VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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(1BM23CS085)

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

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

This is to certify that the Lab work entitled **“DATA STRUCTURES”** carried out by **Dama Yohitesh Naveen Sai(1BM23CS085)**, 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 202425. 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.

GitHub Link: https://github.com/Yohitesh/DS-lab

Lab program 1

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>
#define MAX 100

int stack[MAX];
int top = -1;

void push(int value) {
    if (top == MAX - 1) {
        printf("Stack Overflow! Cannot push %d.\n", value);
    } else {
        top++;
        stack[top] = value;
        printf("%d pushed onto the stack.\n", value);
    }
}

void pop() {
    if (top == -1) {
        printf("Stack Underflow! Cannot pop.\n");
    } else {
        printf("%d popped from the stack.\n", stack[top]);
        top--;
    }
}

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

```
int main() {
    int choice, value;

    while (1) {
        printf("\nStack
        Operations:\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 the value to push:
                "); scanf("%d", &value);
                push(value);
                break;
            case 2:
                pop();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }
}
```

Output:

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

Stack Operations:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2
4 popped from the stack.

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

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

Lab Program 2

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

<ctype.h> #define

MAX 100 char

stack[MAX]; int

top = -1;

void push(char c) {

    if (top == MAX - 1) {

        printf("Stack

        Overflow!\n");

    } else {

        stack[++top] = c;

    }

}

char pop() {

    if (top == -1) {

        printf("Stack Underflow!\n");
```

```
        return -1;

    } else {
         return stack[top--];

    }

}

char peek() {

    if (top == -1) {

        return -1;

    } else {

        return stack[top];

    }

}

int precedence(char op) {

    switch (op) {

        case '+':

        case '-':

            return

        1; case '*':

        case '/':

            return

        2; default:
```

```
        return 0;
    }
void infixToPostfix(char* infix) {
    char postfix[MAX];
    int i = 0, j =
    0; char c;
    while ((c = infix[i++]) != '\0')
        { if (isalnum(c)) { //
        Operand
            postfix[j++] = c;
        } else if (c == '(') {
            push(c);
        } else if (c == ')') {
            while (peek() != '(') {
                postfix[j++] = pop();
            }
            pop(); // Remove '('
        } else { // Operator
            while (top != -1 && precedence(peek()) >= precedence(c))
            postfix[j++] = pop();
```

```
            }

            push(c);
}

        while (top != -1) {

            postfix[j++] = pop();

        }

        postfix[j] = '\0';

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

    }

    int main() {

        char infix[MAX];

        printf("Enter a valid infix expression:

        "); scanf("%s", infix);

        infixToPostfix(infix);

        return 0;

  }
```
Output:

```
Enter a valid parenthesized infix expression: ((A+B)*(C-D))
Postfix expression: AB+CD-*
```

Lab Program 3

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> #define
MAX 100

int queue[MAX];
int front = -1, rear = -1;
void insert(int value) {
    if ((rear + 1) % MAX == front) {
        printf("Queue Overflow! Cannot insert %d.\n", value);
    } else {
        if (front == -1) {
            front = 0;
        }
        rear = (rear + 1) % MAX;
        queue[rear] = value;
        printf("%d inserted into the queue.\n", value);
    }
}
void delete() {
    if (front == -1) {
        printf("Queue Underflow! Cannot delete.\n");
    } else {
        printf("%d deleted from the queue.\n", queue[front]);
        if (front == rear) {
            front = rear = -1; // Reset the queue
```

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

int main() {
    int choice, value;

    while (1) {
        printf("\nQueue Operations:\n");
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display\n");
```

```
        printf("4. 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:
                delete()
                ; break;
            case 3:
                display()
                ; break;
            case 4:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }
}
```

Output:

```
Enter no of elements
3

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter an integer to insert: 4
Inserted 4

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter an integer to insert: 5
Inserted 5

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

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 5

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Queue is underflow
```

3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display Th program should print appropriate messages for queue empty and queue overflow conditions.

```
#include
<stdio.h>  #define
 MAX 100

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

 // Function to insert an element into the circular queue
 void insert(int value) {
     if ((rear + 1) % MAX == front) {
         printf("Queue Overflow! Cannot insert %d.\n", value);
     } else {
         if (front == -1) {
             front = 0;
         }
         rear = (rear + 1) % MAX;
         queue[rear] = value;
         printf("%d inserted into the queue.\n", value);
     }
 }
```

```c
// Function to delete an element from the circular queue
void delete() {

    if (front == -1) {

        printf("Queue Underflow! Cannot delete.\n");

    } else {

        printf("%d deleted from the queue.\n", queue[front]);

        if (front == rear) {

            front = rear = -1; // Reset the queue

        } else {

            front = (front + 1) % MAX;

        }

    }

}


// Function to display the elements of the circular queue

void display() {

    if (front == -1) {

        printf("Queue is empty.\n");

    } else {

        printf("Queue elements are: ");

        int i = front;

        while (1) {

            printf("%d ", queue[i]);

            if (i == rear) {

                break;

            }
```

```
            i = (i + 1) % MAX;
        }
        printf("\n");
    }
}

int main() {
    int choice, value;

    while (1) {
        printf("\nCircular Queue Operations:\n");
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display\n");
        printf("4. 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:
```

```
            delete()
            ; break;
        case 3:
            display()
            ; break;
        case 4:
            printf("Exiting...\n");
            return 0;
        default:
            printf("Invalid choice. Please try again.\n");
      }
    }
}
```

Output:

```
Enter no of elements
4

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter an integer to insert: 4
Inserted 4

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter an integer to insert: 8
Inserted 8

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter an integer to insert: 7
Inserted 7

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter an integer to insert: 0
Inserted 0

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter an integer to insert: 6
Queue is overflow

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

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 8

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 7

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 0

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Queue is underflow
```

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.

c) Display the contents of the linked list.

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

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

struct Node* head = NULL;

void createLinkedList(int value) {
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node)); newNode->data = value;
    newNode->next = NULL;
    head = newNode;
    printf("Linked list created with value %d.\n", value);
}
void insertAtBeginning(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = value;
    newNode->next = head;
    head = newNode;
    printf("%d inserted at the beginning.\n", value);
}
void insertAtPosition(int value, int position) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = value;

    if (position == 1) {
        newNode->next = head;
        head = newNode;
        printf("%d inserted at position %d.\n", value, position);
        return;
    }

    struct Node* temp = head;
    for (int i = 1; i < position - 1 && temp != NULL; i++) {
        temp = temp->next;
    }
```

```
    if (temp == NULL) {
        printf("Invalid position!\n");
    } else {
        newNode->next = temp->next;
        temp->next = newNode;
        printf("%d inserted at position %d.\n", value, position);
    }
}
void insertAtEnd(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = value;
    newNode->next = NULL;

    if (head == NULL) {
        head = newNode;
        printf("%d inserted at the end.\n", value);
        return;
    }

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

    temp->next = newNode;
    printf("%d inserted at the end.\n", value);
}
void displayLinkedList() {
    if (head == NULL) {
        printf("Linked list is empty.\n");
        return;
    }

    struct Node* temp = head;
    printf("Linked list contents: ");
    while (temp != NULL) {
        printf("%d -> ", temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}

int main() {
    int choice, value, position;

    while (1) {
        printf("\nSingly Linked List Operations:\n");
        printf("1. Create Linked List\n");
        printf("2. Insert at Beginning\n");
```

```
        printf("3. Insert at Any Position\n");
        printf("4. Insert at End\n");
        printf("5. Display Linked List\n");
        printf("6. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the value for the first node: ");
                scanf("%d", &value);
                createLinkedList(value);
                break;
            case 2:
                printf("Enter the value to insert at the beginning: ");
                scanf("%d", &value);
                insertAtBeginning(value);
                break;
            case 3:
                printf("Enter the value to insert: ");
                scanf("%d", &value); printf("Enter the position: "); scanf("%d", &position);
                insertAtPosition(value, position); break;
            case 4:
                printf("Enter the value to insert at the end: ");
                scanf("%d", &value);
                insertAtEnd(value);
                break;
            case 5:
                displayLinkedList();
                break;
            case 6:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }
}
```

OUTPUT:

```
1. Insert at beginning
2. Insert at end
3. Insert at a position
4. Delete at beginning
5. Delete at end
6. Delete a value
7. Display
8. Exit
Enter choice: 1
Enter the element: 23
1. Insert at beginning
2. Insert at end
3. Insert at a position
4. Delete at beginning
5. Delete at end
6. Delete a value
7. Display
8. Exit
Enter choice: 1
Enter the element: 89
1. Insert at beginning
2. Insert at end
3. Insert at a position
4. Delete at beginning
5. Delete at end
6. Delete a value
7. Display
8. Exit
Enter choice: 2
Enter the element: 97
1. Insert at beginning
2. Insert at end
3. Insert at a position
4. Delete at beginning
5. Delete at end
6. Delete a value
7. Display
8. Exit
Enter choice: 3
Enter the element and position: 12
2
1. Insert at beginning
2. Insert at end
3. Insert at a position
4. Delete at beginning
5. Delete at end
6. Delete a value
7. Display
8. Exit
Enter choice: 7
89 12 23 97
```

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* head = NULL;

struct Node* createNode(int value) {

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

    newNode->data = value;

    newNode->next = NULL;

    return newNode;

}

void insertAtEnd(int value) {

    struct Node* newNode = createNode(value);

    if (head == NULL) {

        head = newNode;
```

```
        return;
    }
    struct Node* temp = head;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = newNode;
}
void displayLinkedList(struct Node* headRef) {
    if (headRef == NULL) {
        printf("Linked list is empty.\n");
        return;
    }
    struct Node* temp = headRef;
    printf("Linked list contents: ");
    while (temp != NULL) {
        printf("%d -> ", temp->data);
        temp = temp->next;
    }
```

```
    printf("NULL\n");
}
void sortLinkedList() {
    if (head == NULL || head->next == NULL) {
        return;
    }
    struct Node* i;
    struct Node* j;
    for (i = head; i->next != NULL; i = i->next) {
        for (j = i->next; j != NULL; j = j->next) {
            if (i->data > j->data) {
                int temp = i->data;
                i->data = j->data;
                j->data = temp;
            }
        }
    }
    printf("Linked list sorted.\n");
}
```

```
}

void reverseLinkedList() {
    struct Node* prev = NULL;
    struct Node* current = head;
    struct Node* next = NULL;
    while (current != NULL) {
        next = current->next;
        current->next = prev;
        prev = current;
        current = next;
    }
    head = prev;
    printf("Linked list reversed.\n");
}

struct Node* concatenateLists(struct Node* head1, struct Node* head2) {
    if (head1 == NULL) {
        return head2;
    }
    if (head2 == NULL) {
        return head1;
```

```
    }

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

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

    while (1) {
        printf("\nSingle Linked List Operations:\n");
        printf("1. Insert at End\n");
        printf("2. Display Linked List\n");
        printf("3. Sort Linked List\n");
```

```
printf("4. Reverse Linked List\n");

printf("5. Concatenate with Another List\n");

printf("6. Exit\n");

printf("Enter your choice: ");

scanf("%d", &choice);

switch (choice) {

    case 1:

        printf("Enter the value to insert at the end: ");

        scanf("%d", &value);

        insertAtEnd(value);

        break;

    case 2:

        displayLinkedList(head);

        break;

    case 3:

        sortLinkedList();

        break;

    case 4:

        reverseLinkedList();
```

```
    break;
case 5:
    printf("Enter the number of elements for the second list: ");
    int n;
    scanf("%d", &n);
    for (int i = 0; i < n; i++) {
        printf("Enter value %d: ", i + 1);
        scanf("%d", &value);
        struct Node* newNode = createNode(value);
        if (secondList == NULL) {
            secondList = newNode;
        } else {
            struct Node* temp = secondList;
            while (temp->next != NULL) {
                temp = temp->next;
            }
            temp->next = newNode;
        }
    }
```

```c
                head = concatenateLists(head, secondList);
                printf("Lists concatenated.\n");
                break;
            case 6:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    }
}
```

OUTPUT:

```
1. Insert at End (List 1)
2. Insert at End (List 2)
3. Sort List 1
4. Reverse List 1
5. Concatenate List 2 to List 1
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 1
Enter data: 20
1. Insert at End (List 1)
2. Insert at End (List 2)
3. Sort List 1
4. Reverse List 1
5. Concatenate List 2 to List 1
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 1
Enter data: 10
1. Insert at End (List 1)
2. Insert at End (List 2)
3. Sort List 1
4. Reverse List 1
5. Concatenate List 2 to List 1
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 1
Enter data: 50
1. Insert at End (List 1)
2. Insert at End (List 2)
3. Sort List 1
4. Reverse List 1
5. Concatenate List 2 to List 1
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 2
Enter data: 40
1. Insert at End (List 1)
2. Insert at End (List 2)
3. Sort List 1
4. Reverse List 1
5. Concatenate List 2 to List 1
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 2
Enter data: 30
1. Insert at End (List 1)
2. Insert at End (List 2)
3. Sort List 1
```

LAB PROGRAM 6

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 Node* head = NULL;
struct Node* createNode(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct
    Node)); newNode->data = value;
    newNode->next = NULL;
    return newNode;
}
void push(int value) {
    struct Node* newNode =
    createNode(value); newNode->next = head;
    head = newNode;
    printf("%d pushed to stack.\n", value);
}

void pop() {
    if (head == NULL) {
        printf("Stack underflow.\n");
        return;
    }
    struct Node* temp = head;
    head = head->next;
    printf("%d popped from stack.\n", temp->data);
    free(temp);
}

void displayStack() {
    if (head == NULL) {
        printf("Stack is empty.\n");
        return;
    }
    struct   Node*   temp   =
    head;          printf("Stack
    contents:  ");  while  (temp
```

```
    != NULL) {
        printf("%d -> ", temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}
struct Node* tail = NULL; // Tail pointer for queue
void enqueue(int value) {
    struct Node* newNode = createNode(value);
    if (tail == NULL) {
        head = tail = newNode;
    } else {
        tail->next = newNode;
        tail = newNode;
    }
    printf("%d enqueued to queue.\n", value);
}

void dequeue() {
    if (head == NULL) {
        printf("Queue underflow.\n");
        return;
    }
    struct Node* temp = head;
    head = head->next;
    if (head == NULL)
        { tail = NULL;
    }
    printf("%d dequeued from queue.\n", temp->data);
    free(temp);
}

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

```
int main() {
    int choice, value;
    while (1) {
        printf("\nSingle Linked List as Stack and Queue:\n");
        printf("1. Push to Stack\n");
        printf("2. Pop from Stack\n");
        printf("3. Display Stack\n");
        printf("4. Enqueue to Queue\n");
        printf("5. Dequeue from Queue\n");
        printf("6. Display Queue\n");
        printf("7. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to push: ");
                scanf("%d", &value);
                push(value);
                break;
            case 2:
                pop();
                break;
            case 3:
                displayStack();
                break;
            case 4:
                printf("Enter value to enqueue:
                "); scanf("%d", &value);
                enqueue(value);
                break;
            case 5:
                dequeue();
                break;
            case 6:
                displayQueue();
                break;
            case 7:
                printf("Exiting...\n");
                return 0;
            default:
                printf("Invalid choice. Please try again.\n");
```

Output:

```
1.Push
2. Pop
3. Enqueue
4. Dequeue
5.Display
Enter choice: 1
Enter element :23
1.Push
2. Pop
3. Enqueue
4. Dequeue
5.Display
Enter choice: 1
Enter element :56
1.Push
2. Pop
3. Enqueue
4. Dequeue
5.Display
Enter choice: 2
1.Push
2. Pop
3. Enqueue
4. Dequeue
5.Display
Enter choice: 3
Enter element :45
1.Push
2. Pop
3. Enqueue
4. Dequeue
5.Display
Enter choice: 4
1.Push
2. Pop
3. Enqueue
4. Dequeue
5.Display
Enter choice: 5
23
```

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 list.

```
#include <stdio.h>

#include <stdlib.h>


 struct Node {

    int data;

    struct Node* prev;

    struct Node* next;

};


struct Node* head = NULL;

struct Node* createNode(int value) {

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

    newNode->data = value;

    newNode->prev            =

    NULL; newNode->next =

    NULL; return newNode;

}


void createDoublyLinkedList(int value) {

    struct Node* newNode = createNode(value);

    if (head == NULL) {

        head = newNode;
```

```
        printf("Doubly linked list created with value %d.\n", value);
    } else {
        printf("List already exists.\n");
    }
}

void insertLeft(int target, int value) {
    if (head == NULL) {
        printf("List is empty. Cannot insert.\n");
        return;
    }

    struct Node* temp = head;
    while (temp != NULL && temp->data != target) {
        temp = temp->next;
    }

    if (temp == NULL) {
        printf("Target node with value %d not found.\n", target);
        return;
    }

    struct Node* newNode = createNode(value);
    newNode->next = temp;
    newNode->prev = temp->prev;

    if (temp->prev != NULL) {
        temp->prev->next = newNode;
```

```
    } else {
        head = newNode;
    }

    temp->prev = newNode;
    printf("%d inserted to the left of %d.\n", value, target);
}

void deleteNode(int value) {
    if (head == NULL) {
        printf("List is empty. Cannot delete.\n");
        return;
    }

    struct Node* temp = head;
    while (temp != NULL && temp->data != value) {
        temp = temp->next;
    }

    if (temp == NULL) {
        printf("Node with value %d not found.\n", value);
        return;
    }

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

```
    }

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

    free(temp);
    printf("Node with value %d deleted.\n", value);
}
void displayList() {
    if (head == NULL) {
        printf("List is empty.\n");
        return;
    }

    struct Node* temp = head;
    printf("Doubly linked list contents: ");
    while (temp != NULL) {
        printf("%d <-> ", temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}

int main() {
    int choice, value, target;

    while (1) {
```

```
printf("\nDoubly Linked List Operations:\n");
printf("1. Create Doubly Linked List\n");
printf("2. Insert to the Left of a Node\n");
printf("3. Delete a Node\n");
printf("4. Display List\n");
printf("5. Exit\n");
printf("Enter your choice: ");
scanf("%d", &choice);

switch (choice) {
  case 1:
    printf("Enter value to create the list: ");
    scanf("%d", &value);
    createDoublyLinkedList(value);
    break;
  case 2:
    printf("Enter the target value to insert left of: ");
    scanf("%d", &target);
    printf("Enter the value to insert: ");
    scanf("%d", &value);
    insertLeft(target, value);
    break;
  case 3:
    printf("Enter the value of the node to delete: ");
    scanf("%d", &value);
    deleteNode(value);
    break;
  case 4:
```

```
            displayList();
            break;
        case 5:
            printf("Exiting...\n");
            return 0;
        default:
            printf("Invalid choice. Please try again.\n");
      }
   }
}
```

OUTPUT:

```
1. Insert new node left of a node
2. Delete node based on value
3. Display
4. Insert at beginning
Enter choice: 4
Enter the element: 23
1. Insert new node left of a node
2. Delete node based on value
3. Display
4. Insert at beginning
Enter choice: 4
Enter the element: 56
1. Insert new node left of a node
2. Delete node based on value
3. Display
4. Insert at beginning
Enter choice: 3
56 23
1. Insert new node left of a node
2. Delete node based on value
3. Display
4. Insert at beginning
Enter choice: 1
Enter the element: 57
Enter the position: 2
1. Insert new node left of a node
2. Delete node based on value
3. Display
4. Insert at beginning
Enter choice: 2
Enter the element: 57
1. Insert new node left of a node
2. Delete node based on value
3. Display
4. Insert at beginning
Enter choice: 3
56 23
```

Lab Program 8

a) WAP: 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.

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

// Define a node structure for 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 = NULL;
    newNode->right = NULL;
    return newNode;
}

// Function to insert a node into the binary search tree
struct Node* insertNode(struct Node* root, int value) {
```

```
    if (root == NULL) {
    return createNode(value);
    }

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

    return root;
}

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

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

```
}

// Post-order traversal
void postorderTraversal(struct Node* root) {
    if (root != NULL) {
        postorderTraversal(root->left);
        postorderTraversal(root->right);
        printf("%d ", root->data);
    }
}

// Function to display the tree (in-order traversal as default)
void displayTree(struct Node* root) {
    if (root == NULL) {
        printf("Tree is empty.\n");
        return;
    }

    printf("Tree elements (In-order traversal): ");
    inorderTraversal(root);
    printf("\n");
}

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

    while (1) {
```

```
printf("\nBinary Search Tree Operations:\n");
printf("1. Insert Node\n");
printf("2. In-order Traversal\n");
printf("3. Pre-order Traversal\n");
printf("4. Post-order Traversal\n");
printf("5. Display Tree\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 = insertNode(root, value);
    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:
            displayTree(root);
            break;
        case 6:
            printf("Exiting...\n");
            return 0;
        default:
            printf("Invalid choice. Please try again.\n");
      }
   }
}
```

OUTPUT:

```
Menu:
1. Insert
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter data: 23

Menu:
1. Insert
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter data: 67

Menu:
1. Insert
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter data: 45

Menu:
1. Insert
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 2
In-order Traversal: 23 45 67

Menu:
1. Insert
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 3
Pre-order Traversal: 23 67 45

Menu:
1. Insert
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 4
Post-order Traversal: 45 67 23
```

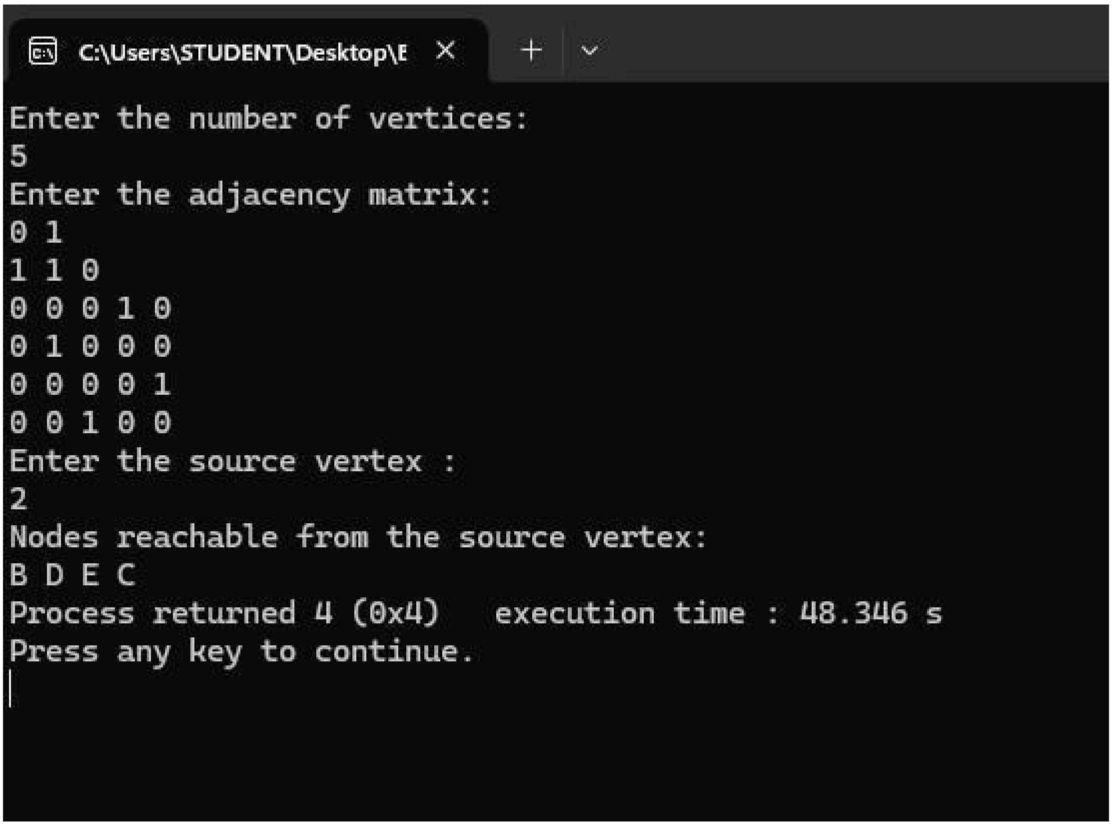
9a. Write a program to traverse a graph using BFS method.

```
#include <stdio.h>

#include

<stdlib.h>  #define

MAX 100

int

adj[MAX][MAX];

int visited[MAX];

int queue[MAX];

int front = -1, rear = -1;


void enqueue(int value) {

    if (rear == MAX - 1) {

        printf("Queue

        Overflow\n"); return;

    }

    if (front == -1) {

        front = 0;

    }

    queue[++rear] = value;

}


int dequeue() {

    if (front == -1 || front > rear) {

        printf("Queue Underflow\n");

        return -1;

    }

    return queue[front++];
```

```
}

void bfs(int start, int n) { for (int i = 0; i < n; i++) {
        visited[i] = 0;

    }


    enqueue(start);

    visited[start] = 1;


    printf("BFS Traversal: ");


    while (front <= rear) {

        int current = dequeue();

        printf("%d ", current);


        for (int i = 0; i < n; i++) {

            if (adj[current][i] == 1 && !visited[i]) {

                enqueue(i);

                visited[i] = 1;

            }

        }

    }

    printf("\n");

}


int main() {

    int n, edges, u, v, start;


    printf("Enter the number of vertices: ");
```

```
    scanf("%d", &n);

    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            adj[i][j] = 0;
        }
    }

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

    printf("Enter the edges (u v):\n");
    for (int i = 0; i < edges; i++) {
        scanf("%d %d", &u, &v);
        adj[u][v] = 1;
        adj[v][u] = 1;
    }

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

    bfs(start, n);

    return 0;
}
```

Output:



```
C:\Users\STUDENT\Desktop\E
Enter the number of vertices:
5
Enter the adjacency matrix:
0 1
1 1 0
0 0 0 1 0
0 1 0 0 0
0 0 0 0 1
0 0 1 0 0
Enter the source vertex :
2
Nodes reachable from the source vertex:
B D E C
Process returned 4 (0x4)   execution time : 48.346 s
Press any key to continue.
```

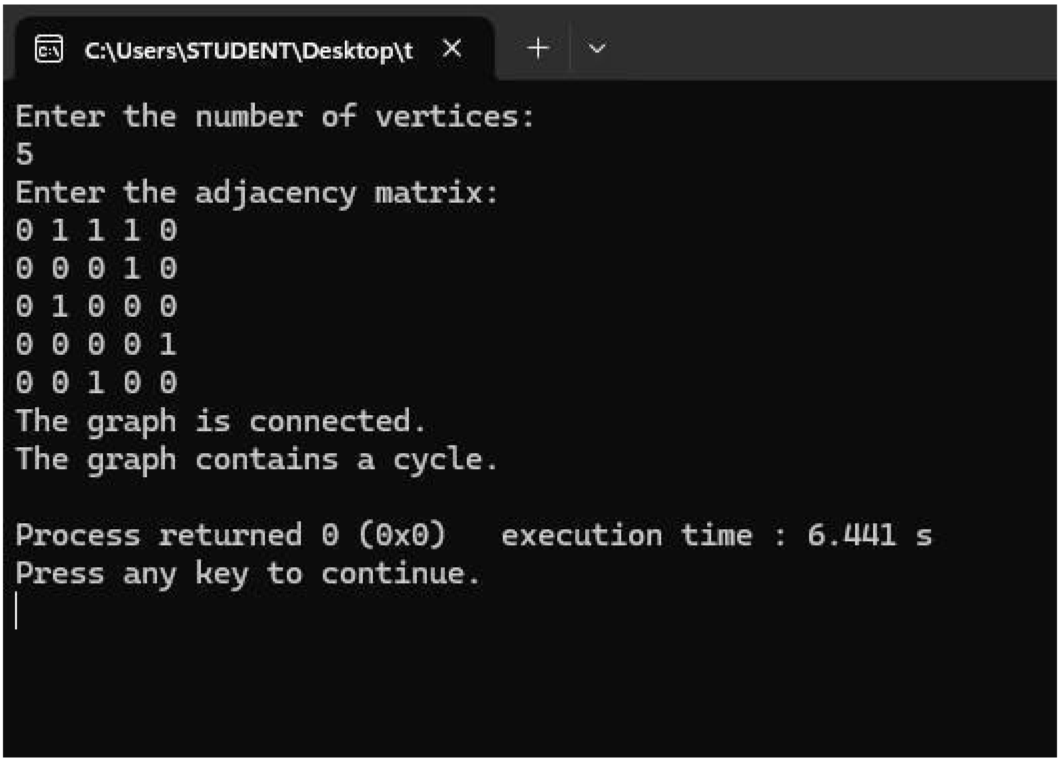
9b. Write a program to check whether given graph is connected or not using DFS method.

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_VERTICES 100
typedef struct Graph {
    int vertices;
    int adjMatrix[MAX_VERTICES][MAX_VERTICES];
    } Graph;
void initGraph(Graph* g, int vertices)
    { g->vertices = vertices;
    for (int i = 0; i < vertices; i++) {
        for (int j = 0; j < vertices; j++) {
            g->adjMatrix[i][j] = 0;
        }
    }
}
void addEdge(Graph* g, int u, int v)
    { g->adjMatrix[u][v] = 1;
    g->adjMatrix[v][u] = 1;
}
void DFS(Graph* g, int vertex, int visited[]) {
    visited[vertex] = 1;
    printf("%d ", vertex);
    for (int i = 0; i < g->vertices; i++) {
        if (g->adjMatrix[vertex][i] == 1 && !visited[i]) {
            DFS(g, i, visited);
```

```
        }
    }
}

int isConnected(Graph* g) {
    int visited[MAX_VERTICES] = {0};

    // Start DFS from the first vertex (0th index)
    DFS(g, 0, visited);
    for (int i = 0; i < g->vertices; i++) { if
    (visited[i] == 0) {
            return 0;
        }
    }
    return 1;
}

int main() {
    int vertices, edges, u, v;

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

    Graph g;
    initGraph(&g, vertices);

    printf("Enter number of edges: ");
```

```
    scanf("%d", &edges);

    printf("Enter edges (u v):\n");

    for (int i = 0; i < edges; i++) {

        scanf("%d %d", &u, &v);

        addEdge(&g, u, v);

    }

    if (isConnected(&g)) {

        printf("The graph is connected.\n");

    } else {

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

    }

    return 0;

}
```

Output:



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_EMPLOYEES 100
#define MAX_KEYS 10

#define m 10

typedef struct HashTable {
  int *table;
} HashTable;

void initHashTable(HashTable *ht) {
  ht->table = (int *)malloc(m * sizeof(int));
  for (int i = 0; i < m; i++) {
    ht->table[i] = -1;
  }
}

int hashFunction(int key) {
  return key % m;
}

void insert(HashTable *ht, int key) {
  int index = hashFunction(key);

  while (ht->table[index] != -1) {
    printf("Collision detected at index %d for key %d. Probing...\n", index, key);
    index = (index + 1) % m;
  }
```

```
    ht->table[index] = key;
    printf("Key %d inserted at index %d\n", key, index);
}
int search(HashTable *ht, int key) {
    int index = hashFunction(key);
    int originalIndex = index;


    while (ht->table[index] != -1) {
        if (ht->table[index] == key) {
            return index;
        }
        index = (index + 1) % m;
        if (index == originalIndex) {
            break;
        }
    }
    return -1;
}

void display(HashTable *ht) {
    printf("Hash Table Contents:\n");
    for (int i = 0; i < m; i++) {
        if (ht->table[i] != -1) {
            printf("Index %d: Key %d\n", i, ht->table[i]);
        } else {
            printf("Index %d: Empty\n", i);
        }
    }
}

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

    int keys[MAX_KEYS], n, key;

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

    printf("Enter the keys (4-digit) for the employee records:\n");
    for (int i = 0; i < n; i++) {
        scanf("%d", &keys[i]);
    }


    for (int i = 0; i < n; i++) {
        insert(&ht, keys[i]);
```

```
    }
    display(&ht);

    printf("Enter a key to search in the hash table: ");

    scanf("%d", &key);

    int index = search(&ht, key);
    if (index != -1) {
        printf("Key %d found at index %d\n", key, index);
    } else {
        printf("Key %d not found in the hash table\n", key);
    }


    free(ht.table);

    return 0;
}
```

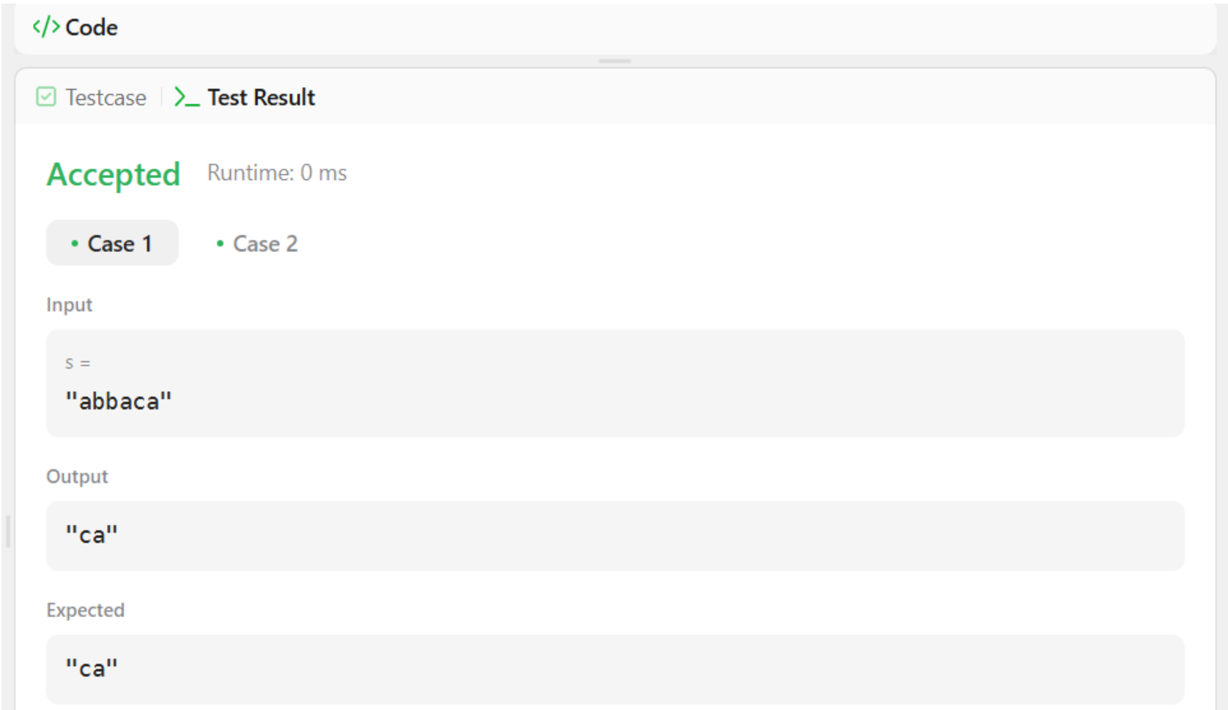
Output:

```
Enter the number of employee  records (N) :   5

Enter the two digit memory locations (m) for hash table:   11

Enter the four digit key values (K) for N Employee Records:
  1234
1245
1678
1908
3456

Hash Table contents are:

 T[0] --> -1
 T[1] --> -1
 T[2] --> 1234
 T[3] --> 1245
 T[4] --> 3456
 T[5] --> 1908
 T[6] --> 1678
 T[7] --> -1
 T[8] --> -1
 T[9] --> -1
 T[10] --> -1
```

LEETCODE PROBLEM – 1

```
char* removeDuplicates(char* s) {
    int n = strlen(s);
    char* stack = (char*)malloc(sizeof(char) * (n + 1));
    if (!stack) return NULL;
    int i = 0;
    for (int j = 0; j < n; j++) {
        char c = s[j];
        if (i && stack[i - 1] == c)
            { i--;
        } else {

            stack[i++] = c;
        }

    }
    stack[i] = '\0';
    return stack;
}
```

OUTPUT:



LEETCODE PROBLEM – 2

```
void backspace(const char* s, char* result) {
    int index = 0;
    for (int i = 0; s[i] != '\0'; i++) {
        if (s[i] != '#') {
            result[index++] = s[i];
        } else if (index > 0) {
            index--;
        }
    }
    result[index] = '\0';
}

bool backspaceCompare(char* s, char* t) {
    char resultS[1000];
    char resultT[1000];

    backspace(s,
    resultS); backspace(t,
    resultT);

    return strcmp(resultS, resultT) == 0;
}
```

OUTPUT:

Code

Testcase | >_ Test Result

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

s =

```
"ab#c"
```

t =

```
"ad#c"
```

Output

```
true
```

Expected

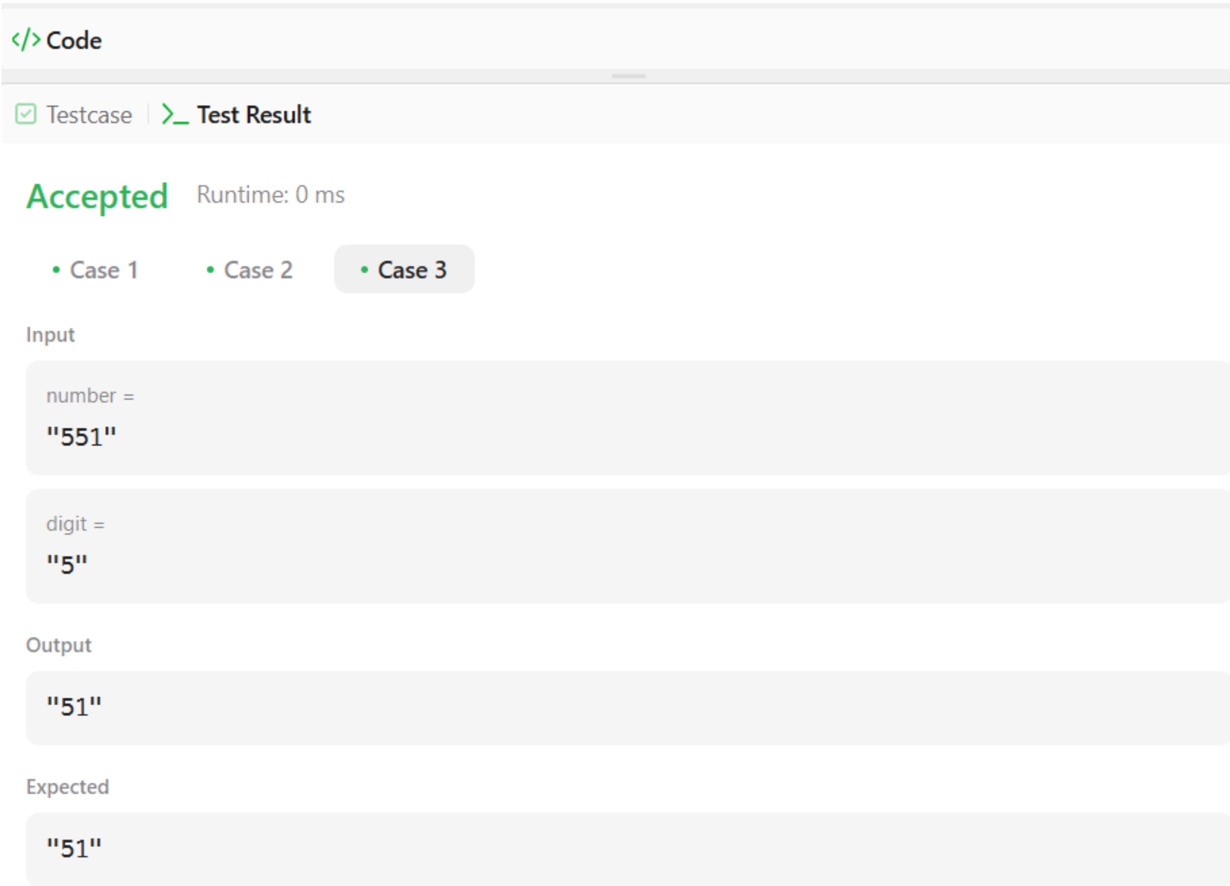
```
true
```

LEETCODE PROGRAM – 3

```
char* removeDigit(char* number, char digit){
	int n = strlen(number);
	static char result[100];
	int maxIndex = -1;

	for(i=0;i<n;i++){
		if(number[i]==digit){
			char temp[100];
			int k = 0;
			for(j=0;j<n;j++)
			{
				if(j!=i){
					temp[k++]=number[j];
				}
			}
			temp[k] = '\0';
			if(maxIndex==-1 || strcmp(temp,result)>0){
				strcpy(result,temp);
				maxIndex=I;
		}
	}
}
```

```
  return result;
}
```

OUTPUT:



LEETCODE PROBLEM 4

```
struct ListNode* deleteDuplicates(struct ListNode* head)
{

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

    struct ListNode* current = head;


    while (current != NULL && current->next != NULL) {

        if (current->val == current->next->val) {

            struct ListNode* temp =
            current->next; current->next =
            current->next->next; free(temp);
        } else {

            current = current->next;
        }
    }

    return head;
}
```

OUTPUT:

</> Code

Testcase | >_ Test Result

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

head =

```
[1,1,2]
```

Output

```
[1,2]
```

Expected

```
[1,2]
```

LEETCODE PROBLEM 5

```
bool hasCycle(struct ListNode *head) {

    if (head == NULL || head->next == NULL)
        { return false;
    }


    struct ListNode *slow = head;
    struct ListNode *fast = head;

    while (fast != NULL && fast->next != NULL) {
        slow = slow->next;
        fast = fast->next->next;

        if (slow == fast) {
            return true;
        }
    }

    return false;
}
```

OUTPUT:

Code

Testcase | >_ Test Result

Accepted Runtime: 0 ms

• Case 1 • Case 2 • Case 3

Input

head =

```
[3,2,0,-4]
```

pos =

```
1
```

Output

```
true
```

Expected

```
true
```