break;
        case '*':
        case '/':
            p = 2;
            break;
        case '+':
        case '-':
            p = 1;
            break;
        case '(':
            p = 0;
            break;
        case '#':
            p = -1;
            break;
        default:
            p = -1;
    }
    return p;
}
```

**Output:**

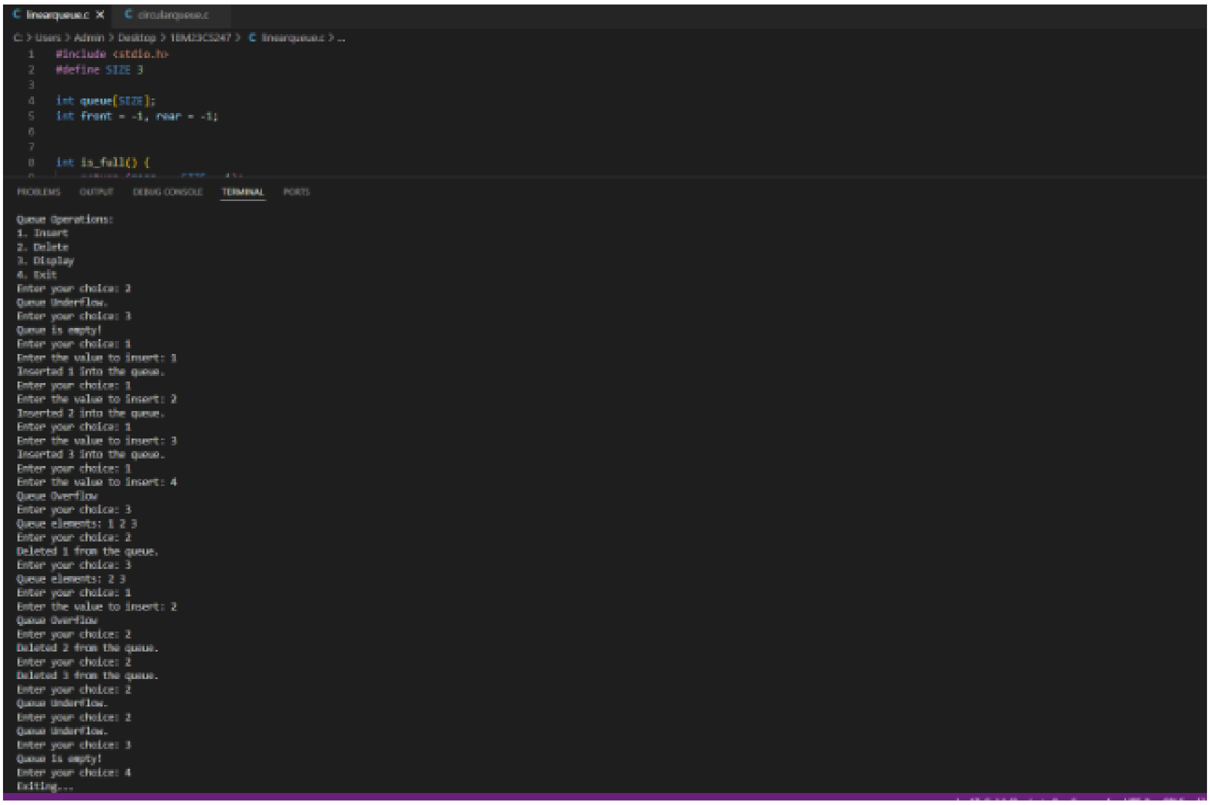
```
Enter infix expression:
7-8+(6-8)*11

Infix expression: 7-8+(6-8)*11
Postfix expression: 78-68-11*+
```

**Lab Program 3**

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

```
#include <stdio.h>
#define SIZE 3

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


int is_full() {
   return (rear == SIZE - 1);
}


int is_empty() {
   return (front == -1);
}


void insert(int value) {
   if (is_full()) {
      printf("Queue Overflow\n");
      return;
   }
   if (front == -1)
      front = 0;
   queue[++rear] = value;
   printf("Inserted %d into the queue.\n", value);
}


void delete() {
   if (is_empty()) {
      printf("Queue Underflow.\n");
      return;
   }
   printf("Deleted %d from the queue.\n", queue[front]);
   front++;
   if (front > rear) {
      front = -1;
      rear = -1;
   }
}

void display() {
   if (is_empty()) {
```

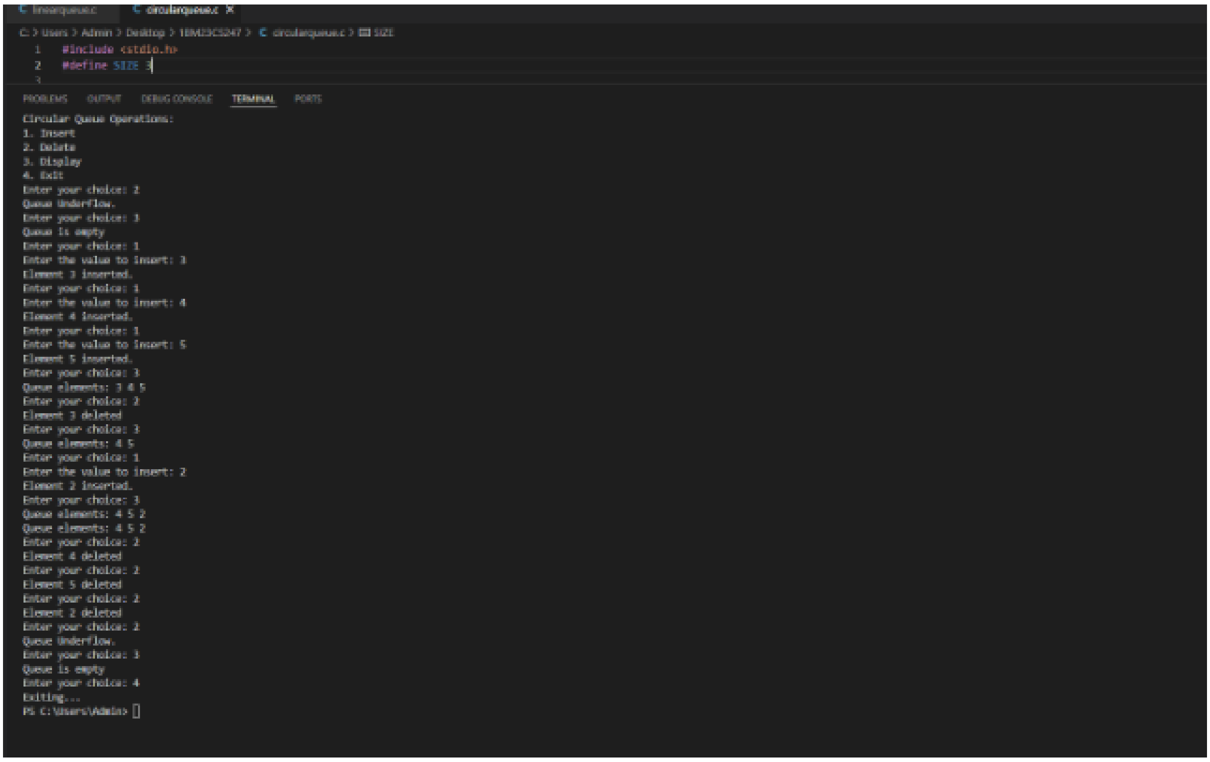
```
        printf("Queue is empty!\n");
        return;
    }
    printf("Queue elements: ");
    for (int i = front; i <= rear; i++) {
        printf("%d ", queue[i]);
    }
    printf("\n");
}


int main() {
    int choice, value;
    printf("\nQueue Operations:\n");
    printf("1. Insert\n");
    printf("2. Delete\n");
    printf("3. Display\n");
    printf("4. Exit\n");
    while (1) {
        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:
                delete();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }
}
```


linearqueue.c
circularqueue.c
C: > Users > Admin > Desktop > 1BM23CS247 > linearqueue.c > ...
#include <stdio.h>
#define SIZE 3
int queue[SIZE];
int front = -1, rear = -1;
int is_full() {
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
PORTS
Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Queue Underflow.
Enter your choice: 3
Queue is empty!
Enter your choice: 1
Enter the value to insert: 1
Inserted 1 into the queue.
Enter your choice: 1
Enter the value to insert: 2
Inserted 2 into the queue.
Enter your choice: 1
Enter the value to insert: 3
Inserted 3 into the queue.
Enter your choice: 1
Enter the value to insert: 4
Queue Overflow
Enter your choice: 3
Queue elements: 1 2 3
Enter your choice: 2
Deleted 1 from the queue.
Enter your choice: 3
Queue elements: 2 3
Enter your choice: 1
Enter the value to insert: 2
Queue Overflow
Enter your choice: 2
Deleted 2 from the queue.
Enter your choice: 2
Deleted 3 from the queue.
Enter your choice: 2
Queue Underflow.
Enter your choice: 2
Queue Underflow.
Enter your choice: 3
Queue is empty!
Enter your choice: 4
Exiting...

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

```
#include <stdio.h>
#define SIZE 3

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


int is_full() {
   return (front == (rear + 1) % SIZE);
}


int is_empty() {
   return (front == -1);
}


void insert(int n) {
   if (is_full()) {
      printf("Queue Overflow\n");
      return;
   }
   if (is_empty())
      front = 0;
      rear = 0;
   else
      rear = (rear + 1) % SIZE;
   queue[rear] = n;
   printf("Element %d inserted.\n", n);
}


void delete() {
   if (is_empty()) {
      printf("Queue Underflow.\n");
      return;
   }
   printf("Element %d deleted\n", queue[front]);
   if (front == rear){
      front = -1;
      rear = -1;
   }
   else
      front = (front + 1) % SIZE;
}
```

```
void display() {
   if (is_empty()) {
      printf("Queue is empty\n");
      return;
   }
   printf("Queue elements: ");
   int i = front;
   while (1) {
      printf("%d ", queue[i]);
      if (i == rear)
         break;
      i = (i + 1) % SIZE;
   }
   printf("\n");
}

int main() {
   int choice, value;
   printf("\nCircular Queue Operations:\n");
   printf("1. Insert\n");
   printf("2. Delete\n");
   printf("3. Display\n");
   printf("4. Exit\n");
   while (1) {
      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:
            delete();
            break;
         case 3:
            display();
            break;
         case 4:
            printf("Exiting...\n");
            return 0;
         default:
            printf("Invalid choice! Please try again.\n");
      }
   }
}
```



```
#include <stdio.h>
#define SIZE 3
```

```
Circular Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Queue Underflow.
Enter your choice: 3
Queue is empty
Enter your choice: 1
Enter the value to insert: 3
Element 3 inserted.
Enter your choice: 1
Enter the value to insert: 4
Element 4 inserted.
Enter your choice: 1
Enter the value to insert: 5
Element 5 inserted.
Enter your choice: 3
Queue elements: 3 4 5
Enter your choice: 2
Element 3 deleted
Enter your choice: 3
Queue elements: 4 5
Enter your choice: 1
Enter the value to insert: 2
Element 2 inserted.
Enter your choice: 3
Queue elements: 4 5 2
Queue elements: 4 5 2
Enter your choice: 2
Element 4 deleted
Enter your choice: 2
Element 5 deleted
Enter your choice: 2
Element 2 deleted
Enter your choice: 2
Queue Underflow.
Enter your choice: 3
Queue is empty
Enter your choice: 4
Exiting...
PS C:\Users\Admin>
```

**Lab Program 4**
**WAP to Implement Singly Linked List with following operations**
**a) Create LinkedList.**
**b) Insertion of a node at first position, at any position and at end of list.**
**c) Deletion of first element, specified element and last element in the list.**
**Display the contents of the linked list**.

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

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

// Create a new node
struct Node* create_node(int data) {
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));
   new_node->data = data;
   new_node->next = NULL;
   return new_node;
}

// Insert node at the beginning
void insert_at_beginning(struct Node** head, int data) {
   struct Node* new_node = create_node(data);
   new_node->next = *head;
   *head = new_node;
}

// Insert node at the end
void insert_at_end(struct Node** head, int data) {
   struct Node* new_node = create_node(data);
   if (*head == NULL) {
      *head = new_node;
      return;
   }
   struct Node* temp = *head;
   while (temp->next != NULL) {
      temp = temp->next;
   }
   temp->next = new_node;
}

// Insert node at a specific position
void insert_at_position(struct Node** head, int data, int position) {
   if (position < 0) return;  // Invalid position
   if (position == 0) {
      insert_at_beginning(head, data);
      return;
   }
```

```c
    struct Node* new_node = create_node(data);
    struct Node* temp = *head;
    for (int i = 0; i < position - 1; i++) {
        if (temp == NULL) return;  // Position out of range
        temp = temp->next;
    }
    new_node->next = temp->next;
    temp->next = new_node;
}

// Delete node at the beginning
void delete_at_beginning(struct Node** head) {
    if (*head != NULL) {
        struct Node* temp = *head;
        *head = (*head)->next;
        free(temp);
    }
}

// Delete node at the end
void delete_at_end(struct Node** head) {
    if (*head == NULL) return;
    if ((*head)->next == NULL) {
        free(*head);
        *head = NULL;
        return;
    }
    struct Node* temp = *head;
    while (temp->next && temp->next->next != NULL) {
        temp = temp->next;
    }
    free(temp->next);
    temp->next = NULL;
}

// Delete node with a specific key
void delete_at_key(struct Node** head, int key) {
    if (*head == NULL) return;
    if ((*head)->data == key) {
        struct Node* temp = *head;
        *head = (*head)->next;
        free(temp);
        return;
    }
    struct Node* temp = *head;
    while (temp->next != NULL && temp->next->data != key) {
        temp = temp->next;
    }
    if (temp->next == NULL) return;
    struct Node* to_delete = temp->next;
    temp->next = temp->next->next;
```

```
    free(to_delete);
}

// Delete node before the key
void delete_before_key(struct Node** head, int key) {
    if (*head == NULL || (*head)->next == NULL) return;
    if ((*head)->next->data == key) {
        struct Node* temp = *head;
        *head = (*head)->next;
        free(temp);
        return;
    }
    struct Node* temp = *head;
    while (temp->next != NULL && temp->next->next != NULL) {
        if (temp->next->next->data == key) {
            struct Node* to_delete = temp;
            temp = temp->next;
            free(to_delete);
            return;
        }
        temp = temp->next;
    }
}

// Delete node after the key
void delete_after_key(struct Node** head, int key) {
    struct Node* temp = *head;
    while (temp != NULL && temp->data != key) {
        temp = temp->next;
    }
    if (temp != NULL && temp->next != NULL) {
        struct Node* to_delete = temp->next;
        temp->next = temp->next->next;
        free(to_delete);
    }
}

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

// Free all nodes to avoid memory leaks
void free_list(struct Node** head) {
    struct Node* temp;
    while (*head != NULL) {
```

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

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

    printf("Choice
:\n1.insert_at_beginning\n2.insert_at_end\n3.insert_at_position\n4.delete_at_beginning\n5.delete
_at_end\n6.delete_at_key\n7.delete_before_key\n8.delete_after_key\n9.display\n10.exit\n");

    int c;
    while (1) {
        printf("Enter choice: ");
        scanf("%d", &c);
        switch (c) {
            case 1:
                printf("Enter the data: ");
                scanf("%d", &data);
                insert_at_beginning(&head, data);
                break;
            case 2:
                printf("Enter the data: ");
                scanf("%d", &data);
                insert_at_end(&head, data);
                break;
            case 3:
                printf("Enter the data and position: ");
                scanf("%d%d", &data, &key);
                insert_at_position(&head, data, key);
                break;
            case 4:
                delete_at_beginning(&head);
                break;
            case 5:
                delete_at_end(&head);
                break;
            case 6:
                printf("Enter the key to delete: ");
                scanf("%d", &key);
                delete_at_key(&head, key);
                break;
            case 7:
                printf("Enter the key to delete before: ");
                scanf("%d", &key);
                delete_before_key(&head, key);
                break;
            case 8:
```

```
            printf("Enter the key to delete after: ");
            scanf("%d", &key);
            delete_after_key(&head, key);
            break;
        case 9:
            display(head);
            break;
        case 10:
            exit(0);
        default:
            printf("Invalid choice...\n");
        }
    }
    return 0;
}
```

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL    PORTS

PS C:\Users\Admin> cd "c:\Users\Admin\Desktop\1BM23CS247\" ;
Choice :
1.insert_at_beginning
2.insert_at_end
3.insert_at_position
4.delete_at_beginning
5.delete_at_end
6.delete_at_key
7.delete_before_key
6.delete_at_key
7.delete_before_key
8.delete_after_key
9.display
9.display
10.exit

Enter choice:1
Enter choice:1
Enter the data : 1
Enter choice:2
Enter the data : 1
Enter choice:2
Enter the data : 2
Enter the data : 2
Enter choice:2
Enter the data : 3
Enter choice:2
Enter the data : 3
Enter choice:2
Enter choice:2
Enter the data : 4
Enter the data : 4
Enter choice:2
Enter choice:2
Enter the data : 5
Enter the data : 5
Enter choice:2
Enter the data : 6
Enter choice:2
Enter the data : 6
Enter choice:3
Enter choice:3
Enter the data and position : 3
4
Enter the data and position : 3
4
Enter choice:9
1 -> 2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:4
Enter choice:9
1 -> 2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:4
Enter choice:9
2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:9
2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:5
Enter choice:5
```

```
Enter choice:2
Enter choice:2
Enter the data : 5
Enter the data : 5
Enter choice:2
Enter the data : 6
Enter choice:2
Enter the data : 6
Enter choice:3
Enter choice:3
Enter the data and position : 3
4
Enter the data and position : 3
4
Enter choice:9
1 -> 2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:4
Enter choice:9
1 -> 2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:4
Enter choice:9
2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:9
2 -> 3 -> 4 -> 3 -> 5 -> 6 -> NULL
Enter choice:5
Enter choice:5
Enter choice:9
Enter choice:9
2 -> 3 -> 4 -> 3 -> 5 -> NULL
2 -> 3 -> 4 -> 3 -> 5 -> NULL
Enter choice:7
Enter choice:7
Enter the key to delete before :4
Enter the key to delete before :4
Enter choice:9
Enter choice:9
2 -> 3 -> 4 -> 3 -> 5 -> NULL
2 -> 3 -> 4 -> 3 -> 5 -> NULL
Enter choice:6
Enter choice:6
Enter the key to delete :3
Enter choice:9
2 -> 4 -> 3 -> 5 -> NULL
Enter choice:8
Enter the key to delete after :2
Enter choice:9
2 -> 3 -> 5 -> NULL
Enter choice:
```

**Lab Program 5**
**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;
};

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) return newNode;

    struct Node* temp = head;
    while (temp->next) temp = temp->next;
    temp->next = newNode;
    return head;
}

void printList(struct Node* head) {
    while (head) {
        printf("%d -> ", head->data);
        head = head->next;
    }
    printf("NULL\n");
}

struct Node* sortList(struct Node* head) {
    if (!head || !head->next) return head;

    struct Node* current = head;
    while (current) {
        struct Node* next = current->next;
        while (next) {
            if (current->data > next->data) {
                int temp = current->data;
                current->data = next->data;
                next->data = temp;
            }
            next = next->next;
        }
        current = current->next;
    }
    return head;
}
```

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

    do {
        printf("\n1. Insert\n2. Sort\n3. Display\n4. Exit\nEnter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert: ");
                scanf("%d", &value);
                head = insertAtEnd(head, value);
                break;
            case 2:
                head = sortList(head);
                printf("List sorted.\n");
                break;
            case 3:
                printf("Linked list: ");
                printList(head);
                break;
            case 4:
                printf("Exiting program.\n");
                break;
            default:
                printf("Invalid choice. Try again.\n");
        }
    } while (choice != 4);

    return 0;
}
```

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

1. Insert
2. Sort
3. Display
4. Exit
Enter your choice: 1
Enter value to insert: 2

1. Insert
2. Sort
3. Display
4. Exit
Enter your choice: 1
Enter value to insert: 7

1. Insert
2. Sort
3. Display
4. Exit
Enter your choice: 1
Enter value to insert: 1

1. Insert
2. Sort
3. Display
4. Exit
Enter your choice: 3
Linked list: 4 -> 2 -> 7 -> 1 -> NULL

1. Insert
2. Sort
3. Display
4. Exit
Enter your choice: 2
List sorted.

1. Insert
2. Sort
3. Display
4. Exit
Enter your choice: 3
Linked list: 1 -> 2 -> 4 -> 7 -> NULL

1. Insert
2. Sort
3. Display
4. Exit
Enter your choice: 4
Exiting program.
```

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

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

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) return newNode;

    struct Node* temp = head;
    while (temp->next) temp = temp->next;
    temp->next = newNode;
    return head;
}

void printList(struct Node* head) {
    while (head) {
        printf("%d -> ", head->data);
        head = head->next;
    }
    printf("NULL\n");
}

struct Node* reverseList(struct Node* head) {
    struct Node* prev = NULL;
    struct Node* current = head;
    struct Node* next = NULL;

    while (current) {
        next = current->next;
        current->next = prev;
        prev = current;
        current = next;
    }
    return prev;
}

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

    printf("Enter values to create a linked list (-1 to stop): ");
    do {
        scanf("%d", &value);
```

```
        if (value != -1) head = insertAtEnd(head, value);
    } while (value != -1);

    printf("Original List: ");
    printList(head);

    head = reverseList(head);

    printf("Reversed List: ");
    printList(head);

    return 0;
}
```

```
Enter values to create a linked list (-1 to stop): 1 2 3 4 5 -1
Original List: 1 -> 2 -> 3 -> 4 -> 5 -> NULL
Reversed List: 5 -> 4 -> 3 -> 2 -> 1 -> NULL
```

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

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

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) return newNode;

    struct Node* temp = head;
    while (temp->next) temp = temp->next;
    temp->next = newNode;
    return head;
}

void printList(struct Node* head) {
    while (head) {
        printf("%d -> ", head->data);
        head = head->next;
    }
    printf("NULL\n");
}

struct Node* concatenateLists(struct Node* head1, struct Node* head2) {
    if (!head1) return head2;
    if (!head2) return head1;

    struct Node* temp = head1;
    while (temp->next) temp = temp->next;
    temp->next = head2;
    return head1;
}

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

    int choice, value;

    printf("Creating List 1:\n");
    do {
        printf("Enter value to insert (-1 to stop): ");
        scanf("%d", &value);
        if (value != -1) list1 = insertAtEnd(list1, value);
```

```
    } while (value != -1);

    printf("Creating List 2:\n");
    do {
        printf("Enter value to insert (-1 to stop): ");
        scanf("%d", &value);
        if (value != -1) list2 = insertAtEnd(list2, value);
    } while (value != -1);

    printf("List 1: ");
    printList(list1);

    printf("List 2: ");
    printList(list2);

    list1 = concatenateLists(list1, list2);

    printf("Concatenated List: ");
    printList(list1);

    return 0;
}
```

```
Creating List 1:
Enter value to insert (-1 to stop): 1
Enter value to insert (-1 to stop): 2
Enter value to insert (-1 to stop): 3
Enter value to insert (-1 to stop): 4
Enter value to insert (-1 to stop): -1
Creating List 2:
Enter value to insert (-1 to stop): 5
Enter value to insert (-1 to stop): 6
Enter value to insert (-1 to stop): 7
Enter value to insert (-1 to stop): -1
List 1: 1 -> 2 -> 3 -> 4 -> NULL
List 2: 5 -> 6 -> 7 -> NULL
Concatenated List: 1 -> 2 -> 3 -> 4 -> 5 -> 6 -> 7 -> NULL
```

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

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

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

struct Queue {
    struct Node* front;
    struct Node* rear;
};

struct Node* createNode(int data) {
    struct Node* node = (struct Node*)malloc(sizeof(struct Node));
    node->data = data;
    node->next = NULL;
    return node;
}

struct Queue* createQueue() {
    struct Queue* queue = (struct Queue*)malloc(sizeof(struct Queue));
    queue->front = NULL;
    queue->rear = NULL;
    return queue;
}

int isEmpty(struct Queue* queue) {
    return queue->front == NULL;
}

void enqueue(struct Queue* queue, int data) {
    struct Node* node = createNode(data);
    if (queue->rear == NULL) {
        queue->front = queue->rear = node;
        return;
    }
    queue->rear->next = node;
    queue->rear = node;
}

int dequeue(struct Queue* queue) {
    if (isEmpty(queue)) {
        printf("Queue underflow\n");
        return NULL;
    }
    struct Node* temp = queue->front;
    int data = temp->data;
    queue->front = queue->front->next;
```

```
    if (queue->front == NULL) queue->rear = NULL;
    free(temp);
    return data;
}


void display(struct Queue* queue) {
    if (isEmpty(queue)) {
        printf("Queue is empty\n");
        return;
    }
    struct Node* temp = queue->front;
    printf("Queue contents:\n");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    struct Queue* queue = createQueue();
    int choice, value;

    while (1) {
        printf("\nQueue Operations Menu:\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 value to enqueue: ");
                scanf("%d", &value);
                enqueue(queue, value);
                printf("Enqueued: %d\n", value);
                break;
            case 2:
                value = dequeue(queue);
                if (value != NULL) {
                    printf("Dequeued: %d\n", value);
                }
                break;
            case 3:
                display(queue);
                break;
            case 4:
                printf("Exiting program.\n");
```

```
            exit(0);
        default:
            printf("Invalid choice! Please try again.\n");
        }
    }
    return 0;
}
```

```
Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter value to enqueue: 1
Enqueued: 1

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter value to enqueue: 2
Enqueued: 2

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter value to enqueue: 3
Enqueued: 3

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue contents:
1 2 3

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Dequeued: 1
```

```
Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue contents:
2 3

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Dequeued: 2

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Dequeued: 3

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue is empty

Queue Operations Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2
Queue underflow

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

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

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

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

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

// Function to push an element onto the stack
void push(struct Node** top, int data) {
    struct Node* node = createNode(data);
    node->next = *top;
    *top = node;
    printf("\nPushed %d onto the stack.", data);
}

// Function to pop an element from the stack
int pop(struct Node** top) {
    if (isEmpty(*top)) {
        printf("Stack underflow\n");
        return -1; // Return -1 to indicate the stack is empty
    }
    struct Node* temp = *top;
    int data = temp->data;
    *top = (*top)->next;
    free(temp);
    return data;
}

// Function to display the elements in the stack
void display(struct Node* top) {
    if (isEmpty(top)) {
        printf("Stack is empty\n");
        return;
    }
    struct Node* temp = top;
    printf("\nStack: ");
```

```
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

// Main function with switch-based menu
int main() {
    struct Node* stack = NULL;
    int choice, value;

    while (1) {
        printf("\nStack Operations Menu:\n");
        printf("1. Push\n");
        printf("2. Pop\n");
        printf("3. Display\n");
        printf("4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to push: ");
                scanf("%d", &value);
                push(&stack, value);
                break;
            case 2:
                value = pop(&stack);
                if (value != -1) { // Check for valid pop operation
                    printf("Popped: %d\n", value);
                }
                break;
            case 3:
                display(stack);
                break;
            case 4:
                printf("Exiting program.\n");
                exit(0);
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }

    return 0;
}
```

```
Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter value to push: 1

Pushed 1 onto the stack.
Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter value to push: 2

Pushed 2 onto the stack.
Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter value to push: 3

Pushed 3 onto the stack.
Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter value to push: 4

Pushed 4 onto the stack.
Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3

Stack: 4 3 2 1
```

```
Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
Popped: 4

Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
Popped: 3

Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
Popped: 2

Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
Popped: 1

Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
Stack is empty
```

```
Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
Stack is empty

Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
Stack underflow

Stack Operations Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 4
Exiting program.
```

**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>

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


node* createnode(int data){
    node* newnode=(node*)malloc(sizeof(node));
    newnode->prev=NULL;
    newnode->next=NULL;
    newnode->data=data;
    return newnode;
}

struct node* createDoublyLinkedList() {
    return NULL;
}
int isempty(node* head){
    return head==NULL;
}

node* insert_at_beginning(int data, node* head){
    node* newnode=createnode(data);
    newnode->next=head;
    if(head!=NULL)
        head->prev=newnode;
    head=newnode;
    printf("%d has been successfully inserted.\n",data);
    return head;
}

node* insert_to_left(int data, int key, node* head) {
    node* temp = head;

    while (temp != NULL && temp->data != key) {
        temp = temp->next;
    }

    if (temp == NULL) {
        printf("Key not found\n");
```

```
        return head;
    }

    node* newnode = createnode(data);
    newnode->next = temp;
    newnode->prev = temp->prev;

    if (temp->prev != NULL) {
        temp->prev->next = newnode;
    } else {
        head = newnode;
    }

    temp->prev = newnode;

    printf("%d has been successfully inserted left of %d\n", data, key);
    return head;
}


node* deletenode(int key,node* head){
    if(isempty(head)){
        printf("List is empty hence cannot delete a node\n ");
        return head;
    }
    node* temp=head;
    while(temp!=NULL && temp->data!=key){
        temp=temp->next;
    }
    if(temp==NULL){
        printf("Key not found\n");
        return head;
    }
    if (temp->prev != NULL) {
        temp->prev->next = temp->next;
    } else {
        head = temp->next;
    }

    if (temp->next != NULL) {
        temp->next->prev = temp->prev;
    }
    printf("The node has been deleted\n");
    free(temp);
    return head;
}

void display(node* head){
    node* temp=head;
    if(isempty(head)){
        printf("List is empty\n");
```

```
        return;
    }
    printf("List elements : ");
    while(temp->next!=NULL){
        printf("%d <-> ",temp->data);
        temp=temp->next;
    }
    printf("%d -> NULL\n",temp->data);
}

int main() {
    node* head = createDoublyLinkedList();
    int choice, value, key;
    printf("\nDoubly Linked List Operations:\n");
    printf("1. Insert at the beginning\n");
    printf("2. Insert to the left of a specific node\n");
    printf("3. Delete a node by value\n");
    printf("4. Display the list\n");
    printf("5. Exit\n");
    while (1) {
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the new value to insert: ");
                scanf("%d", &value);
                head=insert_at_beginning(value,head);
                break;
            case 2:
                if(!isempty(head)){
                    printf("Enter the key value: ");
                    scanf("%d", &key);
                    printf("Enter the new value to insert: ");
                    scanf("%d", &value);
                    head=insert_to_left(value,key,head);
                }
                else
                    printf("List is empty hence cannot insert to left.\n");
                break;

            case 3:
                if(!isempty(head)){
                    printf("Enter the value of the node to delete: ");
                    scanf("%d", &value);
                    head=deletenode(value,head);
                }
                else
                    printf("List is empty hence cannot delete.\n");
                break;
```

```
        case 4:
          display(head);
          break;

        case 5:
          printf("Exiting program.\n");
          exit(0);

        default:
          printf("Invalid choice. Please try again.\n");
      }
    }
    return 0;
}
```

```
C:\247\doublylinkedlist.exe

Doubly Linked List Operations:
1. Insert at the beginning
2. Insert to the left of a specific node
3. Delete a node by value
4. Display the list
5. Exit
Enter your choice: 2
List is empty hence cannot insert to left.
Enter your choice: 1
Enter the new value to insert: 1
1 has been successfully inserted.
Enter your choice: 2
Enter the key value: 1
Enter the new value to insert: 3
3 has been successfully inserted left of 1
Enter your choice: 4
List elements : 3 <-> 1 -> NULL
Enter your choice: 2
Enter the key value: 1
Enter the new value to insert: 2
2 has been successfully inserted left of 1
Enter your choice: 4
List elements : 3 <-> 2 <-> 1 -> NULL
Enter your choice: 3
Enter the value of the node to delete: 2
The node has been deleted
Enter your choice: 3
Enter the value of the node to delete: 2
Key not found
Enter your choice: 3
Enter the value of the node to delete: 3
The node has been deleted
Enter your choice: 3
Enter the value of the node to delete: 1
The node has been deleted
Enter your choice: 4
List is empty
Enter your choice: 3
List is empty hence cannot delete.
Enter your choice: 7
Invalid choice. Please try again.
Enter your choice: 5
Exiting program.

Process returned 0 (0x0)   execution time : 462.681 s
Press any key to continue.
```

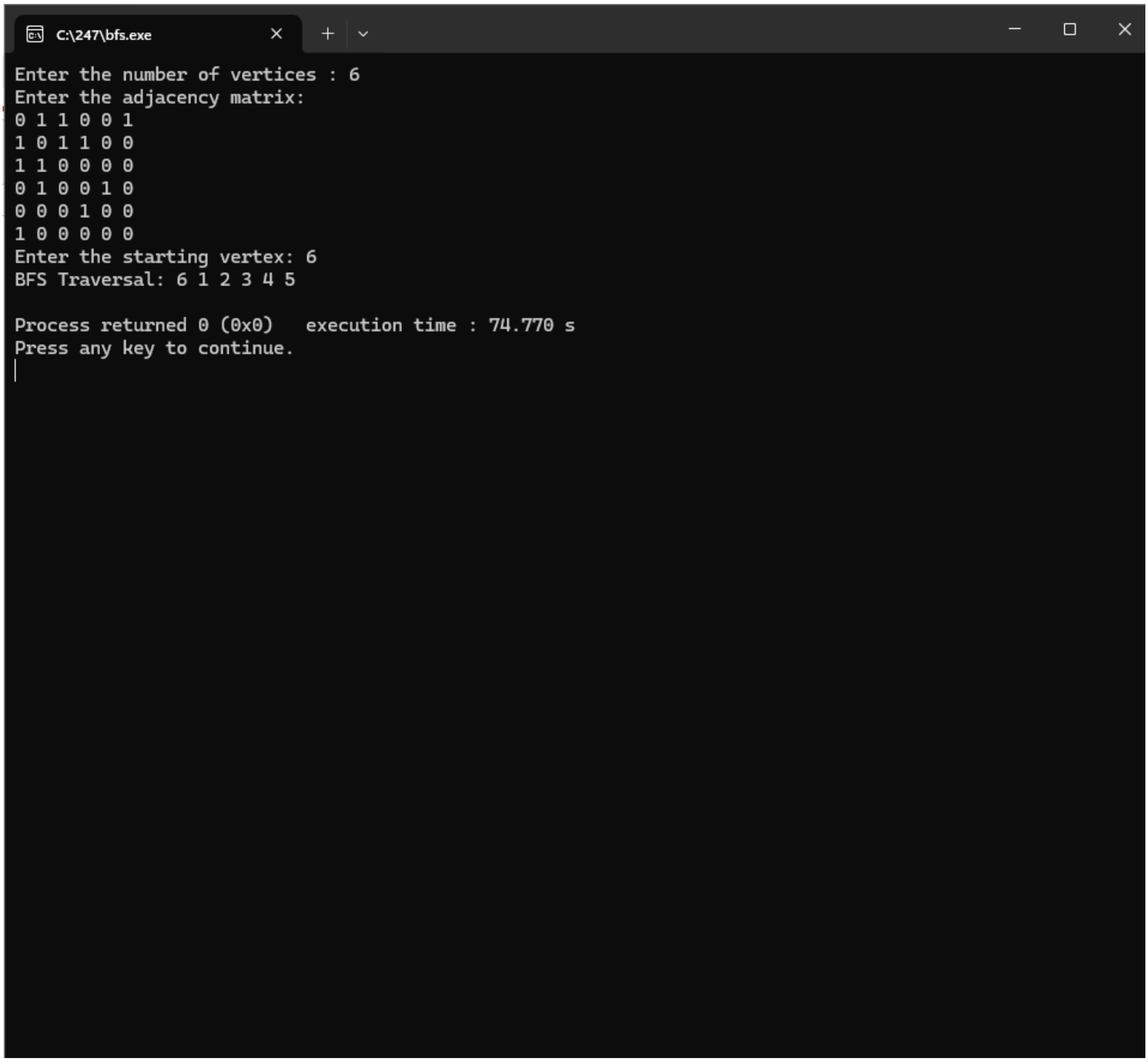
Activate Windows
Go to Settings to activate Windc

**Lab Program 8**
**Write a program**
**a) To construct a binary Search tree.**
**b) To traverse the tree using all the methods i.e., inorder, preorder and post order**
**c) To display the elements in the tree.**

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

struct Node {
    int data;
    struct Node* left;
    struct Node* right;
};

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

struct Node* insert(struct Node* root, int data) {
    if (root == NULL) {
        return createNode(data);
    }
    if (data < root->data) {
        root->left = insert(root->left, data);
    } else if (data > root->data) {
        root->right = insert(root->right, data);
    }
    return root;
}

void inorderTraversal(struct Node* root) {
    if (root == NULL) {
        return;
    }
    inorderTraversal(root->left);
    printf("%d ", root->data);
    inorderTraversal(root->right);
}

void preorderTraversal(struct Node* root) {
    if (root == NULL) {
        return;
    }
    printf("%d ", root->data);
    preorderTraversal(root->left);
    preorderTraversal(root->right);
}
```

```
void postorderTraversal(struct Node* root) {
    if (root == NULL) {
        return;
    }
    postorderTraversal(root->left);
    postorderTraversal(root->right);
    printf("%d ", root->data);
}

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

    while (1) {
        printf("\nBinary Search Tree Operations:\n");
        printf("1. Insert a node\n");
        printf("2. In-order traversal\n");
        printf("3. Pre-order traversal\n");
        printf("4. Post-order traversal\n");
        printf("5. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
                scanf("%d", &data);
                root = insert(root, data);
                printf("Node %d inserted.\n", data);
                break;

            case 2:
                printf("In-order traversal: ");
                inorderTraversal(root);
                printf("\n");
                break;

            case 3:
                printf("Pre-order traversal: ");
                preorderTraversal(root);
                printf("\n");
                break;

            case 4:
                printf("Post-order traversal: ");
                postorderTraversal(root);
                printf("\n");
                break;

            case 5:
```

```
            printf("Exiting...\n");
            exit(0);

        default:
            printf("Invalid choice, please try again.\n");
      }
   }

   return 0;
}
```



**Lab Program 9**

**Write a program to traverse a graph using BFS method**

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

#define MAX 100

struct Queue {
   int items[MAX];
   int front, rear;
};

struct Queue* createQueue() {
   struct Queue* q = (struct Queue*)malloc(sizeof(struct Queue));
   q->front = -1;
   q->rear = -1;
   return q;
}

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

void enqueue(struct Queue* q, int value) {
   if (q->rear == MAX - 1) {
      printf("Queue is full\n");
   } else {
      if (q->front == -1) {
         q->front = 0;
      }
      q->items[++q->rear] = value;
   }
}

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

```
void bfs(int graph[MAX][MAX], int startVertex, int n) {
    int visited[MAX] = {0};
    struct Queue* q = createQueue();

    visited[startVertex] = 1;
    enqueue(q, startVertex);

    printf("BFS Traversal: ");

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

        for (int i = 1; i <= n; i++) {
            if (graph[currentVertex][i] == 1 && !visited[i]) {
                visited[i] = 1;
                enqueue(q, i);
            }
        }
    }

    printf("\n");
}

int main() {
    int n, startVertex;
    int graph[MAX][MAX];

    printf("Enter the number of vertices : ");
    scanf("%d", &n);

    printf("Enter the adjacency matrix:\n");
    for (int i = 1; i <= n; i++) {
        for (int j = 1; j <= n; j++) {
            scanf("%d", &graph[i][j]);
        }
    }

    printf("Enter the starting vertex: ");
    scanf("%d", &startVertex);

    bfs(graph, startVertex, n);

    return 0;
}
```

```
C:\247\bst.exe

Enter the key to be inserted: 20
Key 20 inserted successfully!

Enter your choice: 1
Enter the key to be inserted: 40
Key 40 inserted successfully!

Enter your choice: 1
Enter the key to be inserted: 60
Key 60 inserted successfully!

Enter your choice: 1
Enter the key to be inserted: 80
Key 80 inserted successfully!

Enter your choice: 2
In-order traversal: 20 30 40 50 60 70 80

Enter your choice: 3
Pre-order traversal: 50 30 20 40 70 60 80

Enter your choice: 4
Post-order traversal: 20 40 30 60 80 70 50

Enter your choice: 5
Exiting...

Process returned 0 (0x0)   execution time : 42.089 s
Press any key to continue.
```

**Lab Program 9**
**Write a program to check whether given graph is connected or not using DFS method.**

```
#include <stdio.h>

#define MAX_NODES 100

int adjacencyMatrix[MAX_NODES][MAX_NODES];
int visited[MAX_NODES];
int nodes;

// Function for DFS
void DFS(int vertex) {
    visited[vertex] = 1;
    printf("%d ", vertex);  // Print visited node

    for (int i = 0; i < nodes; i++) {
        if (adjacencyMatrix[vertex][i] == 1 && !visited[i]) {
            DFS(i);
        }
    }
}

// Function to check if the graph is connected
int isConnected() {
    // Initialize visited array to 0
    for (int i = 0; i < nodes; i++) {
        visited[i] = 0;
    }

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

    // Check if all nodes are visited
    for (int i = 0; i < nodes; i++) {
        if (!visited[i]) {
            return 0;  // Graph is not connected
        }
    }
    return 1;  // Graph is connected
}

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

    printf("Enter the adjacency matrix:\n");
    for (int i = 0; i < nodes; i++) {
        for (int j = 0; j < nodes; j++) {
            scanf("%d", &adjacencyMatrix[i][j]);
        }
```

```
    }

    // Check connectivity
    if (isConnected()) {
        printf("\nThe graph is connected.\n");
    } else {
        printf("\nThe graph is not connected.\n");
    }

    return 0;
}
```

```
Enter the number of nodes: 4
Enter the adjacency matrix:
0 1 1 0
1 0 0 1
1 0 0 0
0 1 0 0
0 1 3 2
The graph is connected.
```

**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 MAX_SIZE 100  // Maximum size of the hash table

int hashTable[MAX_SIZE];  // Hash table to store employee keys
int m;  // Number of memory locations in the hash table

// Function to initialize the hash table
void initializeHashTable() {
    for (int i = 0; i < m; i++) {
        hashTable[i] = -1;  // Initialize all locations as empty (-1 indicates empty)
    }
}

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

// Function to insert a key into the hash table using linear probing
void insertKey(int key) {
    int address = hashFunction(key);  // Compute the initial hash address

    // Linear probing to resolve collision
    int originalAddress = address;
    while (hashTable[address] != -1) {  // While the location is occupied
        printf("Collision detected at address %d for key %d. Probing...\n", address, key);
        address = (address + 1) % m;  // Move to the next location
        if (address == originalAddress) {  // If we come back to the start, table is full
            printf("Hash table is full! Cannot insert key %d.\n", key);
            return;
        }
    }
    hashTable[address] = key;  // Place the key at the resolved address
    printf("Key %d inserted at address %d.\n", key, address);
}

// Function to display the hash table
void displayHashTable() {
    printf("\nHash Table:\n");
    for (int i = 0; i < m; i++) {
        if (hashTable[i] == -1)
```

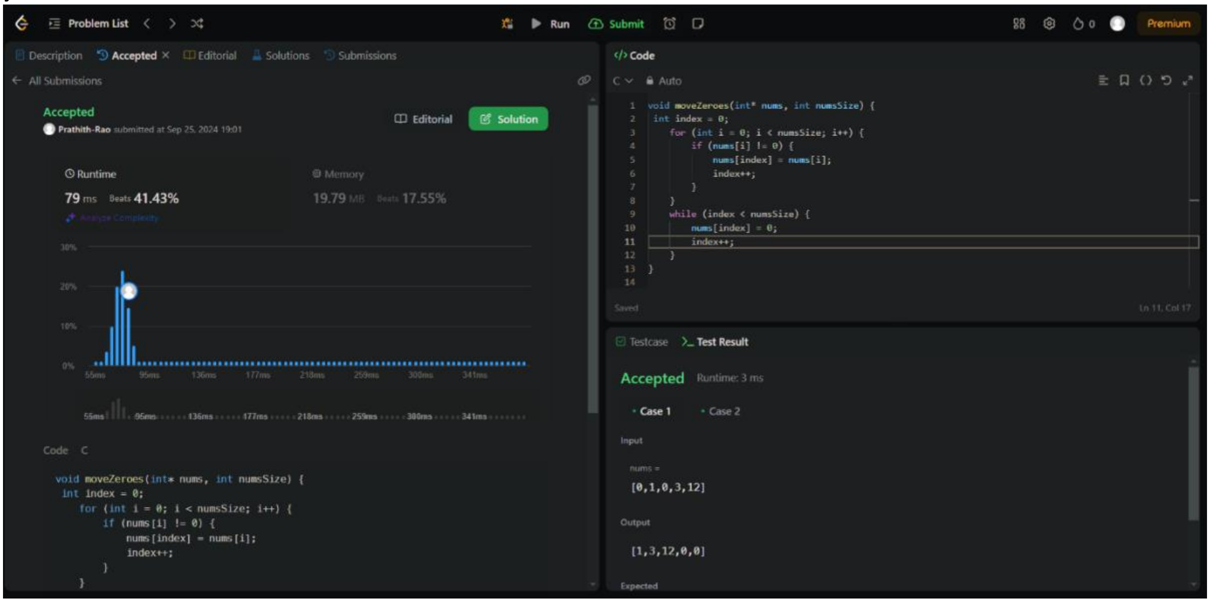
```
            printf("Address %d: EMPTY\n", i);
        else
            printf("Address %d: %d\n", i, hashTable[i]);
    }
}

int main() {
    int n;  // Number of employee keys
    int key;

    printf("Enter the number of memory locations in the hash table (m): ");
    scanf("%d", &m);
    if (m > MAX_SIZE) {
        printf("Error: m exceeds the maximum size %d.\n", MAX_SIZE);
        return 1;
    }

    initializeHashTable();  // Initialize the hash table

    printf("Enter the number of employee keys (n): ");
    scanf("%d", &n);

    printf("Enter %d employee keys (4-digit integers):\n", n);
    for (int i = 0; i < n; i++) {
        scanf("%d", &key);
        insertKey(key);  // Insert each key into the hash table
    }

    displayHashTable();  // Display the final hash table

    return 0;
}
```

```
Enter the number of memory locations in the hash table (m): 10
Enter the number of employee keys (n): 5
Enter 5 employee keys (4-digit integers):
1234
Key 1234 inserted at address 4.
5678
Key 5678 inserted at address 8.
9101
Key 9101 inserted at address 1.
2234
Collision detected at address 4 for key 2234. Probing...
Key 2234 inserted at address 5.
3234
Collision detected at address 4 for key 3234. Probing...
Collision detected at address 5 for key 3234. Probing...
Key 3234 inserted at address 6.

Hash Table:
Address 0: EMPTY
Address 1: 9101
Address 2: EMPTY
Address 3: EMPTY
Address 4: 1234
Address 5: 2234
Address 6: 3234
Address 7: EMPTY
Address 8: 5678
Address 9: EMPTY
```

**Leet Code Programs:**

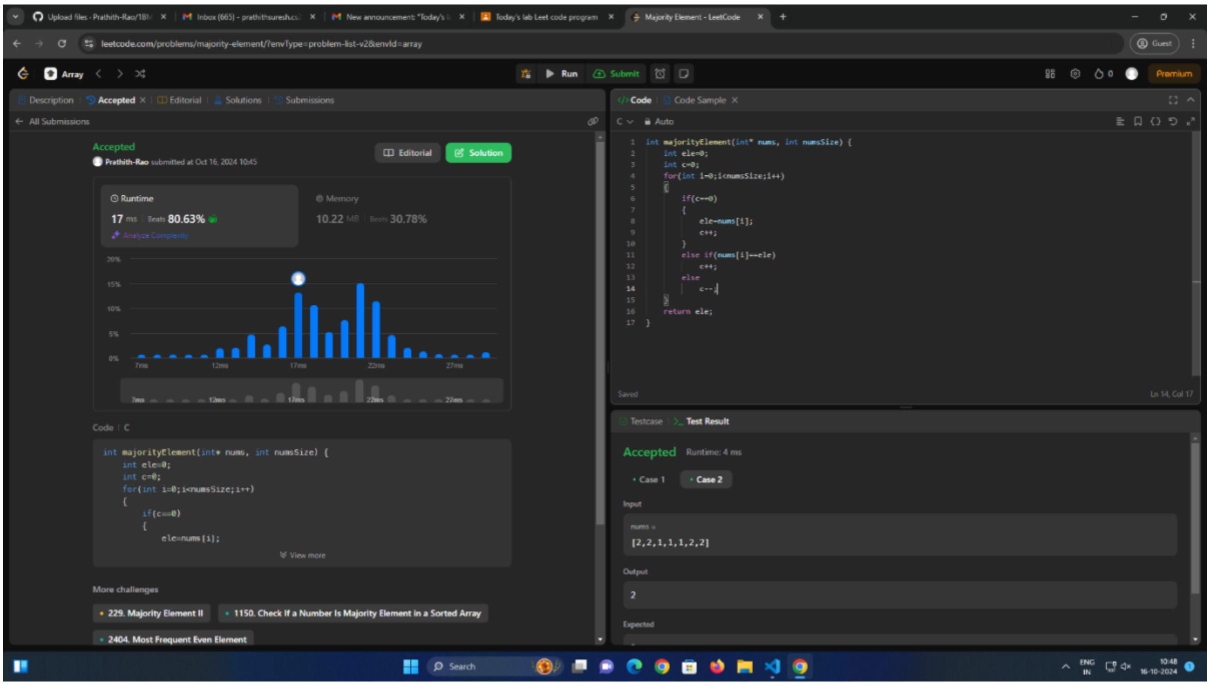
**Move_Zeroes**

```
void moveZeroes(int* nums, int numsSize) {
 int index = 0;
   for (int i = 0; i < numsSize; i++) {
      if (nums[i] != 0) {
         nums[index] = nums[i];
         index++;
      }
   }
   while (index < numsSize) {
      nums[index] = 0;
      index++;
   }
}
```



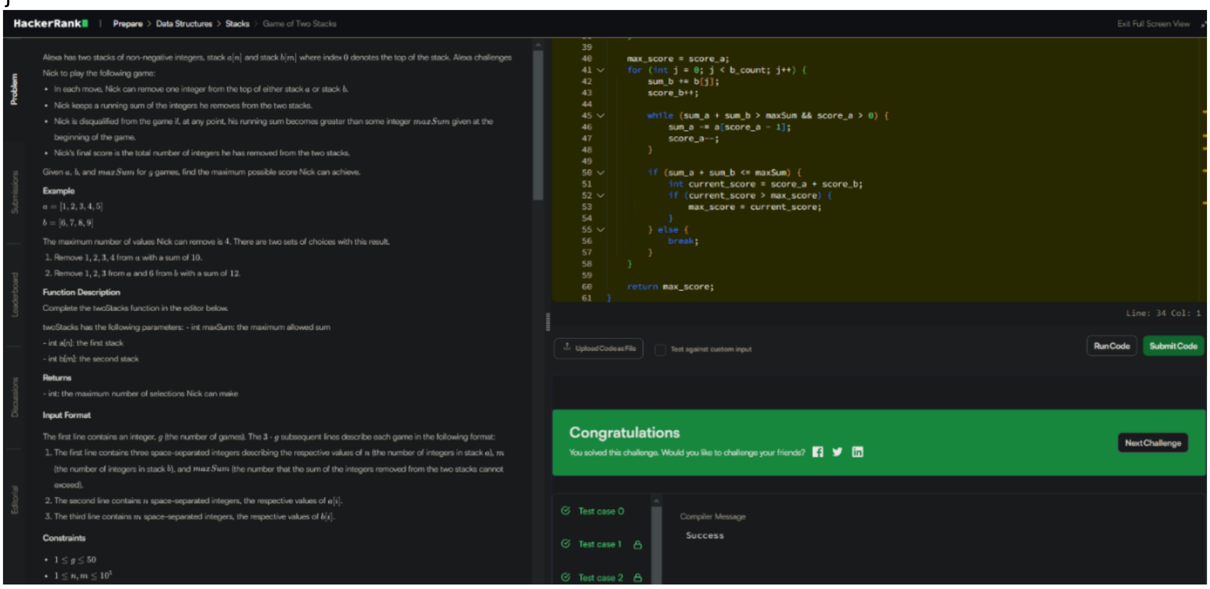
**leetcode_majority_ele**

```
int majorityElement(int* nums, int numsSize) {
   int ele=0;
   int c=0;
   for(int i=0;i<numsSize;i++)
   {
      if(c==0)
      {
         ele=nums[i];
         c++;
      }
      else if(nums[i]==ele)
         c++;
      else
         c--;
   }
   return ele;
}
```



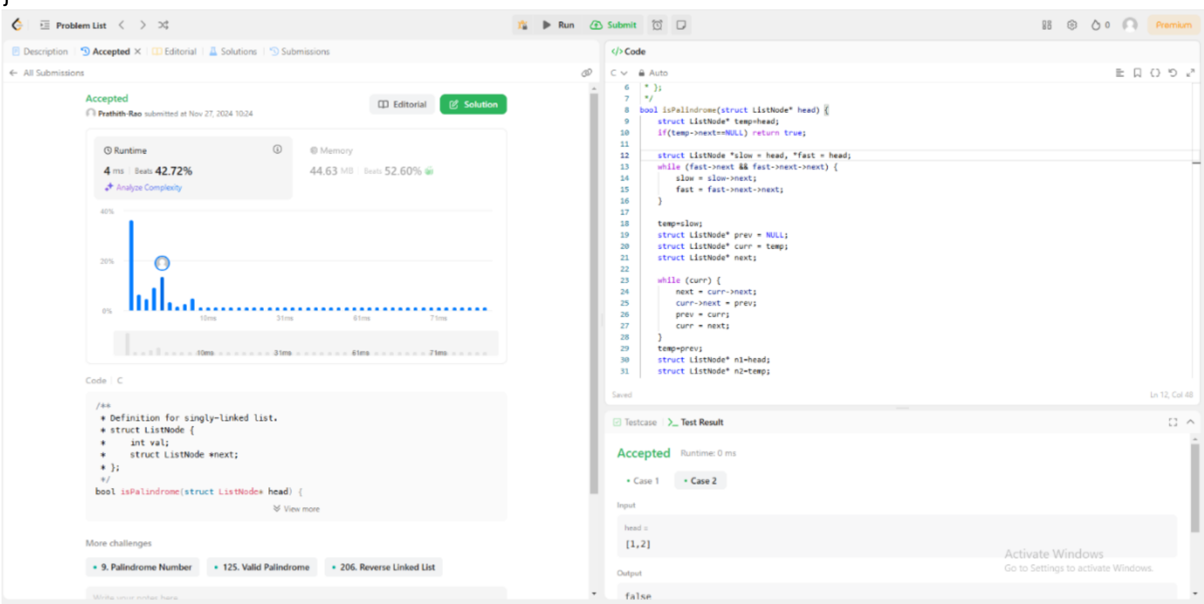
**Game of two stacks**

```
int twoStacks(int maxSum, int a_count, int* a, int b_count, int* b) {
    int sum_a = 0, score_a = 0;
    int sum_b = 0, score_b = 0;
    int max_score = 0;

    for (int i = 0; i < a_count; i++) {
        if (sum_a + a[i] > maxSum) break;
        sum_a += a[i];
        score_a++;
    }

    max_score = score_a;
    for (int j = 0; j < b_count; j++) {
        sum_b += b[j];
        score_b++;

        while (sum_a + sum_b > maxSum && score_a > 0) {
            sum_a -= a[score_a - 1];
            score_a--;
        }

        if (sum_a + sum_b <= maxSum) {
            int current_score = score_a + score_b;
            if (current_score > max_score) {
                max_score = current_score;
            }
        } else {
            break;
        }
    }

    return max_score;
}
```



**leetcode-234_palindrome**

```
bool isPalindrome(struct ListNode* head) {
    struct ListNode* temp=head;
    if(temp->next==NULL) return true;

    struct ListNode *slow = head, *fast = head;
    while (fast->next && fast->next->next) {
        slow = slow->next;
        fast = fast->next->next;
    }

    temp=slow;
    struct ListNode* prev = NULL;
    struct ListNode* curr = temp;
    struct ListNode* next;

    while (curr) {
        next = curr->next;
        curr->next = prev;
        prev = curr;
        curr = next;
    }
    temp=prev;
    struct ListNode* n1=head;
    struct ListNode* n2=temp;
    for(;n1&&n2;n1=n1->next,n2=n2->next)
    {
        if(n1->val!=n2->val)return false;
    }
    return true;
}
```



**Path Sum -112**

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

bool hasPathSum(struct TreeNode* root, int targetSum) {
   if(root==NULL)
      return false;

   if(root->val==targetSum && root->left==NULL && root->right==NULL)
      return true;

   else{
      return(hasPathSum(root->left,targetSum-root->val)  || hasPathSum(root->right,targetSum-root->val));
   }
}
```