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 ROSHAN N **(1BM23CS275)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2024-25. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST)**work prescribed for the said degree.

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Index Sheet

Course outcomes:

CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations of different data structures.

Lab program 1:

Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c) Display
The program should print appropriate messages for stack overflow, stack underflow.

```
#include <stdio.h>

#include <stdlib.h>


#define MAX 100


typedef struct Stack {

    int items[MAX];

    int top;

} Stack;


void initStack(Stack* s) {

    s->top = -1;

}


int isFull(Stack* s) {

    return s->top == MAX - 1;

}


int isEmpty(Stack* s) {

    return s->top == -1;

}


void push(Stack* s, int value) {

    if (isFull(s)) {
```

```
        printf("Stack Overflow: Cannot push %d, stack is full.\n", value);
        return;
    }
    s->items[++(s->top)] = value;
    printf("%d pushed to stack.\n", value);
}

int pop(Stack* s) {
    if (isEmpty(s)) {
        printf("Stack Underflow: Cannot pop, stack is empty.\n");
        return -1;
    }
    return s->items[(s->top)--];
}

void display(Stack* s) {
    if (isEmpty(s)) {
        printf("Stack is empty.\n");
        return;
    }
    printf("Stack elements: ");
    for (int i = 0; i <= s->top; i++) {
        printf("%d ", s->items[i]);
    }
    printf("\n");
}

int main() {
    Stack s;
```

```
initStack(&s);

int choice, value;

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

    switch (choice) {
        case 1:
            printf("Enter value to push: ");
            scanf("%d", &value);
            push(&s, value);
            break;
        case 2:
            value = pop(&s);
            if (value != -1) {
                printf("%d popped from stack.\n", value);
            }
            break;
        case 3:
            display(&s);
            break;
        case 4:
```

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

Output

```
1.push
2.pop
3.display
4.exit
Enter your choice : 1
Enter element to push : 2
1.push
2.pop
3.display
4.exit
Enter your choice : 1
Enter element to push : 4
1.push
2.pop
3.display
4.exit
Enter your choice : 1
Enter element to push : 6
1.push
2.pop
3.display
4.exit
Enter your choice : 1
Enter element to push : 8
1.push
2.pop
3.display
4.exit
Enter your choice : 1
Enter element to push : 9
```

```
Enter element to push : 9
1.push
2.pop
3.display
4.exit
Enter your choice : 1
Enter element to push : 7
Stack overflowing unable to push 71.push
2.pop
3.display
4.exit
Enter your choice : 2
 9 poped from stack1.push
2.pop
3.display
4.exit
Enter your choice : 2
 9 poped from stack1.push
2.pop
3.display
4.exit
Enter your choice : 3
Stack element :9 8 6 4 2 1.push
2.pop
3.display
4.exit
Enter your choice : 4

Process returned 0 (0x0)   execution time : 31.628 s
Press any key to continue.
```

lab program 2 :

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

```
#include <stdio.h>


#define MAX 100


char stack[MAX];
```

```
int top = -1;

void push(char x) {
   if (top == MAX - 1) {
      printf("Stack Overflow\n");
   } else {
      stack[++top] = x;
   }
}

char pop() {
   if (top == -1) {
      printf("Stack Underflow\n");
      return -1;
   } else {
      return stack[top--];
   }
}

int precedence(char x) {
   if (x == '^') {
      return 3;
   } else if (x == '*' || x == '/') {
      return 2;
   } else if (x == '+' || x == '-') {
      return 1;
   } else {
      return 0;
   }
}

int isOperand(char ch) {
```

```
    if ((ch >= 'A' && ch <= 'Z') || (ch >= 'a' && ch <= 'z') || (ch >= '0' && ch <= '9')) {
        return 1;
    }
    return 0;
}

void infixToPostfix(char* exp) {
    char postfix[MAX];
    int i, j = 0;

    for (i = 0; exp[i] != '\0'; i++) {
        char ch = exp[i];

        if (isOperand(ch)) {
            postfix[j++] = ch;
        }
        else if (ch == '(') {
            push(ch);
        }
        else if (ch == ')') {
            while (top != -1 && stack[top] != '(') {
                postfix[j++] = pop();
            }
            pop();
        }
        else {
            while (top != -1 && precedence(stack[top]) >= precedence(ch)) {
                postfix[j++] = pop();
            }
            push(ch);
        }
    }
```

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

    postfix[j] = '\0';
    printf("Postfix Expression: %s\n", postfix);
}

int main() {
    char infix[MAX];
    printf("Enter infix expression: ");
    scanf("%s", infix);
    infixToPostfix(infix);
    return 0;
}
```

OUTPUT

```
Enter infix expression: A+B*(C+D)-E/F
Postfix Expression: ABCD+*+EF/-

Process returned 0 (0x0)   execution time : 6.606 s
Press any key to continue.
```

Lab program 3:

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

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

#define MAX 5

struct Queue {
```

```
    int arr[MAX];
    int front;
    int rear;
};

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

int isFull(struct Queue* q) {
    if (q->rear == MAX - 1) {
        return 1;
    }
    return 0;
}

int isEmpty(struct Queue* q) {
    if (q->front == -1) {
        return 1;
    }
    return 0;
}

void insert(struct Queue* q, int value) {
    if (isFull(q)) {
        printf("Queue Overflow! Cannot insert %d\n", value);
    } else {
        if (q->front == -1) {
            q->front = 0;
        }
        q->rear++;
```

```
        q->arr[q->rear] = value;
        printf("Inserted %d into the queue.\n", value);
    }
}

void delete(struct Queue* q) {
    if (isEmpty(q)) {
        printf("Queue Underflow! Cannot delete element\n");
    } else {
        printf("Deleted %d from the queue.\n", q->arr[q->front]);
        if (q->front == q->rear) {
            q->front = q->rear = -1;
        } else {
            q->front++;
        }
    }
}

void display(struct Queue* q) {
    if (isEmpty(q)) {
        printf("Queue is empty. Nothing to display.\n");
    } else {
        printf("Queue elements: ");
        for (int i = q->front; i <= q->rear; i++) {
            printf("%d ", q->arr[i]);
        }
        printf("\n");
    }
}

int main() {
    struct Queue q;
```

```
initializeQueue(&q);

int choice, value;

while (1) {
   printf("\nQueue Operations Menu:\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 value to insert: ");
         scanf("%d", &value);
         insert(&q, value);
         break;

      case 2:
         delete(&q);
         break;

      case 3:
         display(&q);
         break;

      case 4:
         printf("Exiting program.\n");
         exit(0);
```

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

    return 0;

}
```

OUTPUT:

```
Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 6
Inserted 6 into the queue

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 8
Inserted 8 into the queue

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 9
Inserted 9 into the queue

Queue Operations:
1. Insert
```

```
Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 4
Inserted 4 into the queue

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 7
Inserted 7 into the queue

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

Queue Operations:
1. Insert
```

```
Enter your choice: 1
Enter the value to insert: 3
Queue Overflow

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 6 from the queue

Queue Operations:
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements: 8 9 4 7

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

Process returned 0 (0x0)   execution time : 26.746 s
Press any key to continue.
```

Lab program 4:

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

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

#define MAX 5
struct Queue {
   int arr[MAX];
   int front;
   int rear;
};

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

int isFull(struct Queue* q) {
   if ((q->rear + 1) % MAX == q->front) {
      return 1;
   }
   return 0;
}

int isEmpty(struct Queue* q) {
   if (q->front == -1) {
      return 1;
   }
   return 0;
}
```

```
void insert(struct Queue* q, int value) {
    if (isFull(q)) {
        printf("Queue Overflow! Cannot insert %d\n", value);
    } else {
        if (q->front == -1) {
            q->front = 0;
        }
        q->rear = (q->rear + 1) % MAX;
        q->arr[q->rear] = value;
        printf("Inserted %d into the queue.\n", value);
    }
}

void delete(struct Queue* q) {
    if (isEmpty(q)) {
        printf("Queue Underflow! Cannot delete element\n");
    } else {
        printf("Deleted %d from the queue.\n", q->arr[q->front]);
        if (q->front == q->rear) {
            q->front = q->rear = -1;
        } else {
            q->front = (q->front + 1) % MAX;
        }
    }
}

void display(struct Queue* q) {
    if (isEmpty(q)) {
        printf("Queue is empty. Nothing to display.\n");
    } else {
        printf("Queue elements: ");
        int i = q->front;
```

```
        while (i != q->rear) {
            printf("%d ", q->arr[i]);
            i = (i + 1) % MAX;
        }
        printf("%d\n", q->arr[q->rear]);
    }
}

int main() {
    struct Queue q;
    initializeQueue(&q);

    int choice, value;

    while (1) {
        printf("\nCircular Queue Operations Menu:\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 value to insert: ");
                scanf("%d", &value);
                insert(&q, value);
                break;

            case 2:
                delete(&q);
```

```
            break;

        case 3:
            display(&q);
            break;

        case 4:
            printf("Exiting program.\n");
            exit(0);

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

    return 0;
}
```

OUTPUT:

```
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 2
Inserted 2 into the queue.

--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 3
Inserted 3 into the queue.

--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 5
Inserted 5 into the queue.

--- Circular Queue Operations ---
1. Insert
```

```
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 7
Inserted 7 into the queue.

--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 8
Inserted 8 into the queue.

--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 9
Queue Overflow! Cannot insert 9

--- Circular Queue Operations ---
1. Insert
```

```
--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 2 from the queue.

--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Deleted 3 from the queue.

--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue elements are: 5 7 8

--- Circular Queue Operations ---
1. Insert
2. Delete
3. Display
4. Exit
```

Lab program 5:

WAP of insertion in linked list:

```
#include <stdio.h>

#include <stdlib.h>


struct Node {

   int data;

   struct Node *next;

};

struct Node *top = NULL;

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(int value) {
    struct Node *newNode = createNode(value);
    newNode->next = top;
    top = newNode;
    printf("Inserted %d at the beginning.\n", value);
}
void insertAtEnd(int value) {
    struct Node *newNode = createNode(value);
    if (top == NULL) {
        top = newNode;
        printf("Inserted %d at the end.\n", value);
        return;
    }
    struct Node *ptr = top;
    while (ptr->next != NULL) {
        ptr = ptr->next;
    }
    ptr->next = newNode;
    printf("Inserted %d at the end.\n", value);
}
void insertAfterPosition(int position, int value) {
    struct Node *newNode = createNode(value);
    struct Node *ptr = top;
    for (int i = 0; i < position; i++) {
```

```
        if (ptr == NULL) {
            printf("Position %d is out of bounds.\n", position);
            free(newNode);
            return;
        }
        ptr = ptr->next;
    }
    newNode->next = ptr->next;
    ptr->next = newNode;
    printf("Inserted %d after position %d.\n", value, position);
}
void displayList() {
    if (top == NULL) {
        printf("The list is empty.\n");
        return;
    }
    struct Node *ptr = top;
    printf("Linked list: ");
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
    }
    printf("NULL\n");
}


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

```
        switch (choice) {
          case 1:
            printf("Enter value to insert at beginning: ");
            scanf("%d", &value);
            insertAtBeginning(value);
            break;
          case 2:
            printf("Enter value to insert at end: ");
            scanf("%d", &value);
            insertAtEnd(value);
            break;
          case 3:
            printf("Enter position after which to insert: ");
            scanf("%d", &position);
            printf("Enter value to insert: ");
            scanf("%d", &value);
            insertAfterPosition(position, value);
            break;
          case 4:
            displayList();
            break;
          case 5:
            exit(0);
          default:
            printf("Invalid choice. Please try again.\n");
        }
    }
    return 0;
}
```

OUTPUT:

```
Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 1
Enter value to insert at beginning: 200
Inserted 200 at the beginning.

Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 1
Enter value to insert at beginning: 150
Inserted 150 at the beginning.

Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 1
Enter value to insert at beginning: 100
Inserted 100 at the beginning.
```

```
Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 4
Linked list: 100 -> 150 -> 200 -> NULL

Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 2
Enter value to insert at end: 250
Inserted 250 at the end.

Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 3
Enter position after which to insert: 3
Enter value to insert: 300
```

```
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 3
Enter position after which to insert: 3
Enter value to insert: 300
Inserted 300 after position 3.

Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 4
Linked list: 100 -> 150 -> 200 -> 250 -> 300 -> NULL

Menu:
1. Insert at beginning
2. Insert at end
3. Insert after position
4. Display list
5. Exit
Enter your choice: 5
```

WAP of Deletion in linked list.

```
#include <stdio.h>

#include <stdlib.h>


struct Node {

   int data;

   struct Node *next;

};

struct Node *top = NULL;

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(int value) {

   struct Node *newNode = createNode(value);

   if (top == NULL) {

      top = newNode;

      return;

   }

   struct Node *ptr = top;

   while (ptr->next != NULL) {

      ptr = ptr->next;

   }

   ptr->next = newNode;

}

void deleteFromBeginning() {
```

```
    if (top == NULL) {
        printf("The list is empty. Nothing to delete.\n");
        return;
    }
    struct Node *temp = top;
    top = top->next;
    printf("Deleted %d from the beginning.\n", temp->data);
    free(temp);
}
void deleteFromEnd() {
    if (top == NULL) {
        printf("The list is empty. Nothing to delete.\n");
        return;
    }
    struct Node *ptr = top;
    if (ptr->next == NULL) {
        printf("Deleted %d from the end.\n", ptr->data);
        free(ptr);
        top = NULL;
        return;
    }
    while (ptr->next->next != NULL) {
        ptr = ptr->next;
    }
    struct Node *temp = ptr->next;
    printf("Deleted %d from the end.\n", temp->data);
    ptr->next = NULL;
    free(temp);
}
void deleteByValue(int value) {
    if (top == NULL) {
        printf("The list is empty. Nothing to delete.\n");
```

```
        return;
    }
    struct Node *ptr = top, *prev = NULL;
    if (ptr != NULL && ptr->data == value) {
        top = ptr->next;
        printf("Deleted %d from the list.\n", ptr->data);
        free(ptr);
        return;
    }
    while (ptr != NULL && ptr->data != value) {
        prev = ptr;
        ptr = ptr->next;
    }
    if (ptr == NULL) {
        printf("Value %d not found in the list.\n", value);
        return;
    }
    prev->next = ptr->next;
    printf("Deleted %d from the list.\n", ptr->data);
    free(ptr);
}
void displayList() {
    if (top == NULL) {
        printf("The list is empty.\n");
        return;
    }
    struct Node *ptr = top;
    printf("Linked list: ");
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
    }
```

```
    printf("NULL\n");
}

int main() {
    int choice, value;
    while (1) {
        printf("\nMenu:\n1. Insert at end\n2. Delete from beginning\n3. Delete from end\n4. Delete by value\n5. Display list\n6. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter value to insert at end: ");
                scanf("%d", &value);
                insertAtEnd(value);
                break;
            case 2:
                deleteFromBeginning();
                break;
            case 3:
                deleteFromEnd();
                break;
            case 4:
                printf("Enter value to delete: ");
                scanf("%d", &value);
                deleteByValue(value);
                break;
            case 5:
                displayList();
                break;
            case 6:
```

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

OUTPUT:

```
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert at end: 100

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert at end: 200

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert at end: 300
```

```
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5
Linked list: 100 -> 200 -> 300 -> NULL

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 2
Deleted 100 from the beginning.

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5
```

```
Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 1
Enter value to insert at end: 400

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5
Linked list: 200 -> 300 -> 400 -> NULL

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
```

```
6. Exit
Enter your choice: 3
Deleted 400 from the end.

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 4
Enter value to delete: 300
Deleted 300 from the list.

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 5
Linked list: 200 -> NULL

Menu:
1. Insert at end
2. Delete from beginning
3. Delete from end
4. Delete by value
```

```
3. Delete from end
4. Delete by value
5. Display list
6. Exit
Enter your choice: 6

Process returned 0 (0x0)   execution time : 77.742 s
Press any key to continue.
```

Lab program 6:

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>

```c
#include<stddef.h>

struct Node {
    int data;
    struct Node *next;
};
struct Node *top1 = NULL, *top2 = NULL;

void sortLinkedList(struct Node *top) {
    struct Node *ptr, *pre_ptr;
    int temp;

    if (top == NULL || top->next == NULL) {
        return;
    }
    for (ptr = top; ptr != NULL; ptr = ptr->next) {
        for (pre_ptr = top; pre_ptr->next != NULL; pre_ptr = pre_ptr->next) {
            if (pre_ptr->data > pre_ptr->next->data) {
                temp = pre_ptr->data;
                pre_ptr->data = pre_ptr->next->data;
                pre_ptr->next->data = temp;
            }
        }
    }
}

struct Node* reverseLinkedList(struct Node *top) {
    struct Node *ptr = top, *pre_ptr = NULL, *next_ptr = NULL;

    while (ptr != NULL) {
        next_ptr = ptr->next;
        ptr->next = pre_ptr;
```

```
        pre_ptr = ptr;
        ptr = next_ptr;
    }
    return pre_ptr;
}

struct Node* concatenateLinkedLists(struct Node *top1, struct Node *top2) {
    struct Node *ptr = top1;

    if (top1 == NULL) return top2;
    if (top2 == NULL) return top1;

    while (ptr->next != NULL) {
        ptr = ptr->next;
    }

    ptr->next = top2;
    return top1;
}

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

void displayList(struct Node *top) {
    struct Node *ptr = top;
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
```

```
    }
    printf("NULL\n");
}

void main() {
    top1 = createNode(20);
    top1->next = createNode(30);
    top1->next->next = createNode(40);

    top2 = createNode(50);
    top2->next = createNode(60);

    printf("Original List 1: ");
    displayList(top1);

    printf("Original List 2: ");
    displayList(top2);

    sortLinkedList(top1);
    printf("Sorted List 1: ");
    displayList(top1);

    top1 = reverseLinkedList(top1);
    printf("Reversed List 1: ");
    displayList(top1);

    struct Node *mergedList = concatenateLinkedLists(top1, top2);
    printf("Concatenated List: ");
    displayList(mergedList);
}
```

OUTPUT:

```
Original List 1: 100 -> 300 -> 200 -> NULL
Original List 2: 400 -> 500 -> NULL
Sorted List 1: 100 -> 200 -> 300 -> NULL
Reversed List 1: 300 -> 200 -> 100 -> NULL
Concatenated List: 300 -> 200 -> 100 -> 400 -> 500 -> NULL

Process returned 0 (0x0)   execution time : 0.047 s
Press any key to continue.
```

Lab program 7:

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

```c
#include <stdio.h>

#include <stdlib.h>


struct Node {

   int data;

   struct Node* next;

};


struct Node* top = NULL;

struct Node* front = NULL;

struct Node* rear = NULL;


struct Node* createNode(int value) {

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

   ptr->data = value;

   ptr->next = NULL;

   return ptr;

}


void push(int value) {

   struct Node* ptr = createNode(value);

   ptr->next = top;
```

```
    top = ptr;
    printf("Pushed %d to stack\n", value);
}

void pop() {
    if (top == NULL) {
        printf("Stack Underflow\n");
        return;
    }
    struct Node* ptr = top;
    printf("Popped %d from stack\n", top->data);
    top = top->next;
    free(ptr);
}

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

void dequeue() {
    if (front == NULL) {
        printf("Queue Underflow\n");
        return;
    }
    struct Node* ptr = front;
```

```
    printf("Dequeued %d from queue\n", front->data);
    front = front->next;
    if (front == NULL) {
        rear = NULL;
    }
    free(ptr);
}

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

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

```c
    }
    printf("NULL\n");
}

int main() {
    push(500);
    push(600);
    push(700);
    displayStack();
    pop();
    displayStack();

    enqueue(800);
    enqueue(900);
    enqueue(1000);
    displayQueue();
    dequeue();
    displayQueue();

    return 0;
}
```

OUTPUT:

};

```
Pushed 10 to stack
Pushed 20 to stack
Pushed 30 to stack
Stack: 30 -> 20 -> 10 -> NULL
Popped 30 from stack
Stack: 20 -> 10 -> NULL
Enqueued 40 to queue
Enqueued 50 to queue
Enqueued 60 to queue
Queue: 40 -> 50 -> 60 -> NULL
Dequeued 40 from queue
Queue: 50 -> 60 -> NULL

Process returned 0 (0x0)   execution time : 0.042 s
Press any key to continue.
```

Lab program 8:

1.WAP to Implement doubly link list with primitive operations Create a doubly linked list.Insert a new node to the left of the node.Delete the node based on a specific value Display the contents of the list.

```
#include <stdio.h>

#include <stdlib.h>



struct Node {

    int data;

    struct Node *prev;

    struct Node *next;

};
```

```
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 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;
    }
}


void insertBefore(struct Node** head, int newValue, int targetValue) {
    struct Node* temp = *head;
    while (temp != NULL && temp->data != targetValue) {
        temp = temp->next;
    }

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

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

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


void deleteNode(struct Node** head, int value) {
    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(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, targetValue;

    while (1) {
        printf("\nDoubly Linked List Operations:\n");
        printf("1. Insert at Beginning\n");
        printf("2. Insert Before 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 insert at the beginning: ");
        scanf("%d", &value);
        insertAtBeginning(&head, value);
        break;
      case 2:
        printf("Enter target value before which to insert: ");
        scanf("%d", &targetValue);
        printf("Enter new value to insert: ");
        scanf("%d", &value);
        insertBefore(&head, value, targetValue);
        break;
      case 3:
        printf("Enter value to delete: ");
        scanf("%d", &value);
        deleteNode(&head, value);
        break;
      case 4:
        displayList(head);
        break;
      case 5:
        printf("Exiting...\n");
        return 0;
      default:
        printf("Invalid choice! Please try again.\n");
    }
  }
```

```
    return 0;
}
```

OUTPUT:

```
Initial list:
List contents: 10 20 30

List after inserting 15 to the left of 20:
List contents: 10 15 20 30
Node with value 20 deleted.

List after deleting node with value 20:
List contents: 10 15 30
Node with value 100 not found.

List after attempting to delete node with value 100:
List contents: 10 15 30

Process returned 0 (0x0)   execution time : 0.045 s
Press any key to continue.
```

Lab program 9:

Write a program

- **To construct a binary Search tree.**
- **To traverse the tree using all the methods i.e., in-order, preorder and post order**
- **To display the elements in the tree.**

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


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


struct Node* createNode(int data) {
```

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

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

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

    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);
    }
}

void displayTree(struct Node* root) {
    printf("In-order Traversal: ");
    inOrderTraversal(root);
    printf("\n");

    printf("Pre-order Traversal: ");
    preOrderTraversal(root);
    printf("\n");

    printf("Post-order Traversal: ");
    postOrderTraversal(root);
    printf("\n");
}

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

```c
    int n, data;

    printf("Enter the number of elements to insert in the binary search tree: ");
    scanf("%d", &n);

    printf("Enter the elements to insert into the tree:\n");
    for (int i = 0; i < n; i++) {
        printf("Enter element %d: ", i + 1);
        scanf("%d", &data);
        root = insert(root, data);
    }

    displayTree(root);

    return 0;
}
```

OUTPUT:

```
Enter the number of elements to insert in the binary search tree:
 6
Enter the elements to insert into the tree:
Enter element 1: 8
Enter element 2: 20
Enter element 3: 25
Enter element 4: 14
Enter element 5: 9
Enter element 6: 3
In-order Traversal: 3 8 9 14 20 25
Pre-order Traversal: 8 3 20 14 9 25
Post-order Traversal: 3 9 14 25 20 8

Process returned 0 (0x0)   execution time : 24.585 s
Press any key to continue.
```

Lab program 10:

Write a program to traverse a graph using BFS method.

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

```c
#include <stdbool.h>

#define MAX_NODES 100

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

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

bool isQueueEmpty(struct Queue* q) {
    return (q->front == -1);
}

void enqueue(struct Queue* q, int value) {
    if (q->rear == MAX_NODES - 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 (isQueueEmpty(q)) {
        printf("Queue Underflow\n");
        return -1;
    } else {
        int item = q->items[q->front];
        if (q->front == q->rear) {
            q->front = q->rear = -1;
        } else {
            q->front++;
        }
        return item;
    }
}

void BFS(int adjMatrix[MAX_NODES][MAX_NODES], int numVertices, int startVertex) {
    struct Queue q;
    initQueue(&q);

    bool visited[MAX_NODES] = {false};
    visited[startVertex] = true;

    enqueue(&q, startVertex);

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

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

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

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

int main() {
    int adjMatrix[MAX_NODES][MAX_NODES];
    int numVertices, startVertex;

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

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

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

    BFS(adjMatrix, numVertices, startVertex);

    return 0;
}
```

OUTPUT:

```
Enter the number of vertices in the graph: 5
Enter the adjacency matrix (enter 1 if there's an edge, otherwise 0):
0 1 0 1 1
1 0 0 1 0
0 1 0 1 1
1 0 1 0 1
0 1 1 1 0
Enter the starting vertex (0 to 4): 3
BFS Traversal: 3 0 2 4 1

Process returned 0 (0x0)   execution time : 61.713 s
Press any key to continue.
```

Lab program 11:

write a program to traverse a graph using DFS method:

```
#include <stdio.h>

#include <stdbool.h>


#define MAX 100


int adjMatrix[MAX][MAX];

bool visited[MAX];

int stack[MAX];

int top = -1;


void push(int vertex) {

   if (top == MAX - 1) {

      printf("Stack Overflow\n");

      return;

   }

   stack[++top] = vertex;

}


int pop() {

   if (top == -1) {
```

```
        printf("Stack Underflow\n");
        return -1;
    }
    return stack[top--];
}

void dfsUsingStack(int startVertex, int numVertices) {
    push(startVertex);
    visited[startVertex] = true;

    while (top != -1) {
        int currentVertex = pop();

        for (int i = 0; i < numVertices; i++) {
            if (adjMatrix[currentVertex][i] == 1 && !visited[i]) {
                push(i);
                visited[i] = true;
            }
        }
    }
}

bool isConnected(int numVertices) {
    for (int i = 0; i < numVertices; i++) {
        visited[i] = false;
    }

    dfsUsingStack(0, numVertices);

    for (int i = 0; i < numVertices; i++) {
        if (!visited[i]) {
            return false;
```

```
        }
    }
    return true;
}

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

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

    for (int i = 0; i < numVertices; i++) {
        for (int j = 0; j < numVertices; j++) {
            adjMatrix[i][j] = 0;
        }
    }

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

    if (isConnected(numVertices)) {
        printf("The graph is connected.\n");
    } else {
        printf("The graph is not connected.\n");
    }
```

```
    return 0;
}
```

OUTPUT:

```
Enter the number of vertices: 6
Enter the number of edges: 8
Enter the edges (start_vertex end_vertex):
0 1
1 2
2 3
3 4
4 5
5 6
6 7
7 8
The graph is connected.

Process returned 0 (0x0)   execution time : 39.121 s
Press any key to continue.
```

Lab program 12:

write Hashing program:

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

struct Employee {
    int k;
    char n[50];
};

struct Employee ht[MAX];
int ts;

void init() {
    for (int i = 0; i < MAX; i++) ht[i].k = -1;
```

```
}

int hash(int k) {
    return k % ts;
}

void insert(int k, char n[]) {
    int idx = hash(k);
    while (ht[idx].k != -1) {
        idx = (idx + 1) % ts;
    }
    ht[idx].k = k;
    for (int i = 0; n[i] != '\0' && i < 49; i++) {
        ht[idx].n[i] = n[i];
    }
    ht[idx].n[49] = '\0';
}

void display() {
    for (int i = 0; i < ts; i++) {
        if (ht[i].k != -1)
            printf("Idx %d: Key = %d, Name = %s\n", i, ht[i].k, ht[i].n);
        else
            printf("Idx %d: Empty\n", i);
    }
}

int main() {
    int n;
    printf("Enter table size (max size %d): ", MAX);
    scanf("%d", &ts);
```

```
    if (ts > MAX) ts = MAX;

    init();

    printf("Enter number of employees: ");
    scanf("%d", &n);
    getchar();

    for (int i = 0; i < n; i++) {
        int k;
        char name[50];
        printf("Enter key and name for employee %d: ", i + 1);
        scanf("%d", &k);
        getchar();
        gets(name);
        insert(k, name);
    }

    display();

    return 0;
}
```

OUTPUT:

```
Enter table size (max size 100): 7
Enter number of employees: 4
Enter key and name for employee 1: 100 raja
Enter key and name for employee 2: 200 rohan
Enter key and name for employee 3: 300 rohit
Enter key and name for employee 4: 400 kush
Idx 0: Empty
Idx 1: Key = 400, Name = kush
Idx 2: Key = 100, Name = raja
Idx 3: Empty
Idx 4: Key = 200, Name = rohan
Idx 5: Empty
Idx 6: Key = 300, Name = rohit

Process returned 0 (0x0)   execution time : 43.011 s
Press any key to continue.
```

lab program 13:

Given an array nums of size n, return the majority elements. The majority element is the element that appears more than [n/2] times. you may assume that the majority element always exists in the array.

```
#include <stdio.h>
int majorityElement(int* nums, int numsSize) {
int candidate = nums[0];
int count = 1;
for (int i = 1; i < numsSize; i++) {
if (count == 0) {
candidate = nums[i];
count = 1;
} else if (nums[i] == candidate) {
count++;
} else {
count--;
}
}
return candidate;
```

}

OUTPUT:

```
Input: nums = [2,2,1,1,1,2,2]
Output: 2
```

lab program 14:

Given an integer array nums, move all zeroes to the end of it while maintaining

the relative order of the non-zero elements.

```
#include <stdio.h>
void moveZeroes(int *nums, int numsSize){
int L=0, r=numsSize-1;
for (int i = 0; i < r; i++) {
if (nums[i] == 0) {
for(int j = 1; j<r; j++){
nums[j] = nums[j+1];
}
nums[r] = 0;
r--;
}
}
```

OUTPUT:

```
OUTPUT:-
For the input array {0, 1, 0, 3, 12} the output will be:
1 3 12 0 0
```

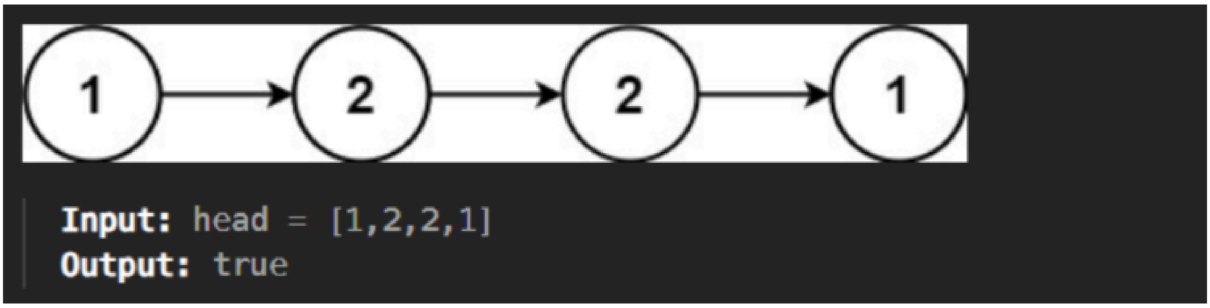
lab program 15:

Given the head of a singly linked list, return true if it is a palindrome OR false otherwise.

```
struct ListNode {
int val;
struct ListNode* next;
};
bool isPalindrome(struct ListNode* head) {
if (!head || !head->next) return true;
struct ListNode* slow = head;
struct ListNode* fast = head;
while (fast && fast->next) {
slow = slow->next;
fast = fast->next->next;
}
struct ListNode* prev = NULL;
while (slow) {
struct ListNode* nextTemp = slow->next;
slow->next = prev;
prev = slow;
slow = nextTemp;
}
struct ListNode* firstHalf = head;
struct ListNode* secondHalf = prev;
while (secondHalf) {
if (firstHalf->val != secondHalf->val) return false;
firstHalf = firstHalf->next;
secondHalf = secondHalf->next;
```

```
}
return true;
}
```

OUTPUT :



lab program 16 :

Given the root of a binary tree and an integer targetSum, return true if the tree

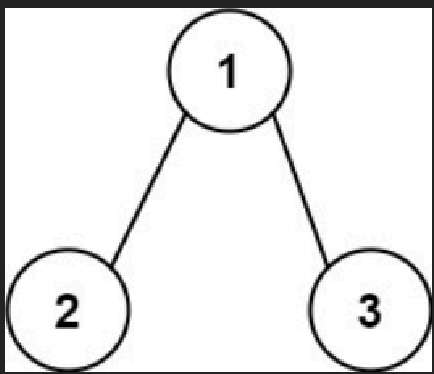
has a root-to-leaf path such that adding up all the values along the path equals.

targetSum, A leaf is a node with no children.

```
struct TreeNode {
int val;
struct TreeNode* left;
struct TreeNode* right;
};
bool hasPathSum(struct TreeNode* root, int targetSum) {
if (root == NULL) {
return false;
}
if (root->left == NULL && root->right == NULL) {
return root->val == targetSum;
}
targetSum -= root->val;
return hasPathSum(root->left, targetSum) || hasPathSum(root->right, targetSum);
}
struct TreeNode* createNode(int val) {
```

```
struct TreeNode* newNode = (struct TreeNode*)malloc(sizeof(struct TreeNode));

newNode->val = val;

newNode->left = NULL;

newNode->right = NULL;

return newNode;

}
```

OUTPUT:



Input: root = [1,2,3], targetSum = 5
Output: false
Explanation: There are two root-to-leaf paths in the tree:
(1 --> 2): The sum is 3.
(1 --> 3): The sum is 4.
There is no root-to-leaf path with sum = 5.