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 NISHANTH K S **(1BM22CS183)**, who is a bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - **(23CS3PCDST) work** prescribed for the said degree.

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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
1. **Pop**
2. **Display**

The program should print appropriate messages for stack overflow, stack underflow.

```
#include <stdio.h>
#include <stdlib.h>
#define SIZE 5
int top = -1;
int stack[SIZE];

void push(int element);
int pop();
void display();

int main() {
   int choice, element;

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

      switch (choice) {
         case 1:
            printf("Enter element to push: ");
            scanf("%d", &element);
            push(element);
            break;
         case 2:
            element = pop();
            if (element != -1) {
               printf("Popped element: %d\n", element);
            }
            break;
         case 3:
            display();
            break;
```

```
            case 4:
                printf("Exiting program.\n");
                break;
            default:
                printf("Invalid choice. Please enter a valid option.\n");
        }

    } while (choice != 4);

    return 0;
}

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

int pop() {
    if (top == -1) {
        printf("Stack Underflow. Cannot pop from an empty stack.\n");
        return -1; // indicating failure
    } else {
        int element = stack[top];
        top--;
        return element;
    }
}

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

Output:

```
1. Push
2. Pop
3. Display stack
4. Exit
Enter choice: 1
Enter integer to be pushed: 3
Enter choice: 1
Enter integer to be pushed: 4
Enter choice: 2
Integer poppped = 4
Enter choice: 1
Enter integer to be pushed: 5
Enter choice: 3
3 5 0 0 0 0 0 0 0 0
Enter choice: 4
```

Lab program 2:

WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and

```
#include<stdio.h>
#include<ctype.h>
#define max 20
void push(char a);
char pop();
char stack[max],top =-1;
int pre(char a);

void main(){
   char infix[max],a;
   char post[max];
   printf("Enter infix expression: ");
   scanf("%s",infix);
   int j=0;
   push('(');
   for(int i=0;i<strlen(infix);i++){
```

```
        if(isalnum(infix[i])){
            post[j]=infix[i];
            j+=1;
        }
       else if((infix[i]=='+' || infix[i]=='-' || infix[i]=='/' || infix[i]=='*')){
              if(pre(infix[i])>pre(stack[top])){
                 push(infix[i]);
              }
              else if(pre(infix[i])<=pre(stack[top])){

                 while(1){
                 a=pop();
                 if(a=='('){
                    push(a);
                    break;
                 }
                 post[j]=a;
                 j+=1;
              }
              push(infix[i]);
           }


    }
}
while(top!=-1){
    char y=pop();
    if(y=='('){
        break;
       }
    post[j]=y;
    j+=1;


}
post[j]='\0';
printf("%s",post);

}

void push(char a){
    if(top>max-1){
        printf("Stack overflow");
        exit(0);
    }
    else{
```

```
        ++top;
        stack[top]=a;
    }
}

char pop(){
    if(top==-1){
        printf("Stack underflow:");
        exit(0);
    }
    else{
        return stack[top--];

    }
}

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

OUTPUT:

```
Enter size of expression in terms of characters: 9
Enter infix expression: a*b+c*d-e
Postfix expression: ab*cd*+e-
```

Lab program 3:

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

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

```
#include <stdio.h>
# define SIZE 100
void enqueue();
void dequeue();
void show();
int inp_arr[SIZE];
int Rear = - 1;
int Front = - 1;
main()
{
   int ch;
   while (1)
   {
      printf("1.Enqueue Operation\n");
      printf("2.Dequeue Operation\n");
      printf("3.Display the Queue\n");
      printf("4.Exit\n");
      printf("Enter your choice of operations : ");
      scanf("%d", &ch);
      switch (ch)
      {
         case 1:
         enqueue();
         break;
         case 2:
         dequeue();
         break;
         case 3:
         show();
         break;
         case 4:
         exit(0);
```

```
            default:
            printf("Incorrect choice \n");
        }
    }
}

void enqueue()
{
    int insert_item;
    if (Rear == SIZE - 1)
      printf("Overflow \n");
    else
    {
        if (Front == - 1)

        Front = 0;
        printf("Element to be inserted in the Queue\n : ");
        scanf("%d", &insert_item);
        Rear = Rear + 1;
        inp_arr[Rear] = insert_item;
    }
}

void dequeue()
{
    if (Front == - 1 || Front > Rear)
    {
        printf("Underflow \n");
        return ;
    }
    else
    {
        printf("Element deleted from the Queue: %d\n", inp_arr[Front]);
        Front = Front + 1;
    }
}

void show()
{

    if (Front == - 1)
        printf("Empty Queue \n");
    else
    {
        printf("Queue: \n");
        for (int i = Front; i <= Rear; i++)
```

```
            printf("%d ", inp_arr[i]);
        printf("\n");
    }
}
```

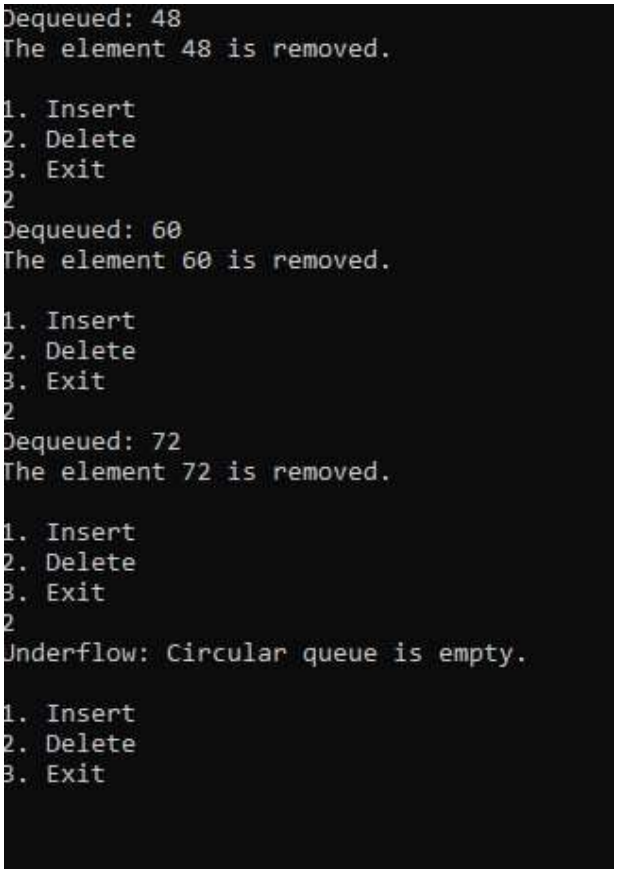
OUTPUT:

```
1. Insert
2. Delete
3. Exit
1
Enter the element to be inserted: 12
Enqueued: 12

1. Insert
2. Delete
3. Exit
1
Enter the element to be inserted: 24
Enqueued: 24

1. Insert
2. Delete
3. Exit
1
Enter the element to be inserted: 36
Enqueued: 36

1. Insert
2. Delete
3. Exit
1
Enter the element to be inserted: 48
Enqueued: 48

1. Insert
2. Delete
3. Exit
1
Enter the element to be inserted: 60
Enqueued: 60

1. Insert
2. Delete
3. Exit
1
Enter the element to be inserted: 72
Enqueued: 72

1. Insert
2. Delete
3. Exit
1
Enter the element to be inserted: 84
Overflow: Circular queue is full.

1. Insert
2. Delete
3. Exit
2
Dequeued: 12
The element 12 is removed.

1. Insert
2. Delete
3. Exit
2
Dequeued: 24
The element 24 is removed.
```

```
#include<stdio.h>
#include<stdlib.h>
#define MAX 5
void enqueue(int element);
int dequeue();
void display();
int peep();
int front = -1;
int rear = -1;
int queue[MAX];
int main(){
do
{
   printf("\nEnter options to perform operations\n1.enqueue\n2.dequeue\n3.peep\n4.dispaly\n5.exit\n");
   int option;
   scanf("%d",&option);
   switch (option)
   {
      case 1 : printf("\nEnter the number to add : ");
               int num;
               scanf("%d",&num);
               enqueue(num);
               break;
      case 2 : printf("The deleted element is =  %d\n",dequeue());
               break;
      case 3 : printf("the front element is = %d\n",peep());
               break;
      case 4 : printf("The queue is : \n");
               display();
               break;
      case 5 : exit(0);
               break;
      default : printf("\nenter a valid number");
   }
} while (1);
}

void enqueue(int element){
   if((rear+1)%MAX==front){
      printf("queue is full");
   }else if(front==-1||rear==-1){
      front=rear=0;
      queue[rear]=element;
```

```
    }else{
        rear=(rear+1)%MAX;
        queue[rear]=element;
        printf("\nelement added\n");
    }
}
int dequeue(){
    if(front==-1||rear==-1){
        printf("\nqueue is empty\n");
        return -1;
    }else if(front==rear){
        int element = queue[front];
        front=rear=-1;
        return element;
    }else{
        int element = queue[front];
        front=(front+1)%MAX;
        return element;
    }
}
int peep(){
    if(front==-1||rear==-1){
        printf("\nque is empty\n");
        return -1;
    }else{
        return queue[front];
    }
}
void display(){
    int i;
    if(front==-1||rear==-1){
        printf("\nqueue is empty\n");
    }else{
        for(i = front ; i!=rear/*||i==rear*/ ; i=(i+1)%MAX){
            printf("%d\t",queue[i]);
        }
        printf("%d\t",queue[i]);
    }

}
```

OUTPUT:



Lab program 4:

WAP to Implement Singly Linked List with the following operations

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

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

// Describes a Node
struct Node {
    int data;
```

```
    struct Node *next;
};

// Inserts an element at the start of the node
struct Node *insertstart(struct Node *start, int data) {
    struct Node *ptr = (struct Node *)malloc(sizeof(struct Node));
    ptr->data = data;
    ptr->next = start;
    return ptr;
}

// Inserts a new Node at a given index
struct Node *insertIndex(struct Node *start, int data, int index) {
    struct Node *ptr = (struct Node *)malloc(sizeof(struct Node));
    ptr->data = data;

    struct Node *p = start;
    int i = 0;
    while (i < index - 1 && p != NULL) {
        p = p->next;
        i++;
    }
    if (p == NULL) {
        printf("Index out of bounds:\n");
        free(ptr);
        return start;
    }
    ptr->next = p->next;
    p->next = ptr;
    return start;
}

// Insert at the end
struct Node *InsertEnd(struct Node *start, int data) {
    struct Node *ptr = (struct Node *)malloc(sizeof(struct Node));
    ptr->data = data;
    ptr->next = NULL;

    if (start == NULL) {
        // If the list is empty, the new node becomes the start
        return ptr;
    }

    struct Node *p = start;
    while (p->next != NULL) {
        p = p->next;
```

```
    }
    p->next = ptr;
    return start;
}

// Prints all the elements present in a Node
void display(struct Node *ptr) {
    while (ptr != NULL) {
        printf("Element: %d\n", ptr->data);
        ptr = ptr->next;
    }
}

int main() {
    struct Node *first = NULL;

    char choice;
    int newData, newIndex;

    do {
        printf("\nChoose an option:\n");
        printf("1. Insert at the beginning\n");
        printf("2. Insert at a specific index\n");
        printf("3. Insert at end\n");
        printf("4. Display the list\n");
        printf("5. Quit\n");
        printf("Enter your choice: ");
        scanf(" %c", &choice);

        switch (choice) {
            case '1':
                printf("Enter the new element to insert at the beginning: ");
                scanf("%d", &newData);
                first = insertstart(first, newData);
                break;
            case '2':
                printf("Enter the new element to insert: ");
                scanf("%d", &newData);
                printf("Enter the index to insert at: ");
                scanf("%d", &newIndex);
                first = insertIndex(first, newData, newIndex);
                break;
            case '3':
                printf("Enter the new element to insert: ");
                scanf("%d", &newData);
                first = InsertEnd(first, newData);
```

```
            break;
        case '4':
            printf("Linked List:\n");
            display(first);
            break;
        case '5':
            printf("Quitting the program.\n");
            break;
        default:
            printf("Invalid choice. Please enter a valid option.\n");
    }
  } while (choice != '5');

  return 0;
}
```

OUTPUT:

```
Choose an option:
1. Insert at the beginning
2. Insert at a specific index
3. Insert at end
4. Display the list
5. Quit
Enter your choice:
1
Enter the new element to insert at the beginning: 1

Choose an option:
1. Insert at the beginning
2. Insert at a specific index
3. Insert at end
4. Display the list
5. Quit
Enter your choice: 3
Enter the new element to insert: 2

Choose an option:
1. Insert at the beginning
2. Insert at a specific index
3. Insert at end
4. Display the list
5. Quit
Enter your choice: 2
Enter the new element to insert: 3
Enter the index to insert at: 1

Choose an option:
1. Insert at the beginning
2. Insert at a specific index
3. Insert at end
4. Display the list
5. Quit
Enter your choice: 4
Linked List:
Element: 1
Element: 3
Element: 2

Choose an option:
1. Insert at the beginning
2. Insert at a specific index
3. Insert at end
4. Display the list
5. Quit
Enter your choice: 5
Quitting the program.

Process returned 0 (0x0)   execution time : 62.938 s
Press any key to continue.
```

Lab program 5:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.
b) Deletion of first element, specified element and last element in

the list.

3. **Display the contents of the linked list.**

```
#include<stdio.h>
#include<stdlib.h>
struct node {
```

```
    int data;
    struct node *next;
};
struct node *head = NULL;
void display() {
    printf("Elements are: ");
    struct node *ptr = head;
    while (ptr != NULL) {
        printf("%d -> ", ptr->data);
        ptr = ptr->next;
    }
    printf("NULL\n");
}
void insert_begin() {
    struct node *temp = (struct node*)malloc(sizeof(struct node));
    printf("Enter the value to be inserted: ");
    scanf("%d", &temp->data);
    temp->next = head;
    head = temp;
}
void delete_begin() {
    if (head == NULL) {
        printf("List is empty. Deletion not possible.\n");
        return;
    }
    struct node *temp = head;
    head = head->next;
    printf("Element deleted from the beginning: %d\n", temp->data);
    free(temp);
}
void delete_end() {
    if (head == NULL) {
        printf("List is empty. Deletion not possible.\n");
        return;
    }
    struct node *temp, *prev;
    temp = head;
    while (temp->next != NULL) {
        prev = temp;
        temp = temp->next;
    }
    if (temp == head) {
        head = NULL;
    } else {
        prev->next = NULL;
    }
```

```
    printf("Element deleted from the end: %d\n", temp->data);
    free(temp);
}
void delete_at_position() {
    int position;
    printf("Enter the position to delete: ");
    scanf("%d", &position);

    if (head == NULL) {
        printf("List is empty. Deletion not possible.\n");
        return;
    }
    struct node *temp, *prev;
    temp = head;
    if (position == 0) {
        head = head->next;
        printf("Element at position %d deleted successfully.\n", position);
        free(temp);
        return;
    }
    for (int i = 0; temp != NULL && i < position; i++) {
        prev = temp;
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Position %d is out of bounds.\n", position);
        return;
    }
    prev->next = temp->next;
    printf("Element at position %d deleted successfully.\n", position);
    free(temp);
}
int main() {
    int choice;
    while (1) {
        printf("\n 1. to insert at the beginning\n 2. to delete beginning\n 3. to delete at end\n 4.
to delete at any position\n 5. to display\n 6. to exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                insert_begin();
                break;
            case 2:
                delete_begin();
                break;
```

```
            case 3:
                delete_end();
                break;
            case 4:
                delete_at_position();
                break;
            case 5:
                display();
                break;
            case 6:
                exit(0);
                break;
            default:
                printf("Enter the correct choice\n");
                break;
        }
    }
    return 0;
}
```

OUTPUT:

```
3. Exit
Choice: 1
Enter data and position: 1 0
Count: 1
Linked List: 1
Enter choice: 1
Enter data and position: 2 1
Count: 2
Linked List: 1 2
Enter choice: 1
Enter data and position: 3 2
Count: 3
Linked List: 1 2 3
Enter choice: 1
Enter data and position: 4 3
Count: 4
Linked List: 1 2 3 4
Enter choice: 2
Enter position: 0
Count: 3
Linked List: 2 3 4
Enter choice: 2
Enter position: 1
Count: 2
Linked List: 2 4
Enter choice: 2
Enter position: 1
Count: 1
Linked List: 2
```

Lab program 6:

a) WAP to Implement Single Link List with following operations: Sortthelinked

list, Reversethelinkedlist, Concatenation of two linked lists.
b) WAP to Implement Single Link List to simulate Stack & Queue Operations.

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

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

struct Node* insert(struct Node* first, int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = NULL;

    if (first == NULL) {
```

```
        return newNode;
    }

    struct Node* ptr = first;
    while (ptr->next != NULL) {
        ptr = ptr->next;
    }

    ptr->next = newNode;
    return first;
}

void sort(struct Node* first) {
    if (first == NULL) {
        printf("List is empty.\n");
        return;
    }

    struct Node* ptr;
    struct Node* p;

    for (ptr = first; ptr != NULL; ptr = ptr->next) {
        bool swapped = false;
        for (p = first; p->next != NULL; p = p->next) {
            if (p->data > (p->next)->data) {
                int temp = p->data;
                p->data = (p->next)->data;
                (p->next)->data = temp;
                swapped = true;
            }
        }
        if (!swapped) {
            break;
        }
    }
    struct Node* p1 = first;
    while (p1 != NULL) {
        printf(" Element: %d", p1->data);
        p1 = p1->next;
    }
    printf("\n");
}

void display(struct Node* first) {
    struct Node* p1 = first;
    while (p1 != NULL) {
```

```
        printf(" Element: %d", p1->data);
        p1 = p1->next;
    }
    printf("\n");
}

struct Node* reverse(struct Node* first) {
    struct Node* prev = NULL;
    struct Node* current = first;
    struct Node* next = NULL;

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

    return prev;
}

struct Node* concatenate(struct Node* first1, struct Node* first2) {
    if (first1 == NULL) {
        return first2;
    }

    struct Node* ptr = first1;
    while (ptr->next != NULL) {
        ptr = ptr->next;
    }

    ptr->next = first2;
    return first1;
}

int main() {
    struct Node* first1 = NULL;
    struct Node* first2 = NULL;
    int n, ele;

    do {
        printf("\n1. Add Element to List 1\n2. Sort List 1\n3. Reverse List 1\n4. Display List
1\n");
        printf("5. Add Element to List 2\n6. Sort List 2\n7. Reverse List 2\n8. Display List
2\n");
        printf("9. Concatenate Lists\n10. Exit\n");
```

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

        switch (n) {
            case 1:
                printf("Enter the data for List 1:\n");
                scanf("%d", &ele);
                first1 = insert(first1, ele);
                break;
            case 2:
                sort(first1);
                break;
            case 3:
                first1 = reverse(first1);
                printf("List 1 reversed.\n");
                break;
            case 4:
                display(first1);
                break;
            case 5:
                printf("Enter the data for List 2:\n");
                scanf("%d", &ele);
                first2 = insert(first2, ele);
                break;
            case 6:
                sort(first2);
                break;
            case 7:
                first2 = reverse(first2);
                printf("List 2 reversed.\n");
                break;
            case 8:
                display(first2);
                break;
            case 9:
                first1 = concatenate(first1, first2);
                printf("Lists concatenated.\n");
                break;
            case 10:
                exit(0);
            default:
                printf("Enter correct choice\n");
        }
    } while (1);

    return 0;
}
```

OUTPUT:

```
1. Add Element
2. Sort
3. Reverse
4. Display
5. Exit
1
Enter the data:
1

1. Add Element
2. Sort
3. Reverse
4. Display
5. Exit
1
Enter the data:
2

1. Add Element
2. Sort
3. Reverse
4. Display
5. Exit
1
Enter the data:
3

1. Add Element
2. Sort
3. Reverse
4. Display
5. Exit
1
Enter the data:
4

1. Add Element
2. Sort
3. Reverse
4. Display
5. Exit
2
 Element: 1 Element: 2 Element: 3 Element: 4

1. Add Element
2. Sort
3. Reverse
4. Display
5. Exit
3
List reversed.

1. Add Element
2. Sort
3. Reverse
4. Display
5. Exit
4
 Element: 4 Element: 3 Element: 2 Element: 1
```

```
Original List 1: 1 -> 2 -> 3 -> NULL
Original List 2: 4 -> 5 -> 6 -> NULL
Concatenated List: 1 -> 2 -> 3 -> 4 -> 5 -> 6 -> NULL

Process returned 0 (0x0)   execution time : 0.000 s
Press any key to continue.
```

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

```
// Structure to create a node with data and the next pointer
struct node {
   int data;
   struct node * next;
};

struct node * front = NULL;
struct node * rear = NULL;

// Enqueue() operation on a queue
void enqueue(int value) {
   struct node * ptr;
   ptr = (struct node * ) malloc(sizeof(struct node));
   ptr-> data = value;
   ptr-> next = NULL;
   if ((front == NULL) && (rear == NULL)) {
      front = rear = ptr;
   } else {
      rear-> next = ptr;
      rear = ptr;
   }
   printf("Node is Inserted\n\n");
}

// Dequeue() operation on a queue
int dequeue() {
   if (front == NULL) {
      printf("\nUnderflow\n");
      return -1;
   } else {
      struct node * temp = front;
      int temp_data = front-> data;
      front = front-> next;
      free(temp);
      return temp_data;
   }
}

// Display all elements of the queue
void display() {
   struct node * temp;
   if ((front == NULL) && (rear == NULL)) {
      printf("\nQueue is Empty\n");
   } else {
      printf("The queue is \n");
```

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

int main() {
    int choice, value;
    printf("\nImplementation of Queue using Linked List\n");
    while (choice != 4) {
        printf("1.Enqueue\n2.Dequeue\n3.Display\n4.Exit\n");
        printf("\nEnter your choice : ");
        scanf("%d", & choice);
        switch (choice) {
            case 1:
                printf("\nEnter the value to insert: ");
                scanf("%d", & value);
                enqueue(value);
                break;
            case 2:
                printf("Popped element is :%d\n", dequeue());
                break;
            case 3:
                display();
                break;
            case 4:
                exit(0);
                break;
            default:
                printf("\nWrong Choice\n");
        }
    }
    return 0;
}
```

```
Queue Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the element to enqueue: 1

Queue Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the element to enqueue: 2

Queue Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the element to enqueue: 3

Queue Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter the element to enqueue: 4

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

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

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

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

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

struct node {
   int info;
   struct node *ptr;
}*top,*top1,*temp;

int count = 0;
void push(int data) {
    if (top == NULL)
   {
      top =(struct node *)malloc(1*sizeof(struct node));
      top->ptr = NULL;
      top->info = data;
   }
   else
   {
      temp =(struct node *)malloc(1*sizeof(struct node));
      temp->ptr = top;
      temp->info = data;
      top = temp;
   }
   count++;
   printf("Node is Inserted\n\n");
}

int pop() {
    top1 = top;

   if (top1 == NULL)
   {
      printf("\nStack Underflow\n");
      return -1;
   }
   else
      top1 = top1->ptr;
   int popped = top->info;
   free(top);
   top = top1;
   count--;
   return popped;
}

void display() {
```

```
    // Display the elements of the stack
    top1 = top;

    if (top1 == NULL)
    {
        printf("\nStack Underflow\n");
        return;
    }

    printf("The stack is \n");
    while (top1 != NULL)
    {
        printf("%d--->", top1->info);
        top1 = top1->ptr;
    }
    printf("NULL\n\n");

}

int main() {
    int choice, value;
    printf("\nImplementation of Stack using Linked List\n");
    while (1) {
        printf("\n1. Push\n2. Pop\n3. Display\n4. Exit\n");
        printf("\nEnter your choice : ");
        scanf("%d", &choice);
        switch (choice) {
        case 1:
            printf("\nEnter the value to insert: ");
            scanf("%d", &value);
            push(value);
            break;
        case 2:
            printf("Popped element is :%d\n", pop());
            break;
        case 3:
            display();
            break;
        case 4:
            exit(0);
            break;
        default:
            printf("\nWrong Choice\n");
        }
    }
}
```

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

Stack Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter the element to push: 2

Stack Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter the element to push: 3

Stack Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter the element to push: 4

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

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

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

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

Lab Program 7:
WAP to Implement doubly link list with primitive operations

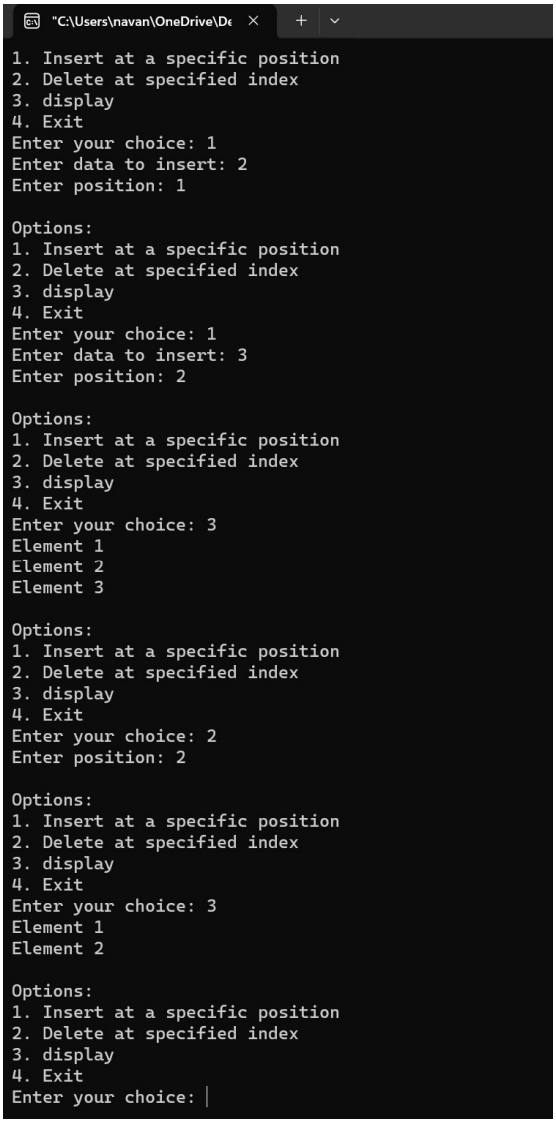
a) Create a doubly linked list.
b) Insert a new node to the left of the node.
c) Delete the node based on a specific value
d) Display the contents of the list

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


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

struct Node* head = NULL;

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

void insertNodeToLeft(struct Node* node, int newData) {
   if (node == NULL) {
      printf("Error: Cannot insert to the left of a NULL node.\n");
      return;
   }

   struct Node* newNode = createNode(newData);

   newNode->next = node;
   newNode->prev = node->prev;

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

```
    node->prev = newNode;
}

void deleteNodeByValue(int value) {
    struct Node* current = head;

    while (current != NULL && current->data != value) {
        current = current->next;
    }

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

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

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

    free(current);
}

void displayList() {
    struct Node* current = head;

    printf("Doubly Linked List: ");
    while (current != NULL) {
        printf("%d <-> ", current->data);
        current = current->next;
    }
    printf("NULL\n");
}

int main() {
    head = createNode(1);
    struct Node* second = createNode(2);
    struct Node* third = createNode(3);

    head->next = second;
```

```
    second->prev = head;
    second->next = third;
    third->prev = second;

    insertNodeToLeft(second, 5);

    deleteNodeByValue(2);

    displayList();

    return 0;
}
```

OUTPUT:



Lab program 8:

Write a program

a) ToconstructabinarySearchtree.
b) To traverse the tree using all the methods i.e., in-order, preorder and post order
c) To display the elements in the tree.

```
#include<stdio.h>
struct node
{
   int data;
   struct node *left;
   struct node *right;
};

struct node *create(int val)
{
   struct node *ptr = (struct node*)malloc(sizeof(struct node));
   ptr->data=val;
   ptr->left=ptr->right=NULL;
   return ptr;
}
struct node *insert(struct node *root,int val)
{
   if(root == NULL)
   {
      return create(val);
   }
   if(val < root->data)
   {
      root->left = insert(root->left,val);
   }else if(val > root->data)
   {
      return insert(root->right,val);
   }
   return root;
}
void preOrder(struct node *root)
{
   if(root != NULL)
   {
      printf("%d",root->data);
      preOrder(root->left);
      preOrder(root->right);
```

```
    }
}
void inOrder(struct node* root)
{
    if (root != NULL)
        {
        inOrder(root->left);
        printf("%d ", root->data);
        inOrder(root->right);
    }
}
void postOrder(struct node* root)
 {
    if (root != NULL)
        {
        postOrder(root->left);
        postOrder(root->right);
        printf("%d ", root->data);
    }
}
void display(struct node* root) {
    printf("Elements in the tree: ");
    inOrder(root);
    printf("\n");
}
int main() {
    struct node* root = NULL;
    int choice, value;

    do {
        printf("\nBinary Search Tree Menu:\n");
        printf("1. Insert element\n");
        printf("2. Display elements\n");
        printf("3. In-order traversal\n");
        printf("4. Pre-order traversal\n");
        printf("5. Post-order traversal\n");
        printf("0. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the element to insert: ");
                scanf("%d", &value);
                root = insert(root, value);
                break;
```

```
            case 2:
                display(root);
                break;
            case 3:
                printf("In-order traversal: ");
                inOrder(root);
                printf("\n");
                break;
            case 4:
                printf("Pre-order traversal: ");
                preOrder(root);
                printf("\n");
                break;
            case 5:
                printf("Post-order traversal: ");
                postOrder(root);
                printf("\n");
                break;
            case 0:
                printf("Exiting program.\n");
                break;
            default:
                printf("Invalid choice. Please try again.\n");
        }
    } while (choice != 0);

    return 0;
}
```

OUTPUT:

```
Enter your choice:
1. In-order traversal
2. Pre-order traversal
3. Post-order traversal
2
Elements in the tree (pre-order traversal): 50 30 20 40 70 60 80
```

```
Enter your choice:
1. In-order traversal
2. Pre-order traversal
3. Post-order traversal
3
Elements in the tree (post-order traversal): 20 40 30 60 80 70 50
```

```
Enter your choice:
1. In-order traversal
2. Pre-order traversal
3. Post-order traversal
1
Elements in the tree (in-order traversal): 20 30 40 50 60 70 80
```

Lab program 9:

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

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

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

#define MAX_NODES 100

int adjMatrix[MAX_NODES][MAX_NODES];
int visited[MAX_NODES];

void DFS(int node, int nodes) {
    visited[node] = 1;
    for (int i = 0; i < nodes; i++) {
        if (adjMatrix[node][i] && !visited[i]) {
            DFS(i, nodes);
        }
    }
}

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

    DFS(0, nodes);

    for (int i = 0; i < nodes; i++) {
        if (!visited[i]) {
            return 0;
        }
    }
    return 1;
}

int main() {
    int nodes;

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

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

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

    return 0;
}
```

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

#define MAX_NODES 100

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

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

int isEmpty(struct Queue* queue) {
    if (queue->rear == -1)
        return 1;
    else
        return 0;
}

void enqueue(struct Queue* queue, int value) {
```

```
    if (queue->rear == MAX_NODES - 1)
        printf("\nQueue is Full!!");
    else {
        if (queue->front == -1)
            queue->front = 0;
        queue->rear++;
        queue->items[queue->rear] = value;
    }
}

int dequeue(struct Queue* queue) {
    int item;
    if (isEmpty(queue)) {
        printf("\nQueue is Empty!!");
        item = -1;
    } else {
        item = queue->items[queue->front];
        queue->front++;
        if (queue->front > queue->rear) {
            queue->front = queue->rear = -1;
        }
    }
    return item;
}

int adjMatrix[MAX_NODES][MAX_NODES];
int visited[MAX_NODES];

void BFS(int start, int nodes) {
    struct Queue* queue = createQueue();

    visited[start] = 1;
    enqueue(queue, start);

    printf("Breadth First Search starting from node %d: ", start);

    while (!isEmpty(queue)) {
        int currentNode = dequeue(queue);
        printf("%d ", currentNode);

        for (int i = 0; i < nodes; i++) {
            if (adjMatrix[currentNode][i] && !visited[i]) {
                visited[i] = 1;
                enqueue(queue, i);
            }
        }
```

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

int main() {
    int nodes, startNode;

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

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

    for (int i = 0; i < nodes; i++) {
        visited[i] = 0;
    }

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

    BFS(startNode, nodes);

    return 0;
}
```

OUTPUT:

```
Enter the number of nodes: 5
Enter adjacency matrix for the graph:
0 1 1 0 1
1 0 1 1 0
1 1 0 1 0
0 1 1 0 1
1 0 0 1 0
Enter the starting node for BFS: 3
```

```
Enter the number of nodes: 5
Enter adjacency matrix for the graph:
0 1 1 0 1
1 0 1 1 0
1 1 0 1 0
0 1 1 0 1
1 0 0 1 0
The graph is connected.

Process returned 0 (0x0)   execution time : 134.374 s
Press any key to continue.
```

Lab Program 10

Given a File of N employee records with a set K of Keys(4-digit) which

uniquely determine the records in file F.
Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT.
Let the keys in K and addresses in L are integers.
Design and develop a Program in C that uses Hash function H: K -> L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L.
Resolve the collision (if any) using linear probing.

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

#define TABLE_SIZE 100
#define KEY_LENGTH 5
#define MAX_NAME_LENGTH 50
#define MAX_DESIGNATION_LENGTH 50

struct Employee {
   char key[KEY_LENGTH];
   char name[MAX_NAME_LENGTH];
   char designation[MAX_DESIGNATION_LENGTH];
   float salary;
};

struct HashTable {
   struct Employee* table[TABLE_SIZE];
};

int hash_function(const char* key, int m) {
   int sum = 0;
   for (int i = 0; key[i] != '\0'; i++) {
      sum += key[i];
   }
   return sum % m;
}

void insert(struct HashTable* ht, struct Employee* emp) {
   int index = hash_function(emp->key, TABLE_SIZE);

   while (ht->table[index] != NULL) {
      index = (index + 1) % TABLE_SIZE;
```

```
    }
    ht->table[index] = emp;
}

struct Employee* search(struct HashTable* ht, const char* key) {
    int index = hash_function(key, TABLE_SIZE);

    while (ht->table[index] != NULL) {
        if (strcmp(ht->table[index]->key, key) == 0) {
            return ht->table[index];
        }
        index = (index + 1) % TABLE_SIZE;
    }
    return NULL;
}

int main() {
    struct HashTable ht;
    struct Employee* emp;
    char key[KEY_LENGTH];
    char filename[100];
    char line[100];
    FILE* file;

    for (int i = 0; i < TABLE_SIZE; i++) {
        ht.table[i] = NULL;
    }

    printf("Enter the filename containing employee records: ");
    scanf("%s", filename);

    file = fopen(filename, "r");
    if (file == NULL) {
        printf("Error opening file.\n");
        return 1;
    }

    while (fgets(line, sizeof(line), file)) {
        emp = (struct Employee*)malloc(sizeof(struct Employee));
        sscanf(line, "%s %s %s %f", emp->key, emp->name, emp->designation, &emp-
>salary);
        insert(&ht, emp);
    }

    fclose(file);
```

```
    int choice;
    do {
        printf("\n1. Search Employee\n");
        printf("2. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter the key to search: ");
                scanf("%s", key);
                emp = search(&ht, key);
                if (emp != NULL) {
                    printf("Employee record found with key %s:\n", emp->key);
                    printf("Name: %s\n", emp->name);
                    printf("Designation: %s\n", emp->designation);
                    printf("Salary: %.2f\n", emp->salary);
                } else {
                    printf("Employee record not 7found for key %s\n", key);
                }
                break;
            case 2:
                printf("Exiting...\n");
                break;
            default:
                printf("Invalid choice! Please enter again.\n");
        }
    } while (choice != 2);

    for (int i = 0; i < TABLE_SIZE; i++) {
        if (ht.table[i] != NULL) {
            free(ht.table[i]);
        }
    }

    return 0;
}
```

Output:

```
Enter the filename containing employee records: Employee.txt

1. Search Employee
2. Exit
Enter your choice: 1
Enter the key to search: 1
Employee record found with key 1:
Name: Navanith
Designation: CEO
Salary: 10000.00

1. Search Employee
2. Exit
Enter your choice: 1
Enter the key to search: 2
Employee record found with key 2:
Name: Nishanth
Designation: CEO
Salary: 10000.00

1. Search Employee
2. Exit
Enter your choice: 1
Enter the key to search: 3
Employee record found with key 3:
Name: Pranav
Designation: CEO
Salary: 10000.00

1. Search Employee
2. Exit
Enter your choice: 1
Enter the key to search: 4
Employee record found with key 4:
Name: NithinCEO
Designation: 10000
Salary: 2154132992.00

1. Search Employee
2. Exit
Enter your choice: 1
Enter the key to search: 5
Employee record found with key 5:
Name: Navneeth
Designation: CEO
Salary: 10000.00

1. Search Employee
2. Exit
Enter your choice: 2
Exiting...

Process returned 0 (0x0)   execution time : 27.868 s
Press any key to continue.
```

LEET CODE:

1. **leetCode/155MinStack.c**

```
#include <stdlib.h>
typedef struct {
    int* stack;
    int top;
    int min;
    int size;
} MinStack;

MinStack* minStackCreate() {
    MinStack* obj = (MinStack*)malloc(sizeof(MinStack));
    obj->stack = (int*)malloc(sizeof(int) * 10); // initial size of 10
    obj->top = -1;
    obj->min = INT_MAX;
    obj->size = 10;
    return obj;
}

void minStackPush(MinStack* obj, int val) {
    if (obj->top == obj->size - 1) {
        obj->size *= 2;
        obj->stack = (int*)realloc(obj->stack, sizeof(int) * obj->size);
    }
    obj->stack[++obj->top] = val;
    obj->min = val < obj->min ? val : obj->min;
}

void minStackPop(MinStack* obj) {
    if (obj->top == -1)
        return;
    if (obj->stack[obj->top--] == obj->min) {
        int min = INT_MAX;
        for (int i = 0; i <= obj->top; i++) {
            min = obj->stack[i] < min ? obj->stack[i] : min;
        }
        obj->min = min;
    }
}

int minStackTop(MinStack* obj) {
    if (obj->top == -1)
        return -1;
    return obj->stack[obj->top];
```

```
}

int minStackGetMin(MinStack* obj) { return obj->min; }

void minStackFree(MinStack* obj) {
    free(obj->stack);
    free(obj);
}
```

2. **leetCode/61RotateList**

```
struct ListNode* rotateRight(struct ListNode* head, int k) {
    if (head == NULL || k == 0) return head;
    struct ListNode* n = head;
    int i=0;
    while(n!=NULL){
        i++;
        n = n->next;
    }
    struct ListNode* temp1;
    struct ListNode* temp2;
    int turns = k%i;
    for (int i = 0; i < turns; i++) {
        temp2 = head;
        while (temp2->next != NULL) {
            temp1 = temp2;
            temp2 = temp2->next;
        }
        temp2->next = head;
        head = temp2;
        temp1->next = NULL;
    }
    return head;
}
```

3. **leetCode/725SplitLinkedListinParts.c**

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

```
 * Note: The returned array must be malloced, assume caller calls free().
 */
typedef struct ListNode lnode;
int get_len(lnode* head) {
    int n = 0;
    while (head) {
        n++;
        head = head->next;
    }
    return n;
}
struct ListNode** splitListToParts(struct ListNode* head, int k,
                                   int* returnSize) {
    int n = get_len(head), elems, i, j;
    *returnSize = k;
    lnode **list = (lnode**)calloc(k, sizeof(lnode*)), *t = head;
    if (n > k) {
        for (i = 0; i < k; i++) {
            elems = i < n % k ? n / k + 1 : n / k;
            j = 0;
            list[i] = head;
            t = head;
            while (j++ < elems) {
                t = head;
                head = head->next;
            }
            t->next = NULL;
        }
    } else {
        for (i = 0; i < n; i++) {
            list[i] = head;
            head = head->next;
            list[i]->next = NULL;
        }
    }
    return list;
}
```

4. **leetCode/725SplitLinkedListinParts.c**

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

```
};

struct ListNode* reverseBetween(struct ListNode* head, int left, int right){

    struct ListNode *p = head,*k=head;
    int i = 1,kk=0;
    int a[100000];
    while(p!=0){
        if (i>=left && i<=right){
            a[kk++]=p->val;
        }
        p=p->next;
        i++;
    }
    i=1;
    while(k!=0){
        if (i>=left && i<=right){
            k->val=a[--kk];
        }
        k=k->next;
        i++;
    }
    return head;
}
```