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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(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by Aryan Navlani**(1BM23CS055)**, 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.

Code-

```
#include <stdio.h>

#define MAX 3

int s[10], TOP = -1, i, item,ch;

void Push();

int pop();

void Display();

void main(){

while(1){

printf("\n 1 PUSH\n\ 2 POP\n 3 DISPLAY\n 4 EXIT"); printf("\n

Enter your choice \n");

scanf("%d", &ch);

switch(ch)

{

case 1:

        Push();

        break;


case 2:

        item = pop();

        if(item != -1){

            printf("Popper element = %d\n", item);

        }

        break;

case 3:
```

```
        Display();
        break;
case 4:
        exit(0);
}
}
getch();
}
void Push()
{
if(TOP == MAX-1){
printf("STACK OVERFLOW \n"); return;
}
printf("Enter element to be pushed \n");
scanf("%d", &item);
TOP = TOP+1;
s[TOP] = item;
}
int pop(){
if(TOP == -1){
    return -1;
}
item = s[TOP];
TOP = TOP - 1;
return item;
}
void Display()
{
```

```
if(TOP == -1){
    printf("STACK IS EMPTY\n"); return ;
    }
    printf("STACK CONTENTS\n"); for(i
    = TOP; i >= 0; i--){
        printf("%d\n", s[i]);
    }
}
```

Output-

```
 1 PUSH
 2 POP
 3 DISPLAY
 4 EXIT
 Enter your choice
1
Enter element to be pushed
4

 1 PUSH
 2 POP
 3 DISPLAY
 4 EXIT
 Enter your choice
3
STACK CONTENTS
4

 1 PUSH
 2 POP
 3 DISPLAY
 4 EXIT
 Enter your choice
2
Popper element = 4

 1 PUSH
 2 POP
 3 DISPLAY
 4 EXIT
 Enter your choice
1
Enter element to be pushed
4

 1 PUSH
 2 POP
 3 DISPLAY
 4 EXIT
 Enter your choice

4

Process returned 0 (0x0)   execution time : 17.587 s
Press any key to continue.
```

Lab program 2;

Write a program the converts infix expression into postfix expression.

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
int index = 0, pos = 0, top = -1, length;
char symbol, temp, infix[20],postfix[20],stack[20];
void infixtopostfix();
void push(char symbol);
char pop();
int pred(char symbol);
void main()
{
clrsrc();
printf("Enter infix expression : \n ");
scanf("%s", infix);
infixtopostfix();
printf("\n Infix expression \n %s", infix); printf("\n
Postfix expression :\n %s", postfix); getch();
}
void infixtopostfix()
{
    length = strlen(infix);
    push('#');
    while(index < length){
        symbol = infix[index];
        switch(symbol);
    {
    case"(":
```

```
        push(symbol);
        break;
    case "(":
        temp = pop();
        while(temp != "(" ){
          postfix[pos] = temp;
        pos++;
        temp = pop();
        }
        break;
        case'+':
        case'-':
        case'*':
        case'/':
        case'^':
          while(pred(stack[top]) >= pred(symbol)){
            temp = pop();
            prefix[pos++] = temp;
          }
          push(symbol); break;
        default:postfix[pos++] = symbol;
        }
    index++;
    while(top > 0){
      temp = pop();
      postfix[pos++] = temp;
      }
    }
```

```
}
void push(char symbol){
    top = top+1; stack[top]
    = symbol;
}
char pop()
{
    char symbol;  symbol
    = stack[top]; top =
    top-1;
    return synbol;
}
int pred(char symbol){
    int p;
    switch(symbol){
        case'^':
                p = 3;
                break;
        case '*':
        case '/':
                p = 2;
                break;
        case'+':
        case'-':
                p = 1;
                break;
        case '(':
                p = 0;
                break;
```

```
        case'#':
                p = -1;
                break;
        }
        return(p);
    }
}
}
```

Output-

```
Enter infix expression:
A*B+C/D-E

Infix expression: A*B+C/D-E
Postfix expression: AB*CD/+E-#

Process returned 32 (0x20)   execution time : 33.517 s
Press any key to continue.
```

Lab Program 3;

Write C code for queue implementation that includes dequeue and enqueue methods.

```
#include <stdio.h>

#include <stdlib.h>

#define SIZE 5

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

isFull() {

    return rear == SIZE - 1;

}

int isEmpty() {

    return front == -1 || front > rear;

}

void enqueue(int value) { if

    (isFull()) {

        printf("Queue is full! Cannot insert %d\n", value);

    } else {

        if (front == -1) {

            front = 0;

        }

        rear++;

        queue[rear] = value;

        printf("Inserted %d into the queue.\n", value);

    }

}

void dequeue() {

    if (isEmpty()) {

        printf("Queue is empty! Cannot dequeue.\n");

    } else {

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

```
        if (front > rear) {
            front = rear = -1;
        }
    }
}
void display() {
    if (isEmpty()) {
        printf("Queue is empty!\n");
    } else {
        printf("Queue elements: ");
        for (int i = front; i <= rear; i++) {
            printf("%d ", queue[i]);
        }
        printf("\n");
    }
}
int main() {
    int choice, value;
    while (1) {
        printf("\nQueue Menu:\n");
        printf("1. Insert (Enqueue)\n");
        printf("2. Delete (Dequeue)\n");
        printf("3. Display Queue\n");
        printf("4. Exit\n"); printf("Enter
        your choice: "); scanf("%d",
        &choice);
        switch (choice) {
            case 1:
                printf("Enter the value to insert: ");
```

```
                scanf("%d", &value);
                enqueue(value); break;
            case 2:
                dequeue();
                break;
            case 3:
                display(); break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice! Please try again.\n");
        }
    }
    return 0;
}
```

Output-

```
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. Exit
Enter your choice: 1
Enter the value to insert: 2
Inserted 2 into the queue.

Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. Exit
Enter your choice: 1
Enter the value to insert: 3
Inserted 3 into the queue.

Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. Exit
Enter your choice: 1
Enter the value to insert: 4
Inserted 4 into the queue.

Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. Exit
Enter your choice: 2
Deleted 2 from the queue.

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

Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. Exit
Enter your choice: 4

Process returned 0 (0x0)   execution time : 15.008 s
Press any key to continue.
```

Lab Program 4:

Implementation of circular queue.

```
#include <stdio.h>
#define MAX_SIZE 5 int
queue[MAX_SIZE]; int
front = -1, rear = -1; int
isFull()
{
    return (rear + 1) % MAX_SIZE == front;
}
int isEmpty()
{
    return front == -1;
}
void enqueue(int data)
{
    if (isFull()) {
        printf("Queue overflow\n");
        return;
    }
    if (front == -1) {
        front = 0;
    }
    rear = (rear + 1) % MAX_SIZE;
    queue[rear] = data;
    printf("Element %d inserted\n", data);
}
int dequeue()
```

```
    if (isEmpty()) {
        printf("Queue underflow\n");
        return -1;
    }
    int data = queue[front]; if
    (front == rear) {
        front = rear = -1;
    }
    else {
        front = (front + 1) % MAX_SIZE;
    }
    return data;
}
void display()
{
    if (isEmpty()) {
        printf("Queue is empty\n"); return;
    }
    printf("Queue elements: "); int
    i = front;
    while (i != rear) { printf("%d
        ", queue[i]);  i = (i + 1) %
        MAX_SIZE;
    }
    printf("%d\n", queue[rear]);
}
void main()
{
```

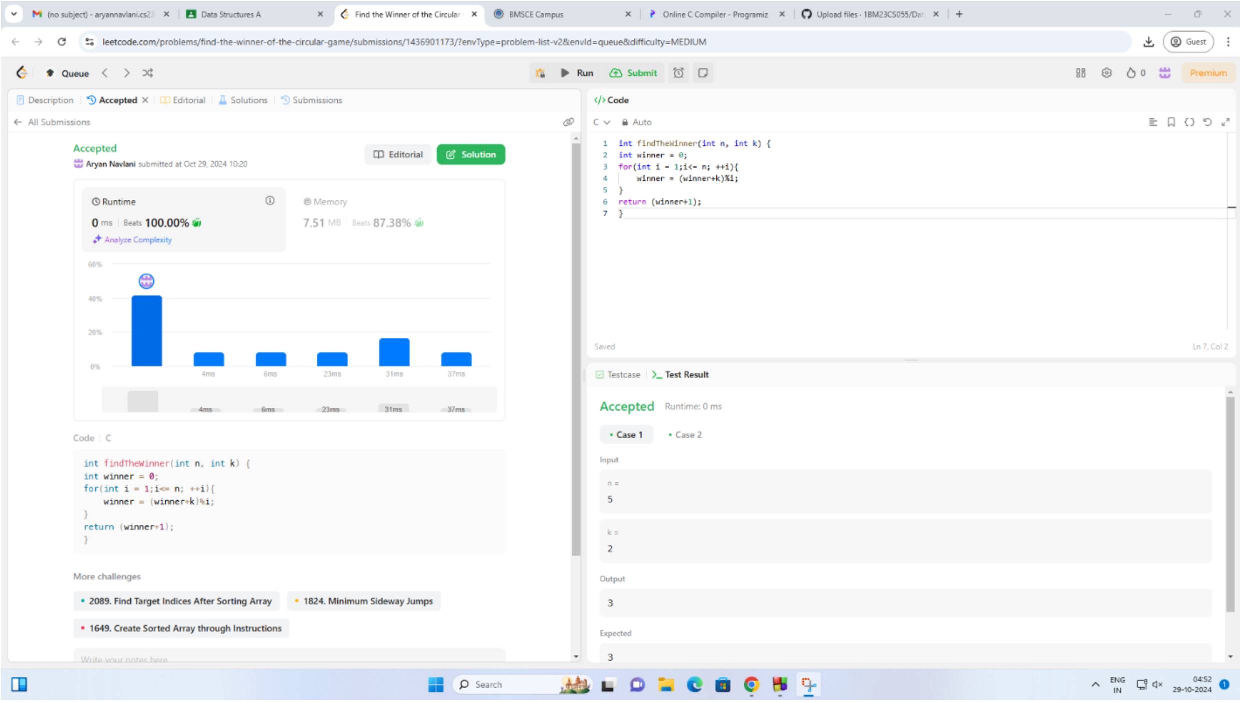
```
    int choice, values; printf("Queue
    Menu: \n");
    printf("1.Insert(Enqueue): \n");
    printf("2.Delete(Deque): \n");
    printf("3.Display Queue \n");
    printf("4.EXIT \n");
    printf("Enter the number choice : ");
    scanf("%d", &choice);  switch(choice)
    {
      case 1:
        printf("Enter the value to insert");
        scanf("%d", &values); enque(values);
        break;
      case 2:
        dequeue();
        break;
      case 3:
        display();
        break;
      case 4:
        exit(0);
      default:
        printf("Invalid Choice! please try again \n");
    }
}
```

```
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 1
Enter the value to insert: 1
Element 1 inserted
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 1
Enter the value to insert: 2
Element 2 inserted
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 1
Enter the value to insert: 3
Element 3 inserted
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 1
Enter the value to insert: 4
Element 4 inserted
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 1
Enter the value to insert: 5
Element 5 inserted
Queue Menu:
```

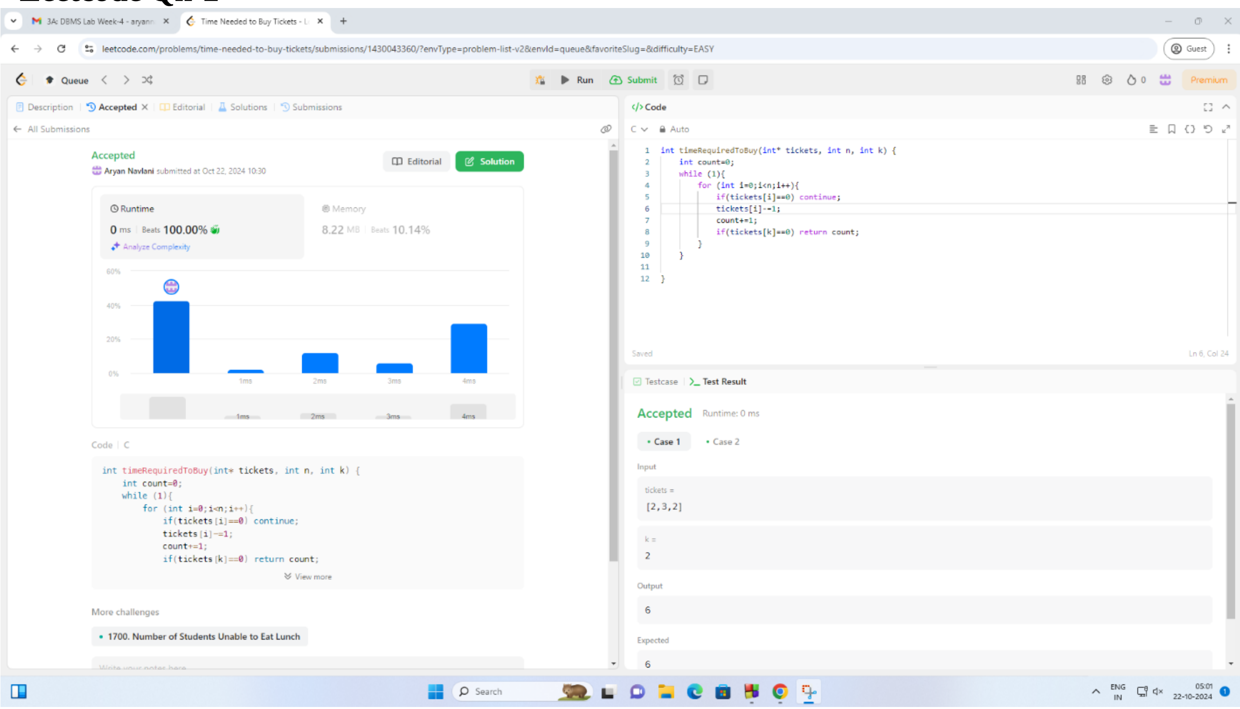
```
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 2
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 2
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 3
Queue elements: 3 4 5
Queue Menu:
1. Insert (Enqueue)
2. Delete (Dequeue)
3. Display Queue
4. EXIT
Enter your choice: 4

Process returned 0 (0x0)   execution time : 55.100 s
Press any key to continue.
```

Leetcode Question - 1



Leetcode Qn-2



Lab program 5

Singly linked list Implementation.

```
#include<stdio.h>

struct Node{
    int data;
    struct Node* link;
}
typedef struct Node node;

node *ptr,*new,*curr1,*start = NULL;

void create(){
    new = (node*)malloc(sizeof(node)); char
    ch;
    do{
        printf("Enter value\n"); scanf("%d",
        &new1->data); if(start == NULL){
            start = new; curr
            = new;
        }else{
            curr->link = new1; curr
            = new1;
            printf("Do you want to add another element(Y/N)");
            scanf("%c", &ch);
        }
    }while(ch == 'y'||ch == 'Y');
```

```
}
void Display(){ if(start
    == NULL){
        printf("Linked list is empty");
    }
    printf("Elements in the list");
    tenp = start;
    while(temp != NULL){
        printf("%d", temp->data);
        temp = temp->link;
    }
}
void insert_beg(){
    new1 = (node*)malloc(sizeof(node));
    printf("Enter element"); scanf("%d",
    &new1 -> data); if(start == NULL){
        start = new1;
        new1->link = NULL;
        return;
    }
    new1-> = start;
    start = new1;
}
void insert_post(int pos){
    new = (node*)malloc(sizeof(node));
    printf("Enter element"); scanf("%d",
    &new1->data);
    if(pos == 1){
```

```
        new1->link = start;
        start = new1; return;
    }
    while(temp != NULL && i < pos){ temp
        = temp->linl;
        pos++;
    }
    if(temp == NULL){
        printf("Enter posistion greate than number of element\n");
    }
    new1->link - temp-.link;
    temp->link = new1;
}
void delete_first(){
    if(start == NULL){
        printf("Linked List Empty \n"); return;
    }
    node  temp  =  startl
    start   =   start->link;
    free(temp);
}
void main(){
    while(1){
        printf("1 Create \n 2.Display  \n3.Insert_Beg \n 4.Insert_pos  \n   5.Deletion
\n6.Exit");
        int c;
        print("Enter option");
        scanf("%d", &c);
```

```
        switch(c){
           case 1:
              create();
              break;
           case 2:
              Display();
              break;
           case3:
              insert_beg();
              break;
           case 4:
              int pos;
              printf("Enter position");
              scanf("%d", &pos);
              insert_post(pos);
              break;
           case 5:
              delete_first();
              break;
           default:
              exit(0);
        }

     }
  }
```

Output-

```
"C:\Users\AYUSH ADITYA\Doc
1. Create
2. Display
3. Insert at Beginning
4. Insert at Position
5. Delete First Node
6. Exit
Enter option: 1
Enter value
5
Do you want to add another element (Y/N)? Y
Enter value
2
Do you want to add another element (Y/N)? Y
Enter value
4
Do you want to add another element (Y/N)? N
1. Create
2. Display
3. Insert at Beginning
4. Insert at Position
5. Delete First Node
6. Exit
Enter option: 2
Elements in the list: 4
1. Create
2. Display
3. Insert at Beginning
4. Insert at Position
5. Delete First Node
6. Exit
Enter option: 3
Enter element: 1
1. Create
2. Display
3. Insert at Beginning
4. Insert at Position
5. Delete First Node
6. Exit
Enter option: 4
Enter position: 3
Enter element: 1

1. Create
2. Display
3. Insert at Beginning
4. Insert at Position
5. Delete First Node
6. Exit
Enter option: 4
Enter position: 3
Enter element: 1
1. Create
2. Display
3. Insert at Beginning
4. Insert at Position
5. Delete First Node
6. Exit
Enter option: 5
1. Create
2. Display
3. Insert at Beginning
4. Insert at Position
5. Delete First Node
6. Exit
Enter option: 6

Process returned 0 (0x0)   execution time : 48.243 s
Press any key to continue.
```

Lab program 6

Stack and queue implementation using linked list.

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

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

// Stack implementation
struct Stack {
    struct Node* top;
};

int isStackEmpty(struct Stack* stack) {
    return stack->top == NULL;
}
void push(struct Stack* stack, int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = stack->top;
    stack->top = newNode;
    printf("Pushed %d to stack\n", data);
}

int pop(struct Stack* stack) { if
    (isStackEmpty(stack)) {
```

```
        printf("Stack is empty\n"); return -
        1;
    }
    struct Node* temp = stack->top;
    int data = temp->data;
    stack->top = temp->next;
    free(temp);
    return data;
}

int peek(struct Stack* stack) { if
    (isStackEmpty(stack)) {
        printf("Stack is empty\n"); return -
        1;
    }
    return stack->top->data;
}

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

void enqueue(struct Queue* queue, int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
```

```
    newNode->next = NULL;
    if (isQueueEmpty(queue)) {
        queue->front = queue->rear = newNode;
    } else {
        queue->rear->next = newNode;
        queue->rear = newNode;
    }
    printf("Enqueued %d to queue\n", data);
}

int dequeue(struct Queue* queue) { if
    (isQueueEmpty(queue)) {
        printf("Queue is empty\n"); return -
        1;
    }
    struct Node* temp = queue->front; int
    data = temp->data;
    queue->front = temp->next; free(temp);

    if (queue->front == NULL) {
        queue->rear = NULL;
    }
    return data;
}

int peekQueue(struct Queue* queue) { if
    (isQueueEmpty(queue)) {
        printf("Queue is empty\n");
```

```
        return -1;
    }
    return queue->front->data;
}

int main() {
    struct   Stack   stack;
    stack.top  =  NULL;
    push(&stack, 10);
    push(&stack, 20);
    push(&stack, 30);
    printf("Top of stack: %d\n", peek(&stack));
    printf("Popped from stack: %d\n", pop(&stack));
    printf("Popped from stack: %d\n", pop(&stack));
    printf("Popped from stack: %d\n", pop(&stack));
    printf("Popped from stack: %d\n", pop(&stack)); struct
    Queue queue;
    queue.front = queue.rear = NULL;
    enqueue(&queue, 10);
    enqueue(&queue, 20);
    enqueue(&queue, 30);
    printf("Front of queue: %d\n", peekQueue(&queue);
    printf("Dequeued from queue: %d\n", dequeue(&queue));
    printf("Dequeued from queue: %d\n", dequeue(&queue));
    printf("Dequeued from queue: %d\n", dequeue(&queue));
    printf("Dequeued from queue: %d\n", dequeue(&queue)); // Queue is empty now return 0;
}
```

Output-

```
Pushed 10 to stack
Pushed 20 to stack
Pushed 30 to stack
Top of stack: 30
Popped from stack: 30
Popped from stack: 20
Popped from stack: 10
Stack is empty
Popped from stack: -1
Enqueued 10 to queue
Enqueued 20 to queue
Enqueued 30 to queue
Front of queue: 10
Dequeued from queue: 10
Dequeued from queue: 20
Dequeued from queue: 30
Queue is empty
Dequeued from queue: -1

Process returned 0 (0x0)   execution time : 2.584 s
Press any key to continue.
```

Lab program 7

Implementation of circular linked list.

```
#include <stdio.h>

#include <stdlib.h>

struct Node {

    int data;

    struct Node* next;

};

struct Node* createNode(int data) {

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

    newNode->data = data;

    newNode->next = NULL;

    return newNode;

}

void insertAtEnd(struct Node** head, int data) { struct

    Node* newNode = createNode(data);


    if (*head == NULL) {

        newNode->next = newNode; // Point to itself if the list is empty

        *head = newNode;

    } else {

        struct Node* temp = *head;

        // Traverse to the last node (which points back to head) while

        (temp->next != *head) {

            temp = temp->next;

        }

        temp->next = newNode;

        newNode->next = *head; // Make it circular

    }
```

```
}
void insertAtBeginning(struct Node** head, int data) {
    struct Node* newNode = createNode(data);
    if (*head == NULL) {
        newNode->next = newNode; // Point to itself if the list is empty
        *head = newNode;
    } else {
        struct Node* temp = *head;
        // Traverse to the last node
        while (temp->next != *head) {
            temp = temp->next;
        }
        // Now the last node points to the new node
        temp->next = newNode;
        newNode->next = *head;
        *head = newNode; // Update head to the new node
    }
}
void insertAtPosition(struct Node** head, int data, int position) { struct
    Node* newNode = createNode(data);
    if (position == 1) {
        insertAtBeginning(head, data); return;
    }
    struct Node* temp = *head; int
    count = 1;
    while (temp != NULL && count < position - 1) { temp
        = temp->next;
        count++;
```

```
        if (temp == *head) break;
    }
    if (temp == NULL || temp->next == *head) {
        insertAtEnd(head, data);
    } else {
        newNode->next = temp->next;
        temp->next = newNode;
    }
}
void deleteFirst(struct Node**head){
   if(head == NULL){
     printf("LL is Empty");
    }
    if(head->next == head->data){
       free(head);
       head = NULL:
    }
   return;
}
struct  Node*  temp  =  head;
while(temp->next  !=  start){
temp = temp->head;
  temp = head;
}
temp->next = head->next;
free(head);
head = temp->next;
}
```

```
void deleteLast(struct Node*head){  if(head
  == NULL){
    printf("LL is emopty");
    return;
  }
  if(head->next == head){
    free(head);
    head = NULL;
    return;
  }
  struct Node* temp = head;
  while(temp->next->next != start){
  temp = temp->next;
  }
  free(temp->next);
  temp->next = start;
}
void deleteSpecific(struct Node* head, int ele){
  if(head == NULL){
    prinntf("Linked List is Empty"); return;
  }
  printf("Enter element");
  scanf("%d", ele);
  if(head->date == ele && head->next == start){
    free(head);
    head = NULL;
    return;
  }
```

```
  if(start->data == ele{
    struct *Node temp = start;
    while(temp->next != start){
    temp = temp->next;
    }
    temp->next = head->next;
    free(head);
    head = temp->head;
    return;
  }
  struct Node*temp = start;
  struct Node*prev = NULL:
  while(temp->data != ele && temp->link != start){
    prev = temp;
    temp = temp->next;
  }
  prev->next = temp->next;
  free(temp);
  return;
}
void display(struct Node* head) { if
    (head == NULL) {
        printf("List is empty.\n"); return;
    }
    struct Node* temp = head;
    do {
        printf("%d -> ", temp->data); temp
        = temp->next;
```

```
    } while (temp != head);
    printf("(head)\n");
}
int main() {
    struct Node* head = NULL;
    insertAtEnd(&head, 10);
    insertAtEnd(&head, 20);
    insertAtEnd(&head, 30);
    printf("List after inserting at the end:\n");
    display(head);
    insertAtBeginning(&head, 5);
    printf("List after inserting at the beginning:\n"); display(head);
    insertAtPosition(&head, 15, 3);
    printf("List after inserting at position 3:\n");
    display(head);
    insertAtPosition(&head, 25, 100);
    printf("List after inserting at position 100 (out of bounds):\n");
    display(head);
    return 0;
}
```

Output-

```
"C:\Users\AYUSH ADITYA\Doc
List after inserting at the end:
10 -> 20 -> 30 -> (head)
List after inserting at the beginning:
5 -> 10 -> 20 -> 30 -> (head)
List after inserting at position 3:
5 -> 10 -> 15 -> 20 -> 30 -> (head)
List after inserting at position 100 (out of bounds):
5 -> 25 -> 10 -> 15 -> 20 -> 30 -> (head)
List after deleting the first element:
25 -> 10 -> 15 -> 20 -> 30 -> (head)
List after deleting the last element:
25 -> 10 -> 15 -> 20 -> (head)
List after deleting element 20:
25 -> 10 -> 15 -> (head)

Process returned 0 (0x0)   execution time : 2.257 s
Press any key to continue.
```

Lab program 8

Doubly linked list implementation.

```
#include <stdio.h>
#include <stdlib.h>
struct Node {
    int data;
    struct Node* prev;
    struct Node* next;
};
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 insertAtBeginning(struct Node** head, int data) {
    struct Node* newNode = createNode(data); newNode-
    >next = *head;

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

    *head = newNode;
}
void insertAtEnd(struct Node** head, int data) {
```

```
    struct Node* newNode = createNode(data); if
    (*head == NULL) {
        *head = newNode; return;
    }
    struct Node* temp = *head;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = newNode;
    newNode->prev = temp;
}
void deleteNode(struct Node** head, int data) { if
    (*head == NULL) {
        printf("List is empty.\n"); return;
    }
    struct Node* temp = *head;
    while (temp != NULL && temp->data != data) {
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Node with value %d not found.\n", data);
        return;
    }
    if (*head == temp) {
        *head = temp->next;
    }
    if (temp->prev != NULL) {
```

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

    free(temp);
    printf("Node with value %d deleted.\n", data);
}
void displayList(struct Node* head) { if
    (head == NULL) {
        printf("List is empty.\n"); return;
    }
    struct Node* temp = head;
    printf("Doubly Linked List: "); while
    (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}
void freeList(struct Node* head) { struct
    Node* temp;
    while (head != NULL) {
        temp = head;
        head = head->next;
        free(temp);
    }
```

```
}
int main() {
    struct Node* head = NULL;
    insertAtBeginning(&head, 10);
    insertAtBeginning(&head, 20);
    insertAtEnd(&head, 30);
    insertAtEnd(&head, 40);
    displayList(head);
    deleteNode(&head, 20);
    displayList(head);
    deleteNode(&head, 10);
    displayList(head);
    freeList(head);
    return 0;
}
```

Output-

```
Doubly Linked List: 20 10 30 40
Node with value 20 deleted.
Doubly Linked List: 10 30 40
Node with value 10 deleted.
Doubly Linked List: 30 40

Process returned 0 (0x0)   execution time : 0.021 s
Press any key to continue.
```

Lab program 9

Implementation of Binary Search 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 value)
{
    if(root==NULL)
    {
        return createNode(value);
    }
    if(value < root->data)
    {
        root->left=insert(root->left,value);
    }
    else
```

```
    {
        root->right=insert(root->right,value);
    }
};

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

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

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

```
    preorder(root->right);
};

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

    printf("Enter the number of nodes you want to insert: ");
    scanf("%d", &num);

    printf("Enter %d values to insert into the binary search tree:\n", num);

    for (int i = 0; i < num; i++) {
        scanf("%d", &value); root
        = insert(root, value);
    }

    printf("\nPostorder traversal:\n");
    postorder(root);
    printf("\n");

    printf("Preorder traversal:\n");
    preorder(root);
    printf("\n");

    printf("Inorder traversal:\n");
    inorder(root);
    printf("\n");
```

```
    return 0;

}
```

Output-

```
Enter the number of nodes you want to insert: 4
Enter 4 values to insert into the binary search tree:
1
2
3
4

Postorder traversal:
4  3  2  1
Preorder traversal:
1  2  3  4
Inorder traversal:
1  2  3  4

Process returned 0 (0x0)   execution time : 10.511 s
Press any key to continue.
```

Lab program 10

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

```
#include <stdio.h>

#include <stdlib.h>

#include <stdbool.h>


struct Queue {

    int *arr;

    int front, rear; int

    capacity;

};


struct Queue* createQueue(int capacity) {

    struct Queue *queue = (struct Queue*)malloc(sizeof(struct Queue));

    queue->capacity = capacity;

    queue->front = -1;

    queue->rear = -1;

    queue->arr = (int*)malloc(capacity * sizeof(int)); return

    queue;

}


bool isEmpty(struct Queue *queue) { return

    queue->front == -1;

}


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

    (queue->rear == queue->capacity - 1) {

        printf("Queue overflow\n");

        return;
```

```
    }
    if (queue->front == -1) {
        queue->front = 0;
    }
    queue->rear++;
    queue->arr[queue->rear] = value;
}

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

void bfs(int graph[][5], int start, int n) {
    bool visited[n];
    for (int i = 0; i < n; i++) {
        visited[i] = false;
    }
    struct Queue *queue = createQueue(n);

    visited[start] = true;
```

```
    enqueue(queue, start);


    printf("BFS Traversal: ");
    while (!isEmpty(queue)) {
        int node = dequeue(queue); printf("%d
        ", node);


        for (int i = 0; i < n; i++) {
            if (graph[node][i] == 1 && !visited[i]) {
                visited[i] = true;
                enqueue(queue, i);
            }
        }
    }
    printf("\n");
}


int main() {
    int n;
    printf("Enter the value for n \n");
    scanf("%d", &n);
    int graph[n][n];
    for(int i = 0; i < n; i++){
        for(int j = 0; j < n; j++){
            printf("Enter value for graph element\n"); scanf("\n%d",
            &graph[i][j]);
        }
    }
    bfs(graph, 0, n);
```

```
    return 0;

}
```

Output-

```
Enter the value for n
4
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
0
Enter value for graph element
1
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
1
BFS Traversal: 0 1 2 3

Process returned 0 (0x0)   execution time : 110.497 s
Press any key to continue.
```

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

```
#include <stdio.h>

#include <stdbool.h>


void dfs(int graph[][5], int node, bool visited[], int n) { visited[node]

    = true;

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

        if (graph[node][i] == 1 && !visited[i]) {

            dfs(graph, i, visited, n);

        }

    }

}

bool isConnected(int graph[][5], int n) {

    bool visited[n];

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

        visited[i] = false;

    }

    dfs(graph, 0, visited, n);



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

        if (!visited[i]) {

            return false;

        }

    }

    return true;

}

int main() {

    int n;
```

```
    printf("Enter the value for n \n");
    scanf("%d", &n);
    int graph[n][n];
    for(int i = 0; i < n; i++){
        for(int j = 0; j < n; j++){
            printf("Enter value for graph element\n"); scanf("\n%d",
            &graph[i][j]);
        }
    }
    if (isConnected(graph, n)) { printf("The
        graph is connected.\n");
    } else {
        printf("The graph is not connected.\n");
    }

    return 0;
}
```

Output-

```
Enter the value for n
4
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
0
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
1
Enter value for graph element
0
The graph is connected.

Process returned 0 (0x0)   execution time : 18.001 s
Press any key to continue.
```