VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
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This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by **Utkrisht Umang (1BM23CS355)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfilment 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/utk1college/DST-Lab-Programs

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.

Code:

```
#include <stdio.h>

#include <stdlib.h>

#define STACK_SIZE 5


void push(int stack[], int *top) {

    int item;

    if (*top == STACK_SIZE - 1) {

        printf("Stack Overflow\n");

    } else {

        printf("Enter item: ");

        scanf("%d", &item);

        stack[++(*top)] = item;

        printf("%d pushed into stack\n", item);

    }

}


void pop(int stack[], int *top) {

    if (*top == -1) {

        printf("Stack Underflow\n");

    } else {

        printf("%d popped from stack\n", stack[(*top)--]);

    }

}
```

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

int main() {
    int stack[STACK_SIZE], top = -1, choice;
    while (1) {
        printf("\n1. Push\n2. Pop\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1: push(stack, &top); break;
            case 2: pop(stack, &top); break;
            case 3: display(stack, &top); break;
            case 4: exit(0);
            default: printf("Invalid choice!!!\n");
        }
    }
    return 0;
}
```

Output:

```
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter item: 5
5 pushed into stack

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter item: 8
8 pushed into stack

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter item: 4
4 pushed into stack

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
Stack elements: 4 8 5

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

1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
Stack elements: 8 5

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

Leetcode

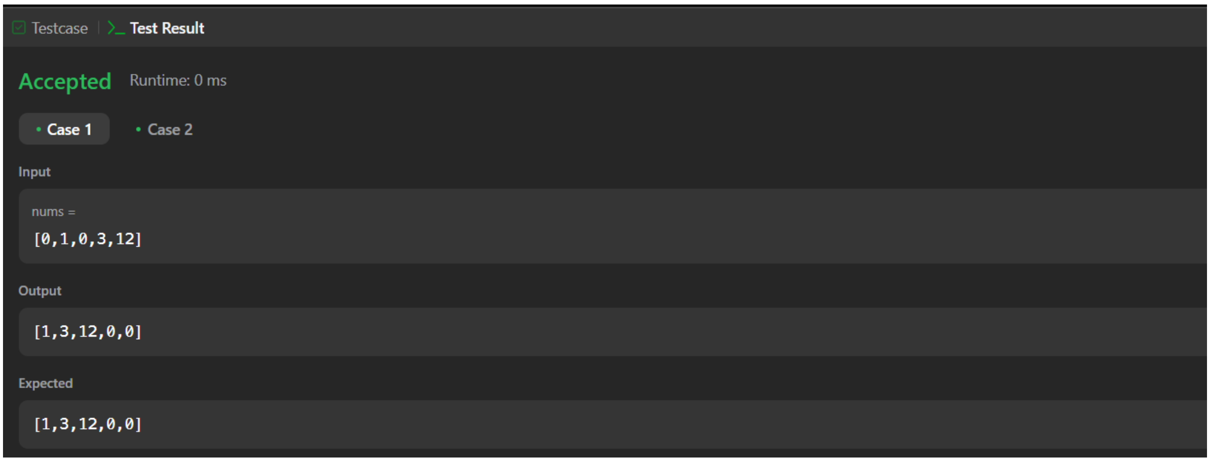
Move Zeroes

Code:

```
#include <stdio.h>
void moveZeroes(int* nums, int numsSize) {
    int j = 0;
    for (int i = 0; i < numsSize; i++) {
        if (nums[i] != 0) {
            int temp = nums[j];
            nums[j] = nums[i];
            nums[i] = temp;
            j++;
        }
    }
}

int main() {
    int nums[] = {0, 1, 0, 3, 12};
    int numsSize = sizeof(nums) / sizeof(nums[0]);

    printf("Original array: ");
    for (int i = 0; i < numsSize; i++) {
        printf("%d ", nums[i]);
    }

    moveZeroes(nums, numsSize);

    printf("\nModified array: ");
    for (int i = 0; i < numsSize; i++) {
```

```
        printf("%d ", nums[i]);
    }
    return 0;
}
```

Output:



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).

Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>
#define STACK_SIZE 50

char stack[STACK_SIZE];
int top = -1;

void push(char c) {
   if (top == STACK_SIZE - 1) {
      printf("Stack overflow\n");
      exit(1);
   }
   stack[++top] = c;
}

char pop() {
   if (top == -1) {
      printf("Stack underflow\n");
      exit(1);
   }
   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[]) {
    int i = 0, j = 0;
    char c;

    while (infix[i] != '\0') {
        if (isalnum(infix[i])) {  // If operand, add to postfix
            postfix[j++] = infix[i];
        } else if (infix[i] == '(') {  // Push '(' onto stack
            push(infix[i]);
        } else if (infix[i] == ')') {  // Pop until '(' is found
            while (top != -1 && (c = pop()) != '(') {
                postfix[j++] = c;
            }
        } else {
            while (top != -1 && precedence(stack[top]) >= precedence(infix[i])) {
                postfix[j++] = pop();
            }
            push(infix[i]);
        }
        i++;
    }

    while (top != -1) {
        postfix[j++] = pop();
```

```
    }

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

int main() {
    char infix[50], postfix[50];

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

    infixToPostfix(infix, postfix);

    printf("Postfix expression: %s\n", postfix);
    return 0;
}
```

Output:

```
Enter a valid infix expression: A+B*C-(D/E)
Postfix expression: ABC*+DE/-
```

Lab program: 3

W AP 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.

Code:

```
#include <stdio.h>
#include <stdlib.h>
#define QUEUE_SIZE 5

void insert(int queue[], int *front, int *rear) {
   int item;
   if (*rear == QUEUE_SIZE - 1) {
      printf("Queue overflow\n");
   } else {
      printf("\nEnter an item: ");
      scanf("%d", &item);
      if (*front == -1) {
         *front = 0;
      }
      queue[++(*rear)] = item;
      printf("%d inserted into the queue\n", item);
   }
}

void delete(int queue[], int *front, int *rear) {
   if (*front == -1 || *front > *rear) {
      printf("Queue is empty\n");
   } else {
      printf("\n%d deleted from the queue\n", queue[(*front)++]);
      if (*front > *rear) { // Reset queue if empty
         *front = *rear = -1;
```

```
        }
    }
}

void display(int queue[], int *front, int *rear) {
    if (*front == -1 || *front > *rear) {
        printf("Queue is empty\n");
    } else {
        printf("Queue elements: ");
        for (int i = *front; i <= *rear; i++) {
            printf("%d\t", queue[i]);
        }
        printf("\n");
    }
}
int main() {
    int queue[QUEUE_SIZE], front = -1, rear = -1, choice;
    while (1) {
        printf("\n1. Insert\n2. Delete\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1: insert(queue, &front, &rear); break;
            case 2: delete(queue, &front, &rear); break;
            case 3: display(queue, &front, &rear); break;
            case 4: exit(0);
            default: printf("Invalid choice!!!\n");
        }
    }
    return 0;
}
```

Output:

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

Enter an item: 7
7 inserted into the queue

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

Enter an item: 9
9 inserted into the queue

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

Enter an item: 4
4 inserted into the queue

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements: 7       9       4

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

7 deleted from the queue

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements: 9       4
```

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.

Code:

```
#include <stdio.h>
#include <stdlib.h>
#define QUEUE_SIZE 5

void insert(int queue[], int *front, int *rear) {
    int item;
    if ((*rear + 1) % QUEUE_SIZE == *front) {
        printf("Queue overflow\n");
    } else {
        printf("\nEnter an item: ");
        scanf("%d", &item);
        if (*front == -1) {
            *front = 0;
        }
        *rear = (*rear + 1) % QUEUE_SIZE;
        queue[*rear] = item;
        printf("%d inserted into the queue\n", item);
    }
}

void delete(int queue[], int *front, int *rear) {
    if (*front == -1) {
        printf("Queue is empty\n");
    } else {
        printf("\n%d deleted from the queue\n", queue[*front]);
        if (*front == *rear) {
            *front = *rear = -1; // Reset queue if empty
        } else {
```

```
            *front = (*front + 1) % QUEUE_SIZE;
        }
    }
}

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

int main() {
    int queue[QUEUE_SIZE], front = -1, rear = -1, choice;
    while (1) {
        printf("\n1. Insert\n2. Delete\n3. Display\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1: insert(queue, &front, &rear); break;
            case 2: delete(queue, &front, &rear); break;
            case 3: display(queue, &front, &rear); break;
```

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

Output:

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

Enter an item: 5
5 inserted into the queue

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

Enter an item: 7
7 inserted into the queue

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

Enter an item: 9
9 inserted into the queue

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

5 deleted from the queue

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements: 7       9
```

Leetcode

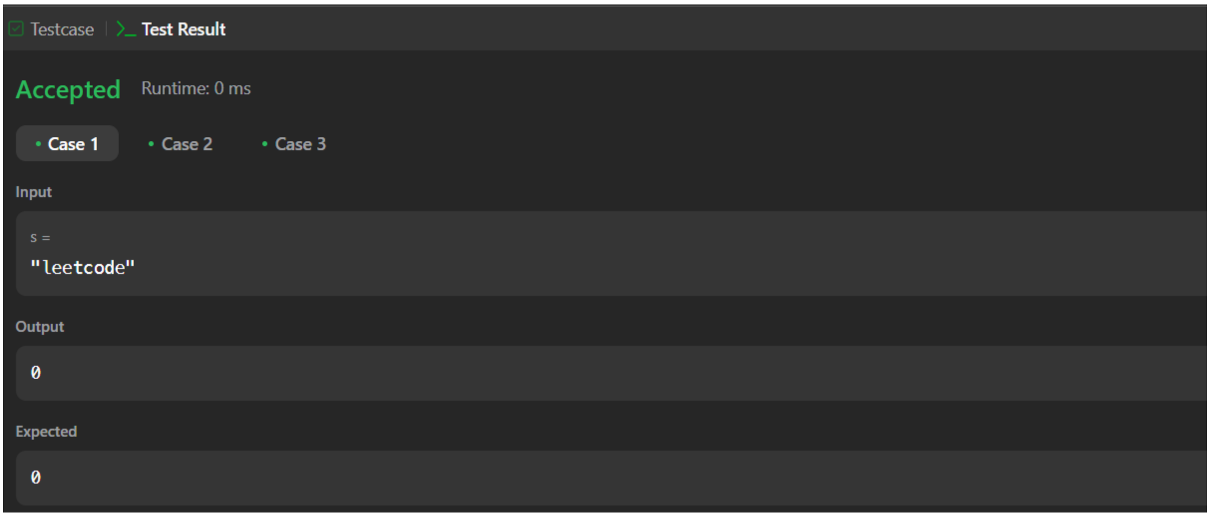
First Unique Character in a String

Code:

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

int firstUniqChar(char* s) {
    int count[26] = {0};
    int n = strlen(s);
    int queue[n], front = 0, rear = -1;

    for (int i = 0; i < n; i++) {
        count[s[i] - 'a']++;
        queue[++rear] = i;
    }

    while (front <= rear) {
        int index = queue[front++];
        if (count[s[index] - 'a'] == 1) {
            return index;
        }
    }

    return -1;
}

int main() {
    char s[] = "leetcode";
    int result = firstUniqChar(s);
    printf("%d\n", result);
```

```
    return 0;
}
```

Output:



<u>Program 4</u>

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

b) Insertion of a node at first position, at any position and at end of list. Display the contents of the linked list.

<u>Code:</u>

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

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

struct Node* createNode(int value) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   if (!newNode) {
      printf("Memory allocation failed\n");
      exit(1);
   }
   newNode->data = value;
   newNode->next = NULL;
   return newNode;
}

void insertAtBeginning(struct Node** head, int value) {
   struct Node* newNode = createNode(value);
   newNode->next = *head;
   *head = newNode;
   printf("%d inserted at the beginning\n", value);
}
```

```
void insertAtEnd(struct Node** head, int value) {
    struct Node* newNode = createNode(value);
    if (*head == NULL) {
        *head = newNode;
    } else {
        struct Node* temp = *head;
        while (temp->next != NULL) {
            temp = temp->next;
        }
        temp->next = newNode;
    }
    printf("%d inserted at the end\n", value);
}

void insertAtPosition(struct Node** head, int value, int position) {
    struct Node* newNode = createNode(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");
        free(newNode);
    } else {
        newNode->next = temp->next;
        temp->next = newNode;
```

```
        printf("%d inserted at position %d\n", value, position);
    }
}

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

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

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

        switch (choice) {
            case 1:
                printf("Enter value to insert: ");
                scanf("%d", &value);
                insertAtBeginning(&head, value);
```

```
            break;
        case 2:
            printf("Enter value to insert: ");
            scanf("%d", &value);
            insertAtEnd(&head, value);
            break;
        case 3:
            printf("Enter value to insert: ");
            scanf("%d", &value);
            printf("Enter position: ");
            scanf("%d", &position);
            insertAtPosition(&head, value, position);
            break;
        case 4:
            displayList(head);
            break;
        case 5:
            return 0;
        default:
            printf("Invalid choice!!!\n");
        }
    }
}
```

Output:

```
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
Enter your choice: 1
Enter value to insert: 6
6 inserted at the beginning

1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
Enter your choice: 2
Enter value to insert: 4
4 inserted at the end

1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
Enter your choice: 3
Enter value to insert: 9
Enter position: 2
9 inserted at position 2

1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display list
5. Exit
Enter your choice: 4
Linked list contents: 6 -> 9 -> 4 -> NULL
```

Leetcode

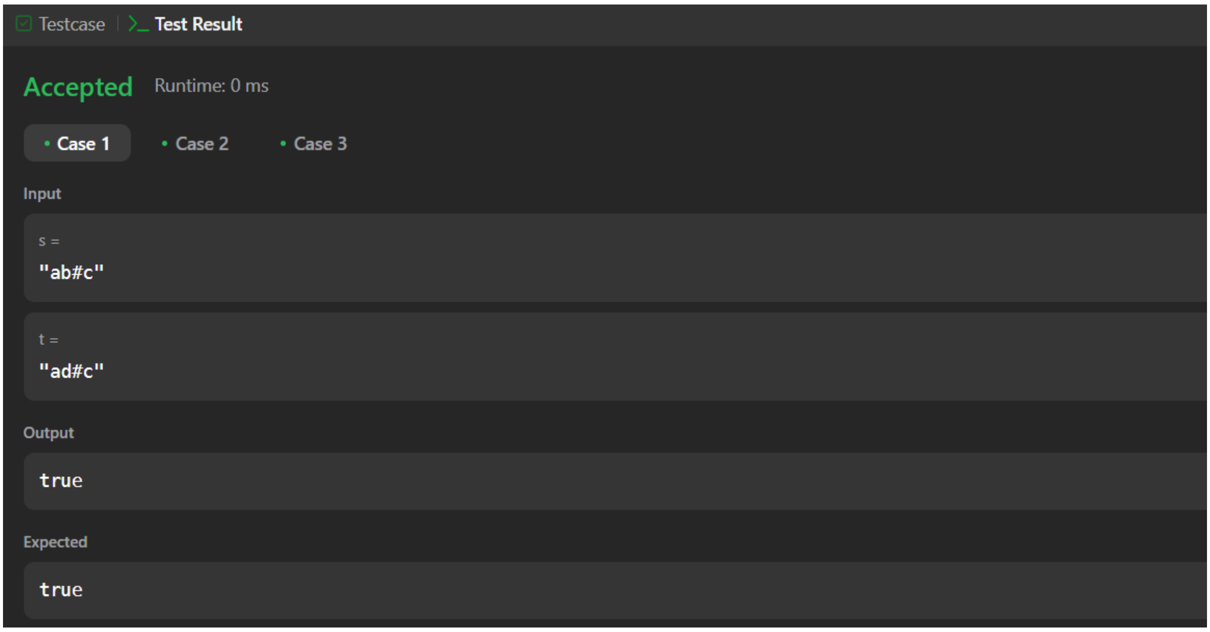
Backspace String Compare

Code:

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

bool backspaceCompare(char* s, char* t) {
    int i = strlen(s) - 1, j = strlen(t) - 1;

    while (i >= 0 || j >= 0) {
        int skipS = 0, skipT = 0;

        while (i >= 0 && (s[i] == '#' || skipS > 0)) {
            if (s[i] == '#') skipS++;
            else skipS--;
            i--;
        }

        while (j >= 0 && (t[j] == '#' || skipT > 0)) {
            if (t[j] == '#') skipT++;
            else skipT--;
            j--;
        }

        if (i >= 0 && j >= 0 && s[i] != t[j]) return false;
        if ((i >= 0) != (j >= 0)) return false;

        i--;
        j--;
    }
```

```
    return true;
}

int main() {
    char s1[] = "ab#c";
    char t1[] = "ad#c";
    printf("Compare '%s' and '%s': %s\n", s1, t1, backspaceCompare(s1, t1) ? "true" : "false");

    char s2[] = "ab##";
    char t2[] = "c#d#";
    printf("Compare '%s' and '%s': %s\n", s2, t2, backspaceCompare(s2, t2) ? "true" : "false");

    char s3[] = "a#c";
    char t3[] = "b";
    printf("Compare '%s' and '%s': %s\n", s3, t3, backspaceCompare(s3, t3) ? "true" : "false");

    return 0;
}
```

Output:



Leetcode

Remove Digit from Number to Maximize Result

Code:

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

char* removeDigit(char* number, char digit) {
    int n = strlen(number);

    for (int i = 0; i < n - 1; i++) {
        if (number[i] == digit && number[i] < number[i + 1]) {
            memmove(&number[i], &number[i + 1], n - i);
            return number;
        }
    }

    for (int i = n - 1; i >= 0; i--) {
        if (number[i] == digit) {
            memmove(&number[i], &number[i + 1], n - i);
            break;
        }
    }

    return number;
}

int main() {
    char number1[] = "1231";
    char digit1 = '1';
    printf("Result after removing '%c' from \"%s\": %s\n", digit1, number1,
removeDigit(number1, digit1));
```

```
    char number2[] = "551";
    char digit2 = '5';
    printf("Result after removing '%c' from \"%s\": %s\n", digit2, number2, removeDigit(number2, digit2));

    char number3[] = "7654321";
    char digit3 = '6';
    printf("Result after removing '%c' from \"%s\": %s\n", digit3, number3, removeDigit(number3, digit3));

    return 0;
}
```

Output:

Program 5

WAP to Implement Singly Linked List with following operations a) Create a linked list. b) Deletion of first element, specified element and last element in the list. c) Display the contents of the linked list.

Code:

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

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

struct Node* createNode(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (!newNode) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = value;
    newNode->next = NULL;
    return newNode;
}

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

```
        }
        temp->next = newNode;
    }
    printf("%d inserted into the list\n", value);
}

void deleteFirst(struct Node** head) {
    if (*head == NULL) {
        printf("List is empty\n");
    } else {
        struct Node* temp = *head;
        *head = (*head)->next;
        printf("%d deleted from the list (first element)\n", temp->data);
        free(temp);
    }
}

void deleteLast(struct Node** head) {
    if (*head == NULL) {
        printf("List is empty\n");
    } else if ((*head)->next == NULL) { // Only one element
        printf("%d deleted from the list (last element)\n", (*head)->data);
        free(*head);
        *head = NULL;
    } else {
        struct Node* temp = *head;
        while (temp->next->next != NULL) {
            temp = temp->next;
        }
        printf("%d deleted from the list (last element)\n", temp->next->data);
        free(temp->next);
        temp->next = NULL;
```

```
    }
}

void deleteElement(struct Node** head, int value) {
    if (*head == NULL) {
        printf("List is empty\n");
    } else if ((*head)->data == value) {
        deleteFirst(head);
    } else {
        struct Node* temp = *head;
        struct Node* prev = NULL;
        while (temp != NULL && temp->data != value) {
            prev = temp;
            temp = temp->next;
        }
        if (temp == NULL) {
            printf("%d not found in the list\n", value);
        } else {
            prev->next = temp->next;
            printf("%d deleted from the list (specified element)\n", temp->data);
            free(temp);
        }
    }
}

void displayList(struct Node* head) {
    if (head == NULL) {
        printf("Linked list is empty\n");
    } else {
        printf("Linked list contents: ");
        while (head != NULL) {
            printf("%d -> ", head->data);
```

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

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

    while (1) {
        printf("\n1. Create (Insert at end)\n2. Delete first element\n3. Delete last element\n4.
Delete specified element\n5. Display list\n6. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert: ");
                scanf("%d", &value);
                insertAtEnd(&head, value);
                break;
            case 2:
                deleteFirst(&head);
                break;
            case 3:
                deleteLast(&head);
                break;
            case 4:
                printf("Enter value to delete: ");
                scanf("%d", &value);
                deleteElement(&head, value);
```

```
            break;
          case 5:
            displayList(head);
            break;
          case 6:
            exit(0);
          default:
            printf("Invalid choice!!!\n");
        }
      }
  return 0;
}
```

Output:

```
1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert: 8
8 inserted into the list

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert: 4
4 inserted into the list

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert: 5
5 inserted into the list

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert: 9
9 inserted into the list

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 5
Linked list contents: 8 -> 4 -> 5 -> 9 -> NULL
```

```
1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 2
8 deleted from the list (first element)

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 5
Linked list contents: 4 -> 5 -> 9 -> NULL

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 3
9 deleted from the list (last element)

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 5
Linked list contents: 4 -> 5 -> NULL

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 4
Enter value to delete: 5
5 deleted from the list (specified element)

1. Create (Insert at end)
2. Delete first element
3. Delete last element
4. Delete specified element
5. Display list
6. Exit
Enter your choice: 5
Linked list contents: 4 -> NULL
```

Leetcode

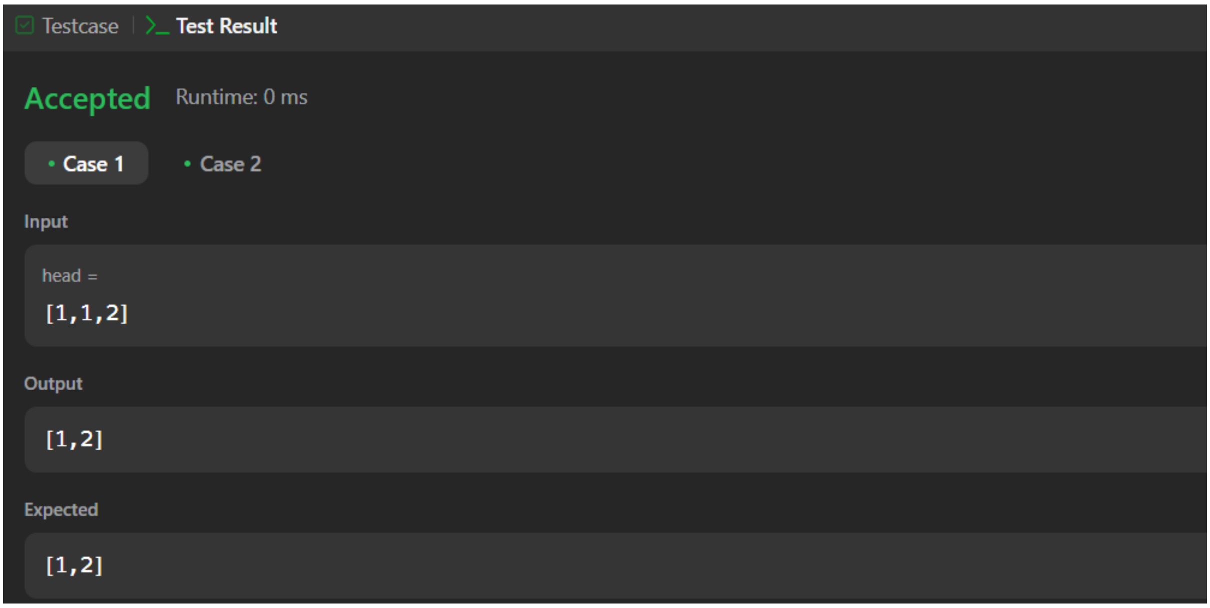
Remove Digit from Number to Maximize Result

Code:

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

struct ListNode {
    int val;
    struct ListNode* next;
};

struct ListNode* deleteDuplicates(struct ListNode* 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;
}

struct ListNode* createNode(int value) {
    struct ListNode* newNode = (struct ListNode*)malloc(sizeof(struct ListNode));
    newNode->val = value;
    newNode->next = NULL;
    return newNode;
```

```
}

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

void freeList(struct ListNode* head) {
    while (head != NULL) {
        struct ListNode* temp = head;
        head = head->next;
        free(temp);
    }
}

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

    printList(head);
    head = deleteDuplicates(head);
    printList(head);
    freeList(head);

    return 0;
}
```

Output:


Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Input
head =
[1,1,2]
Output
[1,2]
Expected
[1,2]

Leetcode

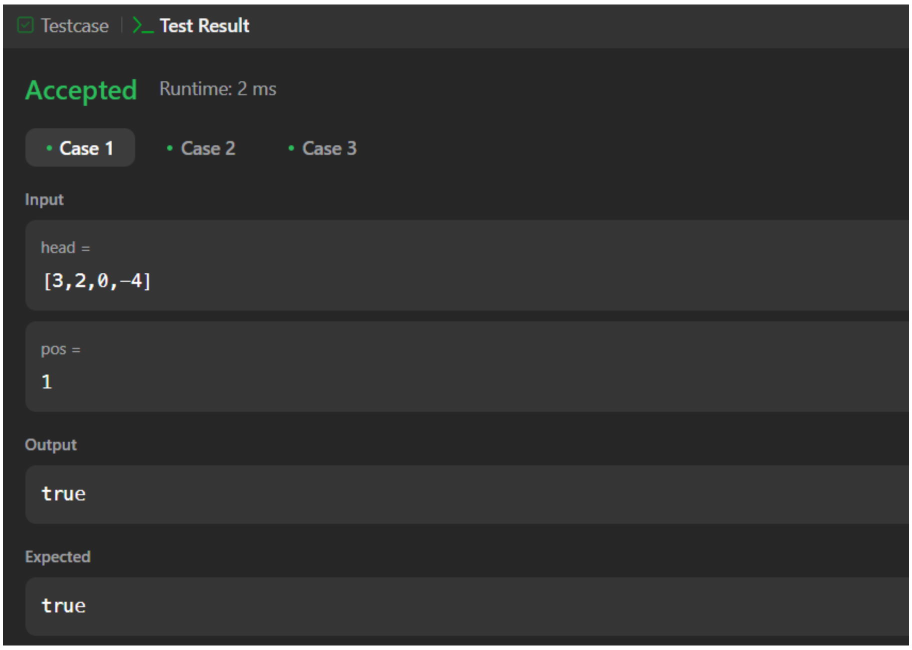
Linked List Cycle

Code:

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

struct ListNode {
    int val;
    struct ListNode* next;
};

bool hasCycle(struct ListNode* head) {
    if (head == NULL) return false;
    struct ListNode *slow = head, *fast = head;
    while (fast != NULL && fast->next != NULL) {
        slow = slow->next;
        fast = fast->next->next;
        if (slow == fast) return true;
    }
    return false;
}

struct ListNode* createNode(int value) {
    struct ListNode* newNode = (struct ListNode*)malloc(sizeof(struct ListNode));
    newNode->val = value;
    newNode->next = NULL;
    return newNode;
}

void freeList(struct ListNode* head) {
    struct ListNode* temp;
```

```
    while (head != NULL) {
        temp = head;
        head = head->next;
        free(temp);
    }
}

int main() {
    struct ListNode* head = createNode(3);
    head->next = createNode(2);
    head->next->next = createNode(0);
    head->next->next->next = createNode(-4);
    head->next->next->next->next = head->next;
    printf("%s\n", hasCycle(head) ? "true" : "false");

    freeList(head);

    return 0;
}
```

Output:



Leetcode

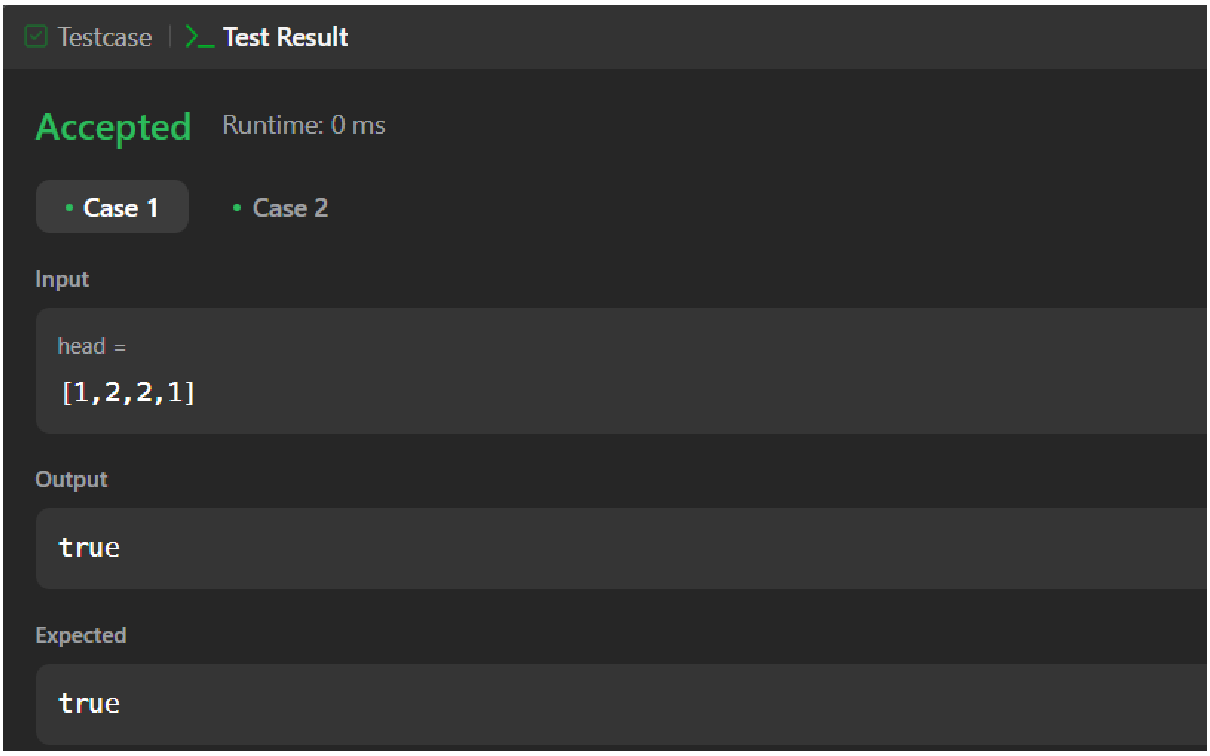
Palindrome Linked List

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

struct ListNode {
    int val;
    struct ListNode* next;
};

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

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

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

    struct ListNode* second_half = slow;
    struct ListNode* prev = NULL;
    while (second_half != NULL) {
        struct ListNode* next = second_half->next;
        second_half->next = prev;
        prev = second_half;
        second_half = next;
    }

    struct ListNode* first_half = head;
    second_half = prev;
```

```
    while (second_half != NULL) {
        if (first_half->val != second_half->val) return false;
        first_half = first_half->next;
        second_half = second_half->next;
    }

    return true;
}

struct ListNode* createNode(int value) {
    struct ListNode* newNode = (struct ListNode*)malloc(sizeof(struct ListNode));
    newNode->val = value;
    newNode->next = NULL;
    return newNode;
}

void freeList(struct ListNode* head) {
    while (head != NULL) {
        struct ListNode* temp = head;
        head = head->next;
        free(temp);
    }
}

int main() {
    struct ListNode* head = createNode(1);
    head->next = createNode(2);
    head->next->next = createNode(2);
    head->next->next->next = createNode(1);

    printf("%s\n", isPalindrome(head) ? "true" : "false");
```

```
    freeList(head);
    return 0;
}
```

Output:



Program 6

a) **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* createNode(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (!newNode) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = value;
    newNode->next = NULL;
    return newNode;
}

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

```
    }
    printf("%d inserted into the list\n", value);
}

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

void sortList(struct Node** head) {
    if (*head == NULL || (*head)->next == NULL) {
        printf("List is already sorted or empty\n");
        return;
    }
    struct Node *i, *j;
    int temp;
    for (i = *head; i != NULL; i = i->next) {
        for (j = i->next; j != NULL; j = j->next) {
            if (i->data > j->data) {
                temp = i->data;
                i->data = j->data;
                j->data = temp;
            }
        }
```

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

void reverseList(struct Node** head) {
    struct Node *prev = NULL, *current = *head, *next = NULL;
    while (current != NULL) {
        next = current->next;
        current->next = prev;
        prev = current;
        current = next;
    }
    *head = prev;
    printf("List reversed\n");
}

void concatenateLists(struct Node** head1, struct Node** head2) {
    if (*head1 == NULL) {
        *head1 = *head2;
    } else {
        struct Node* temp = *head1;
        while (temp->next != NULL) {
            temp = temp->next;
        }
        temp->next = *head2;
    }
    *head2 = NULL;
    printf("Lists concatenated\n");
}

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

```
    int choice, value;

    while (1) {
        printf("\n1. Insert into List 1\n2. Insert into List 2\n3. Sort List 1\n4. Reverse List 1\n5. Concatenate Lists\n6. Display List 1\n7. Display List 2\n8. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert into List 1: ");
                scanf("%d", &value);
                insertAtEnd(&list1, value);
                break;
            case 2:
                printf("Enter value to insert into List 2: ");
                scanf("%d", &value);
                insertAtEnd(&list2, value);
                break;
            case 3:
                sortList(&list1);
                break;
            case 4:
                reverseList(&list1);
                break;
            case 5:
                concatenateLists(&list1, &list2);
                break;
            case 6:
                displayList(list1);
                break;
            case 7:
```

```
                displayList(list2);
                break;
            case 8:
                exit(0);
            default:
                printf("Invalid choice!!!\n");
        }
    }
    return 0;
}
```

Output:

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 1
Enter value to insert into List 1: 3
3 inserted into the list

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 1
Enter value to insert into List 1: 2
2 inserted into the list

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 1
Enter value to insert into List 1: 8
8 inserted into the list

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 2
Enter value to insert into List 2: 6
6 inserted into the list
```

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 2
Enter value to insert into List 2: 5
5 inserted into the list

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 2
Enter value to insert into List 2: 1
1 inserted into the list

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 3
List sorted

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 6
Linked list contents: 2 -> 3 -> 8 -> NULL
```

```
1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 4
List reversed

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 6
Linked list contents: 8 -> 3 -> 2 -> NULL

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 7
Linked list contents: 6 -> 5 -> 1 -> NULL

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 5
Lists concatenated

1. Insert into List 1
2. Insert into List 2
3. Sort List 1
4. Reverse List 1
5. Concatenate Lists
6. Display List 1
7. Display List 2
8. Exit
Enter your choice: 6
Linked list contents: 8 -> 3 -> 2 -> 6 -> 5 -> 1 -> NULL
```

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

Code:

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

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

struct Node* createNode(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (!newNode) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = value;
    newNode->next = NULL;
    return newNode;
}

void push(struct Node** top, int value) {
    struct Node* newNode = createNode(value);
    newNode->next = *top;
    *top = newNode;
    printf("%d pushed onto the stack\n", value);
}

void pop(struct Node** top) {
    if (*top == NULL) {
        printf("Stack underflow\n");
```

```
    } else {
        struct Node* temp = *top;
        *top = (*top)->next;
        printf("%d popped from the stack\n", temp->data);
        free(temp);
    }
}

void enqueue(struct Node** front, struct Node** rear, int value) {
    struct Node* newNode = createNode(value);
    if (*rear == NULL) {
        *front = *rear = newNode;
    } else {
        (*rear)->next = newNode;
        *rear = newNode;
    }
    printf("%d enqueued into the queue\n", value);
}

void dequeue(struct Node** front, struct Node** rear) {
    if (*front == NULL) {
        printf("Queue underflow\n");
    } else {
        struct Node* temp = *front;
        *front = (*front)->next;
        if (*front == NULL) {
            *rear = NULL;
        }
        printf("%d dequeued from the queue\n", temp->data);
        free(temp);
    }
}
```

```
void displayStack(struct Node* top) {
    if (top == NULL) {
        printf("Stack is empty\n");
    } else {
        printf("Stack contents: ");
        while (top != NULL) {
            printf("%d -> ", top->data);
            top = top->next;
        }
        printf("NULL\n");
    }
}

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

int main() {
    struct Node* stackTop = NULL;
    struct Node *queueFront = NULL, *queueRear = NULL;
    int choice, value;
```

```
    while (1) {
        printf("\n1. Push (Stack)\n2. Pop (Stack)\n3. Display Stack\n4. Enqueue (Queue)\n5. Dequeue (Queue)\n6. Display Queue\n7. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);


        switch (choice) {
            case 1:
                printf("Enter value to push onto the stack: ");
                scanf("%d", &value);
                push(&stackTop, value);
                break;
            case 2:
                pop(&stackTop);
                break;
            case 3:
                displayStack(stackTop);
                break;
            case 4:
                printf("Enter value to enqueue into the queue: ");
                scanf("%d", &value);
                enqueue(&queueFront, &queueRear, value);
                break;
            case 5:
                dequeue(&queueFront, &queueRear);
                break;
            case 6:
                displayQueue(queueFront);
                break;
            case 7:
                exit(0);
            default:
```

```
            printf("Invalid choice!!!\n");
        }
    }
  return 0;
}
```

Output:

```
1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 1
Enter value to push onto the stack: 5
5 pushed onto the stack

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 1
Enter value to push onto the stack: 8
8 pushed onto the stack

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 1
Enter value to push onto the stack: 9
9 pushed onto the stack

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 3
Stack contents: 9 -> 8 -> 5 -> NULL
```

```
1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 2
9 popped from the stack

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 3
Stack contents: 8 -> 5 -> NULL
```

```
1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 4
Enter value to enqueue into the queue: 3
3 enqueued into the queue

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 4
Enter value to enqueue into the queue: 8
8 enqueued into the queue

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 4
Enter value to enqueue into the queue: 9
9 enqueued into the queue

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 6
Queue contents: 3 -> 8 -> 9 -> NULL
```

```
1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 5
3 dequeued from the queue

1. Push (Stack)
2. Pop (Stack)
3. Display Stack
4. Enqueue (Queue)
5. Dequeue (Queue)
6. Display Queue
7. Exit
Enter your choice: 6
Queue contents: 8 -> 9 -> NULL
```

<u>Program 7</u>

WAP to Implement doubly link list with primitive operations

a) Create a doubly linked list.

b) Insert a new node at the beginning.

c) Insert the node based on a specific location.

d) Insert a new node at the end.

e) Display the contents of the list.

<u>Code:</u>

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

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

struct Node* createNode(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (!newNode) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = value;
    newNode->next = newNode->prev = NULL;
    return newNode;
}

void insertAtBeginning(struct Node** head, int value) {
    struct Node* newNode = createNode(value);
```

```
    if (*head == NULL) {
        *head = newNode;
    } else {
        newNode->next = *head;
        (*head)->prev = newNode;
        *head = newNode;
    }
    printf("%d inserted at the beginning\n", value);
}

void insertAtPosition(struct Node** head, int value, int position) {
    struct Node* newNode = createNode(value);
    if (position == 1) {
        insertAtBeginning(head, value);
        return;
    }
    struct Node* temp = *head;
    for (int i = 1; temp != NULL && i < position - 1; i++) {
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Position out of range\n");
    } else {
        newNode->next = temp->next;
        if (temp->next != NULL) {
            temp->next->prev = newNode;
        }
        temp->next = newNode;
        newNode->prev = temp;
        printf("%d inserted at position %d\n", value, position);
    }
}
```

```
void insertAtEnd(struct Node** head, int value) {
    struct Node* newNode = createNode(value);
    if (*head == NULL) {
        *head = newNode;
    } else {
        struct Node* temp = *head;
        while (temp->next != NULL) {
            temp = temp->next;
        }
        temp->next = newNode;
        newNode->prev = temp;
    }
    printf("%d inserted at the end\n", value);
}

void displayList(struct Node* head) {
    if (head == NULL) {
        printf("The list is empty\n");
        return;
    }
    struct Node* temp = head;
    printf("Doubly Linked List: ");
    while (temp != NULL) {
        printf("%d <-> ", temp->data);
        temp = temp->next;
    }
    printf("NULL\n");
}

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

```
    int choice, value, position;

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

        switch (choice) {
            case 1:
                printf("Enter value to insert at the beginning: ");
                scanf("%d", &value);
                insertAtBeginning(&head, value);
                break;
            case 2:
                printf("Enter value to insert: ");
                scanf("%d", &value);
                printf("Enter position: ");
                scanf("%d", &position);
                insertAtPosition(&head, value, position);
                break;
            case 3:
                printf("Enter value to insert at the end: ");
                scanf("%d", &value);
                insertAtEnd(&head, value);
                break;
            case 4:
                displayList(head);
                break;
            case 5:
                exit(0);
            default:
```

```
            printf("Invalid choice!!!\n");
        }
    }
    return 0;
}
```

Output:

```
1. Insert at Beginning
2. Insert at Position
3. Insert at End
4. Display List
5. Exit
Enter your choice: 1
Enter value to insert at the beginning: 6
6 inserted at the beginning

1. Insert at Beginning
2. Insert at Position
3. Insert at End
4. Display List
5. Exit
Enter your choice: 3
Enter value to insert at the end: 7
7 inserted at the end

1. Insert at Beginning
2. Insert at Position
3. Insert at End
4. Display List
5. Exit
Enter your choice: 1
Enter value to insert at the beginning: 4
4 inserted at the beginning

1. Insert at Beginning
2. Insert at Position
3. Insert at End
4. Display List
5. Exit
Enter your choice: 2
Enter value to insert: 9
Enter position: 2
9 inserted at position 2

1. Insert at Beginning
2. Insert at Position
3. Insert at End
4. Display List
5. Exit
Enter your choice: 4
Doubly Linked List: 4 <-> 9 <-> 6 <-> 7 <-> NULL
```

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.

Code:

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

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

struct Node* createNode(int value) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (!newNode) {
        printf("Memory allocation failed\n");
        exit(1);
    }
    newNode->data = value;
    newNode->left = newNode->right = NULL;
    return newNode;
}

struct Node* insert(struct Node* root, int value) {
    if (root == NULL) {
        return createNode(value);
    }
```

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

    return root;
}

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

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

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

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

    while (1) {
        printf("\n1. Insert node into BST\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 value to insert into BST: ");
                scanf("%d", &value);
                root = insert(root, value);
                printf("%d inserted into the BST\n", 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:
            exit(0);
        default:
            printf("Invalid choice!!!\n");
      }
   }
  return 0;
}
```

Output:

```
1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter value to insert into BST: 50
50 inserted into the BST

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter value to insert into BST: 30
30 inserted into the BST

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter value to insert into BST: 70
70 inserted into the BST

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter value to insert into BST: 20
20 inserted into the BST

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter value to insert into BST: 40
40 inserted into the BST
```

```
1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter value to insert into BST: 60
60 inserted into the BST

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 1
Enter value to insert into BST: 80
80 inserted into the BST

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 2
In-order traversal: 20 30 40 50 60 70 80

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 3
Pre-order traversal: 50 30 20 40 70 60 80

1. Insert node into BST
2. In-order Traversal
3. Pre-order Traversal
4. Post-order Traversal
5. Exit
Enter your choice: 4
Post-order traversal: 20 40 30 60 80 70 50
```

Program 9

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

Code:

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

#define MAX 20

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

void initQueue(struct Queue* q) {
   q->front = -1;
   q->rear = -1;
}

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

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

```
}

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

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

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

    printf("BFS traversal starting from vertex %d: ", startVertex);

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

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

```
            if (graph[currentVertex][i] == 1 && !visited[i]) {
                enqueue(&q, i);
                visited[i] = 1;
            }
        }
    }
    printf("\n");
}

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



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

    printf("Enter the adjacency matrix (0 for no edge, 1 for edge):\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &graph[i][j]);
        }
    }

    printf("Enter the starting vertex (0 to %d): ", n - 1);
    scanf("%d", &startVertex);

    bfs(graph, startVertex, n);
    return 0;
}
```

Output:

```
Enter the number of vertices: 5
Enter the adjacency matrix (0 for no edge, 1 for edge):
0 1 1 0 0
1 0 0 1 1
1 0 0 0 1
0 1 0 0 0
0 1 1 0 0
Enter the starting vertex (0 to 4): 0
BFS traversal starting from vertex 0: 0 1 2 3 4
```

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

Code:

```
#include <stdio.h>
#include <stdlib.h>
#define MAX 20
void dfs(int graph[MAX][MAX], int visited[MAX], int vertex, int n) {
    visited[vertex] = 1;
    printf("%d ", vertex);
    for (int i = 0; i < n; i++) {
        if (graph[vertex][i] == 1 && !visited[i]) {
            dfs(graph, visited, i, n);
        }
    }
}
int isConnected(int visited[MAX], int n) {
    for (int i = 0; i < n; i++) {
        if (visited[i] == 0) {
            return 0;
        }
    }
    return 1;
}
int main() {
    int graph[MAX][MAX], visited[MAX], n, startVertex;
    printf("Enter the number of vertices: ");
    scanf("%d", &n);
    printf("Enter the adjacency matrix (0 for no edge, 1 for edge):\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &graph[i][j]);
        }
```

```
    }
    for (int i = 0; i < n; i++) {
        visited[i] = 0;
    }
    printf("Enter the starting vertex (0 to %d): ", n - 1);
    scanf("%d", &startVertex);
    printf("DFS traversal starting from vertex %d: ", startVertex);
    dfs(graph, visited, startVertex, n);
    printf("\n");
    if (isConnected(visited, n)) {
        printf("The graph is connected.\n");
    } else {
        printf("The graph is not connected.\n");
    }

    return 0;
}
```

Output:

```
Enter the number of vertices: 4
Enter the adjacency matrix (0 for no edge, 1 for edge):
0 1 0 0
1 0 1 1
0 1 0 1
0 1 1 0
Enter the starting vertex (0 to 3): 0
DFS traversal starting from vertex 0: 0 1 2 3
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.

Code:

```
#include <stdio.h>

#include <stdlib.h>


#define MAX_RECORDS 100

#define MAX_KEYS 10


struct Employee {

    int key;

    char name[50];

};


int linearProbing(int hashTable[], int m, int index) {

    int i = index;

    while (hashTable[i] != -1) {

        i = (i + 1) % m;

        if (i == index) {

            return -1;

        }

    }

    return i;

}
```

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

void insert(int hashTable[], struct Employee employees[], int key, int m, int *size) {
  int index = hashFunction(key, m);
  if (hashTable[index] == -1) {
    hashTable[index] = key;
    employees[index].key = key;
    printf("Enter employee name: ");
    scanf("%s", employees[index].name);
    (*size)++;
    printf("Employee with key %d inserted at index %d.\n", key, index);
  } else {
    int newIndex = linearProbing(hashTable, m, index);
    if (newIndex != -1) {
      hashTable[newIndex] = key;
      employees[newIndex].key = key;
      printf("Enter employee name: ");
      scanf("%s", employees[newIndex].name);
      (*size)++;
      printf("Employee with key %d inserted at index %d.\n", key, newIndex);
    } else {
      printf("No available space to insert the record.\n");
    }
  }
}
int search(int hashTable[], struct Employee employees[], int key, int m) {
  int index = hashFunction(key, m);
  if (hashTable[index] == key) {
    return index;
  } else {
```

```
        int i = (index + 1) % m;
        while (i != index) {
            if (hashTable[i] == key) {
                return i;
            }
            i = (i + 1) % m;
        }
    }
    return -1;
}
void display(int hashTable[], struct Employee employees[], int m) {
    for (int i = 0; i < m; i++) {
        if (hashTable[i] != -1) {
            printf("Employee Key: %d, Name: %s at index %d\n", employees[i].key,
employees[i].name, i);
        }
    }
}

int main() {
    int m, size = 0;

    printf("Enter the size of the hash table (m): ");
    scanf("%d", &m);

    int hashTable[m];
    struct Employee employees[m];

    for (int i = 0; i < m; i++) {
        hashTable[i] = -1;
    }
```

```
    while (1) {
        int choice, key;

        printf("\n1. Insert Employee\n2. Search Employee\n3. Display Employees\n4. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter employee key (4-digit): ");
                scanf("%d", &key);
                insert(hashTable, employees, key, m, &size);
                break;
            case 2:
                printf("Enter employee key to search: ");
                scanf("%d", &key);
                int index = search(hashTable, employees, key, m);
                if (index != -1) {
                    printf("Employee with key %d found at index %d. Name: %s\n", key, index,
employees[index].name);
                } else {
                    printf("Employee with key %d not found.\n", key);
                }
                break;
            case 3:
                display(hashTable, employees, m);
                break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice!\n");
        }
```

```
    }

    return 0;
}
```

Output:

```
Enter the size of the hash table (m): 5

1. Insert Employee
2. Search Employee
3. Display Employees
4. Exit
Enter your choice: 1
Enter employee key (4-digit): 1234
Enter employee name: John
Employee with key 1234 inserted at index 4.

1. Insert Employee
2. Search Employee
3. Display Employees
4. Exit
Enter your choice: 3
Employee Key: 1234, Name: John at index 4

1. Insert Employee
2. Search Employee
3. Display Employees
4. Exit
Enter your choice: 4
```