VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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1BM22CS212

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

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
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B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(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 RACHANA H D **(1BM22CS212)**, 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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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 STACK_SIZE 5
void push(int st[],int *top)
{
	int item;
	if(*top==STACK_SIZE-1)
		printf("Stack overflow\n");
	else
	{
		printf("\nEnter an item :");
		scanf("%d",&item);
		(*top)++;
		st[*top]=item;
	}
}
void pop(int st[],int *top)
{
	if(*top==-1)
		printf("Stack underflow\n");
	else
	{
		printf("\n%d item was deleted",st[(*top)--]);
	}
}
void display(int st[],int *top)
{
	int i;
	if(*top==-1)
		printf("Stack is empty\n");
	for(i=0;i<=*top;i++)
		printf("%d\t",st[i]);
}
void main()
{
	int st[10],top=-1, c,val_del;
	while(1)
	{
		printf("\n1. Push\n2. Pop\n3. Display\n");
		printf("\nEnter your choice :");
		scanf("%d",&c);
		switch(c)
		{
```

```
                    case 1: push(st,&top);
                            break;
                    case 2: pop(st,&top);
                            break;
                    case 3: display(st,&top);
                            break;
                    default: printf("\nInvalid choice!!!");
                            exit(0);
                }
        }
}
```

Output:

```
PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL

PS D:\jyothika\DST> cd "d:\jyothika\DST\" ; if ($?) { gcc 1.c -o 1 } ; if ($?) { .\1 }

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :12

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :65

1. Push
2. Pop
3. Display

Enter your choice :1

Enter an item :45

1. Push
2. Pop
3. Display

Enter your choice :1
Stack overflow
```

```
1. Push
2. Pop
3. Display

Enter your choice :2

45 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2

65 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :3
12
1. Push
2. Pop
3. Display

Enter your choice :2

12 item was deleted
1. Push
2. Pop
3. Display

Enter your choice :2
Stack underflow

1. Push
2. Pop
3. Display

Enter your choice :4

Invalid choice!!!
```

WEEK 2:

Program 2: Write a program 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).

Solution:

```
#include <stdio.h>
#include <ctype.h>
#define SIZE 50
char stack[SIZE];
int top=-1;

void push(char elem)
{
stack [++top]=elem;
}

char pop()
{
return(stack [top--]);
}
int pr(char symbol)
{
if (symbol == '^')
{
return(3);
```

```
}
else if(symbol=='*' || symbol=='/')
{
return(2);
}
else if(symbol == '+' || symbol == '-')
{
return(1);
}
else
{
return(0);
}
}
void main()
{
char infix[50], postfix[50],ch,elem;
int i=0,k=0;
printf("Enter Infix Expression : ");
scanf("%s", infix);
push('#');
while ((ch=infix[i++]) != '\0')
{
if( ch == '(')
push(ch);
else if(isalnum(ch))
postfix[k++]=ch;
```

```
else
{
if( ch == ')')
{
      while (stack[top] != '(')
      postfix[k++]=pop();
      elem=pop();
}
else
{
    while( pr(stack [top]) >= pr(ch) )
    postfix [k++]=pop();
    push(ch);
}
}
}
while (stack[top] != '#')
postfix[k++]=pop();
postfix[k]='\0';
printf("\nPostfix Expression = %s\n", postfix);
}
```

Output:

```
Enter Infix Expression : 2+2*(2*2)

Postfix Expression = 2222**+
```

```
Enter Infix Expression : (4/2)+8*(6/3)

Postfix Expression = 42/863/*+
```

WEEK 3:

Program 3a: Write a program 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

Solution:

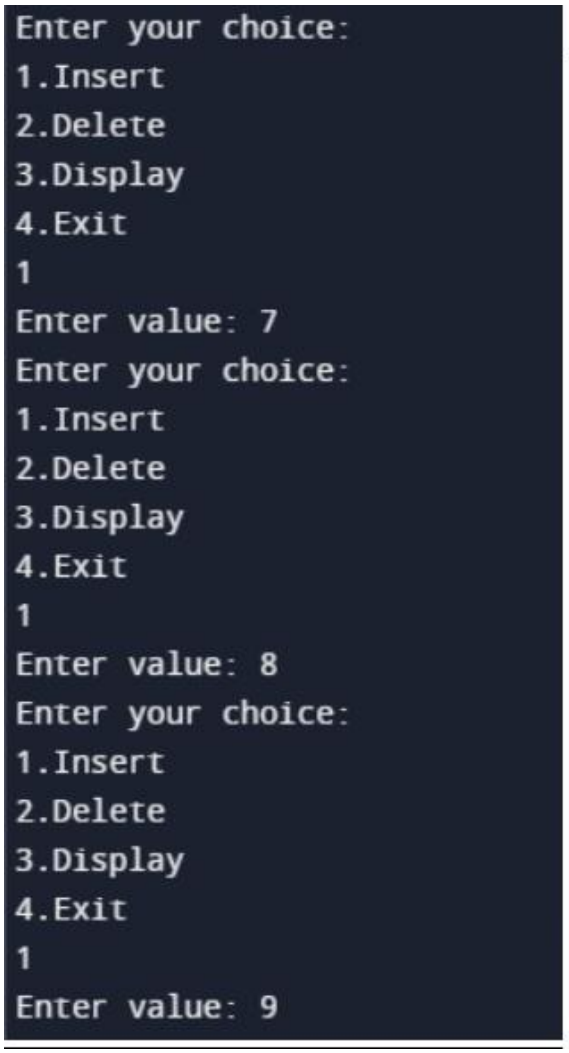
```
#include<stdio.h>
#include<ctype.h>
#include <stdlib.h>
#define s 5
int queue[s], f=-1, r=-1;

int isfull()
{
   if(f==(s-1))
      return 1;
   else
      return 0;
}
int isempty()
{
   if(f==-1||r==-1)
      return 1;
   else
      return 0;
}
void insert()
{
```

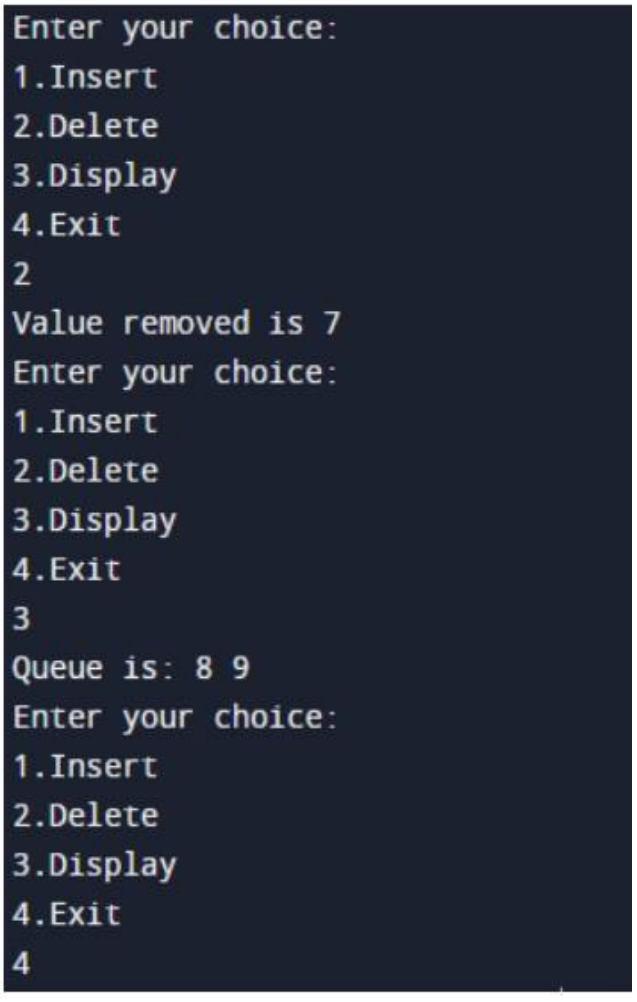
```
    int i;
    printf("Enter value: ");
    scanf("%d",&i);
    if(isfull())
        printf("Queue is full");
    else if(f==-1)
    {
        f=0;
        r=0;
    }
    else
        r=r+1;
    queue[r]=i;
}
void qdelete()
{
    if(isempty())
        printf("Queue is empty");
    else if(f==r)
    {
        f=-1;
        r=-1;
    }
    else
    {
        printf("Value removed is %d\n",queue[f]);
        f=f+1;
```

```
    }
}
void display()
{
    int i;
    if(isempty())
        printf("Queue is empty");
    else
    {
        printf("Queue is: ");
        for(i=f; i<=r;i++)
            printf("%d\t",queue[i]);
        printf("\n");
    }
}
int main()
{
    int ch;
    while(1)
    {
        printf("Enter your choice:\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1: insert(); break;
            case 2: qdelete(); break;
            case 3: display(); break;
```

```
        case 4: {
                printf("Name: RACHANA H D\tUSN:1BM22CS212");
                exit(0);
               }
      }
   }
   return 0;
}
```

Output:





Program 3b: 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

Solution:

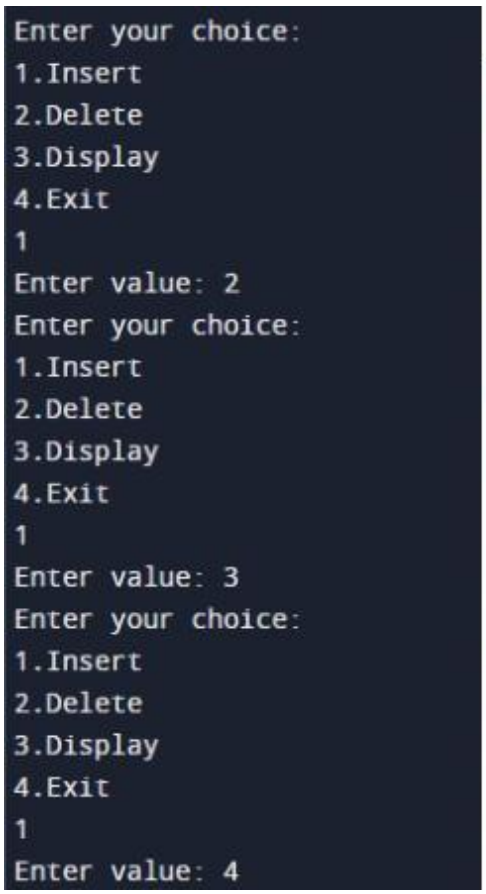
```
#include<stdio.h>
#include<ctype.h>
#include <stdlib.h>
#define s 5
int queue[s], f=-1, r=-1;

int isfull()
{
   if(f==(r+1)||f==0 && r==(s-1))
      return 1;
   else
      return 0;
}
int isempty()
{
   if(f==-1||f>r)
      return 1;
   else
      return 0;
}
void insert()
{
   int i;
```

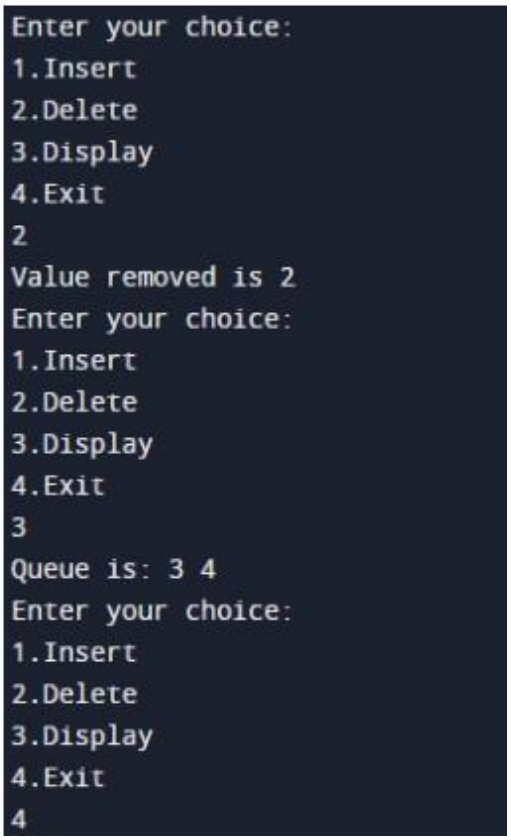
```
    printf("Enter value: ");
    scanf("%d",&i);
    if(isfull())
        printf("Queue is full");
    else if(isempty())
    {
        f=0;
        r=0;
    }
    else
        r=(r+1)%s;
    queue[r]=i;
}
void qdelete()
{
    if(isempty())
        printf("Queue is empty");
    else if(f==r)
    {
        f=-1;
        r=-1;
    }
    else
    {
        printf("Value removed is %d\n",queue[f]);
        f=(f+1)%s;
    }
```

```
}
void display()
{
   int i;
   if(isempty())
      printf("Queue is empty");
   else
   {
      printf("Queue is: ");
      for(i=f; i!=r;i=(i+1)%s)
         printf("%d\t",queue[i]);
      printf("%d",queue[i]);
      printf("\n");
   }
}
int main()
{
   int ch;
   while(1)
   {
      printf("Enter your choice:\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
      scanf("%d",&ch);
      switch(ch)
      {
         case 1: insert(); break;
         case 2: qdelete(); break;
         case 3: display(); break;
```

```
        case 4: {
                printf("Name: RACHANA H D\tUSN:1BM22CS212");
                exit(0);
               }
      }
   }
   return 0;
}
```

OUTPUT:





Lab Program 4: Write a program to implement Singly Linked List with the following operations

1. **Create a linked list.**
2. **Insertion of a node at the first position, at any position, and at the end of the list.**
3. **Display the contents of the linked list.**

Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct Node
{
   int data;
   struct Node *next;
};
struct Node *head;
void insert_begin()
{
   struct Node *ptr;
   int n;
   ptr=(struct Node *)malloc(sizeof(struct Node));
   if(ptr==NULL)
   {
      printf("\nOverflow");
   }
   else
   {
      printf("Enter value: ");
```

```
        scanf("%d",&n);
        ptr->data=n;
        ptr->next=head;
        head=ptr;
    }
}
void insert_end()
{
    struct Node *ptr, *temp;
    int n;
    ptr=(struct Node*)malloc(sizeof(struct Node));
    if(ptr==NULL)
    {
        printf("\nOverflow");
    }
    else
    {
        printf("Enter value: ");
        scanf("%d",&n);
        ptr->data=n;
        if(head==NULL)
        {
            ptr->next=NULL;
            head=ptr;
        }
        else
        {
```

```
            temp=head;
            while(temp->next!=NULL)
               temp=temp->next;
            temp->next=ptr;
            ptr->next=NULL;
        }
    }
}
void insert_random()
{
    int i, loc, n;
    struct Node *ptr, *temp;
    ptr=(struct Node*)malloc(sizeof(struct Node));
    if(ptr==NULL)
    {
        printf("\nOverflow");
    }
    else
    {
        printf("Enter value: ");
        scanf("%d",&n);
        ptr->data=n;
        printf("Enter position: ");
        scanf("%d",&loc);
        if(loc == 0)
        {
            ptr->next = head;
```

```
            head = ptr;
            return;
        }
        temp=head;
        for(i=0; i<loc-1; i++)
        {
            if(temp==NULL)
            {
                printf("Cannot insert at position\n");
                return;
            }
            temp=temp->next;
        }
        ptr->next=temp->next;
        temp->next=ptr;
        }
}
void display()
{
    struct Node * ptr;
    ptr=head;
    printf("List is: ");
    while(ptr!=NULL)
    {
        printf("%d\t", ptr->data);
        ptr=ptr->next;
    }
```

```
    printf("\n");
}
int main()
{
    int ch=0;
    while(1)
    {
        printf("Enter your choice:\n1.Insert at the beginning \n2.Insert at the end \n3.Insert at specified position\n4.Display\n5.Exit\n");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1:insert_begin(); break;
            case 2:insert_end(); break;
            case 3:insert_random(); break;
            case 4:display(); break;
            case 5:{
                      printf("Name: RACHANA H D\tUSN:1BM22CS212");
                       exit(0);
                   }
        }
    }return 0;
}
```

Output:

```
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
1
Enter value: 2
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
4
List is: 2
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
1
Enter value: 2
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
2
Enter value: 3
```

```
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
4
List is: 2  2  3
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
3
Enter value: 1
Enter position: 0
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
4
List is: 1  2  2  3
Enter your choice:
1.Insert at the beginning
2.Insert at the end
3.Insert at specified position
4.Display
5.Exit
5
```

Program - Leetcode platform

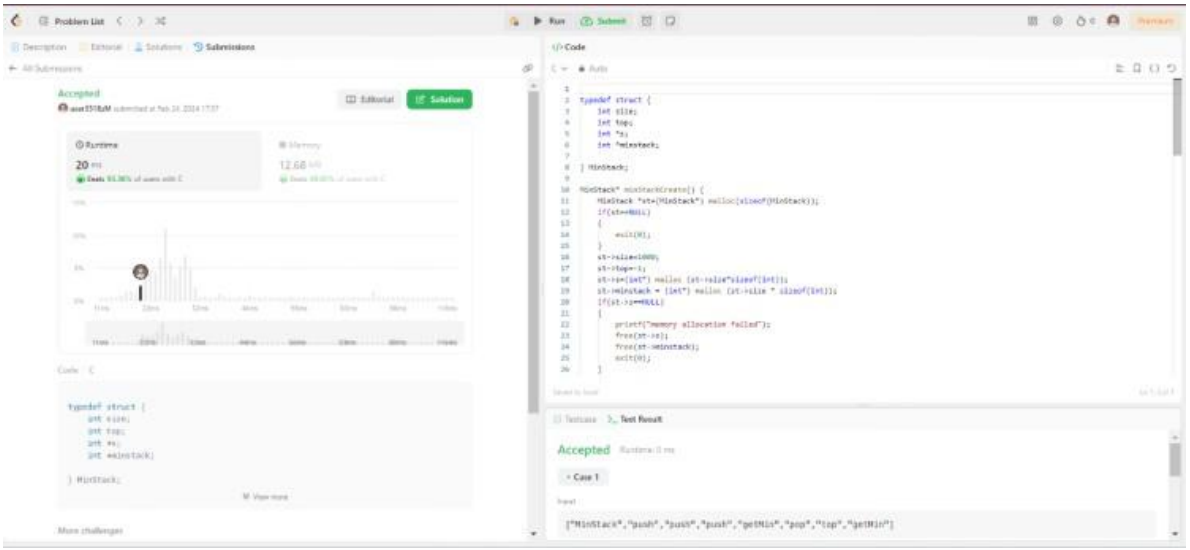
```
typedef struct {
    int size;
    int top;
    int *s;
    int *minstack;

} MinStack;


MinStack* minStackCreate() {
    MinStack *st=(MinStack*) malloc(sizeof(MinStack));
    if(st==NULL)
    {
        exit(0);
    }
    st->size=1000;
    st->top=-1;
    st->s=(int*) malloc (st->size*sizeof(int));
    st->minstack = (int*) malloc (st->size * sizeof(int));
    if(st->s==NULL)
    {
        printf("memory allocation failed");
        free(st->s);
        free(st->minstack);
        exit(0);
```

```
    }
    return st;
}

void minStackPush(MinStack* obj, int val) {
    if(obj->top==obj->size-1)
        printf("stack is overflow");
    else{
        obj->top++;
        obj->s[obj->top]=val;
        if (obj->top == 0 || val < obj->minstack[obj->top - 1]) {
            obj->minstack[obj->top] = val;
        } else {
            obj->minstack[obj->top] = obj->minstack[obj->top - 1];
        }
    }
}

void minStackPop(MinStack* obj) {
    int value;
    if(obj->top==-1)
        printf("underflow");
    else
    {
        value=obj->s[obj->top];
```

```
        obj->top--;
    }
}

int minStackTop(MinStack* obj) {
    int value=-1;
    if(obj->top==-1)
    {
        exit(0);
    }
    else
    {
        value=obj->s[obj->top];
        return value;
    }
}

int minStackGetMin(MinStack* obj) {
    if(obj->top==-1)
    {
        exit(0);
    }
    else
    {
        return obj->minstack[obj->top];
```

```
    }
}

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

Output:



Lab Program 5:

Write a program to implement a Singly Linked List with the following operations: deletion of the first element,specified element, and last element in the list.

Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct Node
{
   int data;
   struct Node *next;
};
struct Node *head;
void insert_begin(int n)
{
   struct Node *ptr;
   ptr=(struct Node *)malloc(sizeof(struct Node));
   if(ptr==NULL)
   {
      printf("\nOverflow");
   }
   else
   {
      ptr->data=n;
      ptr->next=head;
      head=ptr;
   }
```

```
}

void delete_begin()
{
   struct Node *ptr;
   if(head==NULL)
   {
      printf("List is empty\n");
   }
   else
   {
      ptr=head;
      head=ptr->next;
      free(ptr);
      printf("Deleted at the start\n");
   }
}
void delete_end()
{
   struct Node *ptr,*ptr1;
   if(head == NULL)
   {
      printf("List is empty\n");
   }
   else if(head -> next == NULL)
   {
      free(head);
```

```
        head = NULL;
        printf("Only node of the list deleted\n");
    }
    else
    {
        ptr = head;
        while(ptr->next != NULL)
        {
            ptr1 = ptr;
            ptr = ptr ->next;
        }
        ptr1->next = NULL;
        free(ptr);
        printf("Deleted Node from the last\n");
    }
}
void delete_specified()
{
    struct Node *ptr, *ptr1;
    int loc,i;
    printf("Enter position: ");
    scanf("%d",&loc);
    ptr=head;
    for(i=0;i<loc;i++)
    {
        ptr1 = ptr;
        ptr = ptr->next;
```

```
        if(ptr == NULL)
        {
            printf("There are less than %d elements in the list\n",loc);
            return;
        }
    }
    ptr1 ->next = ptr ->next;
    free(ptr);
    printf("Deleted %d node\n",loc);
}
void display()
{
    struct Node * ptr;
    ptr=head;
    printf("List is: ");
    while(ptr!=NULL)
    {
        printf("%d\t", ptr->data);
        ptr=ptr->next;
    }
    printf("\n");
}
int main()
{
    insert_begin(8);
    insert_begin(10);
    insert_begin(12);
```

```
    insert_begin(14);
    insert_begin(16);
    display();
    int ch=0;
    while(1)
    {
        printf("Enter your choice:\n1.Delete at the beginning \n2.Delete at End\n3.Delete at specified position \n4.Display\n5.Exit\n");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1:delete_begin(); display(); break;
            case 2:delete_end(); display(); break;
            case 3:delete_specified(); display(); break;
            case 4:display(); break;
            case 5:{
                                printf("Name: RACHANA H D\tUSN:1BM22CS212");
                                exit(0);
                }
        }
    }return 0;
}
```

Output:

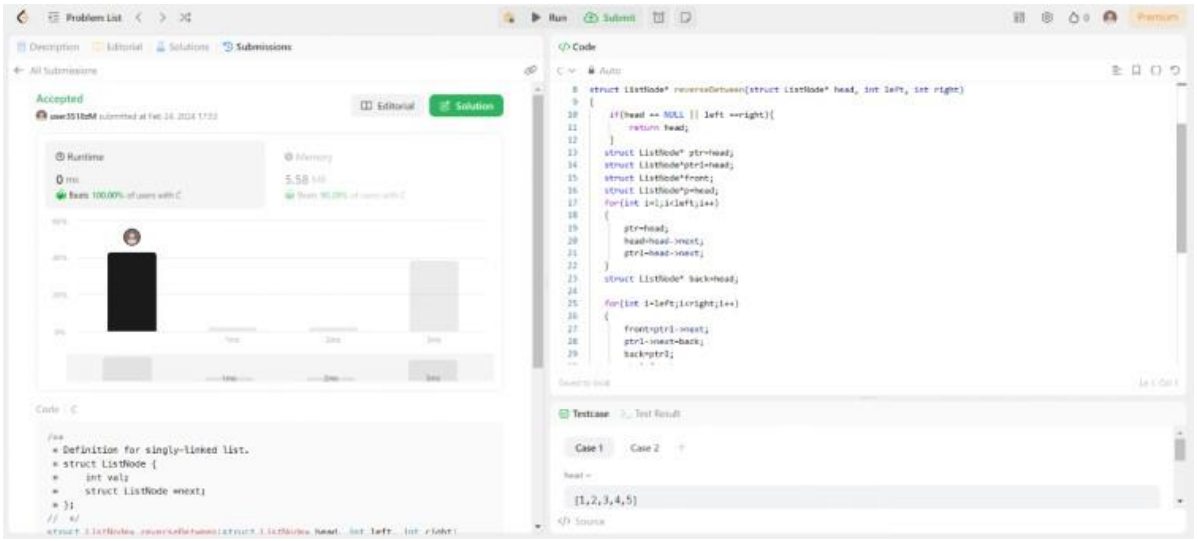
```
List is: 16 14  12  10  8
Enter your choice:
1.Delete at the beginning
2.Delete at End
3.Delete at specified position
4.Display
5.Exit
1
Deleted at the start
List is: 14 12  10  8
Enter your choice:
1.Delete at the beginning
2.Delete at End
3.Delete at specified position
4.Display
5.Exit
2
Deleted Node from the last
List is: 14 12  10
```

```
Enter your choice:
1.Delete at the beginning
2.Delete at End
3.Delete at specified position
4.Display
5.Exit
3
Enter position: 2
Deleted 2 node
List is: 14 12
Enter your choice:
1.Delete at the beginning
2.Delete at End
3.Delete at specified position
4.Display
5.Exit
5
```

Program - Leetcode platform

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
//  */
struct ListNode* reverseBetween(struct ListNode* head, int left, int right)
{
    if(head == NULL || left ==right){
        return head;
    }
   struct ListNode* ptr=head;
   struct ListNode*ptr1=head;
   struct ListNode*front;
   struct ListNode*p=head;
   for(int i=1;i<left;i++)
   {
      ptr=head;
      head=head->next;
      ptr1=head->next;
   }
   struct ListNode* back=head;
```

```
  for(int i=left;i<right;i++)
  {
     front=ptr1->next;
     ptr1->next=back;
     back=ptr1;
     ptr1=front;
  }
  if(left==1)
  {
     p->next=ptr1->next;
     ptr1->next=back;
     p=ptr1;
  }
  else
  {
    ptr->next=back;
    head->next=front;
  }
  return p;
}
```


Problem List
Run
Submit
Premium
Description
Editorial
Solutions
Submissions
All Submissions
Accepted
Editorial
Solution
Runtime
0 ms
Memory
5.58 MB
Code
C
Auto
struct ListNode* reverseBetween(struct ListNode* head, int left, int right)
{
if(head == NULL || left ==right){
return head;
}
struct ListNode* ptr=head;
struct ListNode*ptr1=head;
struct ListNode*front;
struct ListNode*p=head;
for(int i=1;i<left;i++)
{
ptr=head;
head=head->next;
ptr1=head->next;
}
struct ListNode* back=head;
for(int i=left;i<right;i++)
{
front=ptr1->next;
ptr1->next=back;
back=ptr1;
Testcase
Test Result
Case 1
Case 2
[1,2,3,4,5]
Source
/**
* Definition for singly-linked list.
* struct ListNode {
* int val;
* struct ListNode *next;
* };
*/

Lab Program 6a

Write a program to implement a Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

Solution:

```
#include<stdio.h>
#include<stdlib.h>
struct node {
   int data;
   struct node *next;
};
void display(struct node *head)
{
   struct node *ptr = head;
   while (ptr != NULL)
   {
      printf("%d\t", ptr->data);
      ptr = ptr->next;
   }
   printf("\n");
}
void sort(struct node **head)
{
   if (*head == NULL)
      return;
   struct node *current, *next;
   int temp;
```

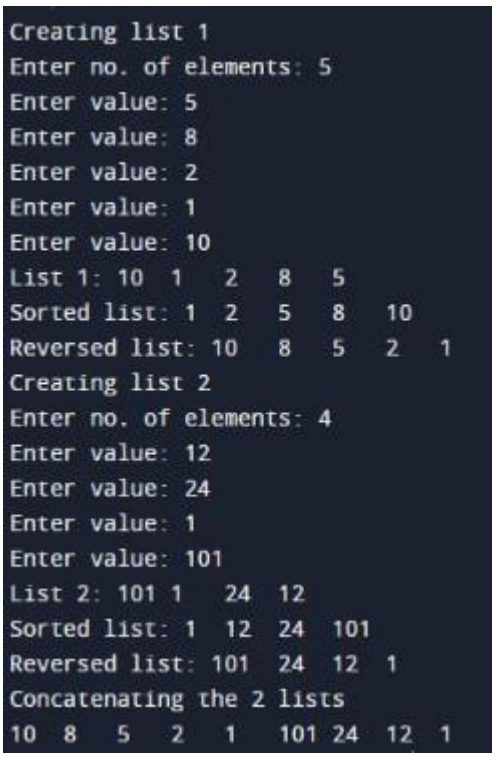
```
    current = *head;
    while (current->next != NULL)
    {
        next = current->next;
        while (next != NULL)
        {
            if (current->data > next->data)
            {
                temp = current->data;
                current->data = next->data;
                next->data = temp;
            }
            next = next->next;
        }
        current = current->next;
    }
}
void reverse(struct node **head)
{
    struct node *cur=*head, *prev=NULL, *next=NULL;
    while(cur!=NULL)
    {
        next=cur->next;
        cur->next=prev;
        prev=cur;
        cur=next;
    }
```

```
    *head=prev;
}
struct node *concatenate(struct node **head1, struct node **head2)
{
    if (*head1 == NULL)
    {
        *head1 = *head2;
        return *head1;
    }
    if (*head2 == NULL)
        return *head1;
    struct node *temp = *head1;
    while (temp->next != NULL)
        temp = temp->next;
    temp->next = *head2;
    return *head1;
}
void PUSH(struct node **head)
{
    struct node *node = (struct node*)malloc(sizeof(struct node));
    if (node == NULL)
    {
        printf("Overflow\n");
        exit(1);
    }
    int n;
    printf("Enter value: ");
```

```
    scanf("%d", &n);
    node->data = n;
    node->next = *head;
    *head = node;
}
int main()
{
    struct node *head1 = NULL, *head2 = NULL;
    int ch;
    printf("Creating list 1\nEnter no. of elements: ");
    int n, i;
    scanf("%d",  &n);
    for (i = 0; i < n; i++)
        PUSH(&head1);
    printf("List 1: ");
    display(head1);
    sort(&head1);
    printf("Sorted list: ");
    display(head1);
    reverse(&head1);
    printf("Reversed list: ");
    display(head1);
    printf("Creating list 2\nEnter no. of elements: ");
    int n1, i1;
    scanf("%d", &n1);
    for (i1 = 0; i1 < n1; i1++)
        PUSH(&head2);
```

```
    printf("List 2: ");
    display(head2);
    sort(&head2);
    printf("Sorted list: ");
    display(head2);
    reverse(&head2);
    printf("Reversed list: ");
    display(head2);
    printf("Concatenating the 2 lists \n");
    struct node *h = concatenate(&head1, &head2);
    display(h);
    return 0;
}
```

Output:



Program 6b: Write a program to implement a Single Link List to simulate Stack & Queue Operations

Solution;

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

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

/* Stack implementation */

void PUSH(struct node **head) {
   struct node *node = (struct node*)malloc(sizeof(struct node));
   int n;
   if (node == NULL) {
      printf("Overflow\n");
   }
   else {
      printf("Enter value: ");
      scanf("%d", &n);
      node->data = n;
      node->next = *head;
      *head = node;
   }
```

```
}

void POP(struct node **head) {
   struct node *node;
   if (*head == NULL) {
      printf("Stack is empty\n");
   }
   else {
      node = *head;
      *head = node->next;
      free(node);
      printf("Node deleted\n");
   }
}

/* Queue implementation */

void enqueue(struct node **head) {
   struct node *node = (struct node*)malloc(sizeof(struct node));
   int n;
   if (node == NULL) {
      printf("Overflow\n");
   }
   else {
      printf("Enter value: ");
      scanf("%d", &n);
      node->data = n;
```

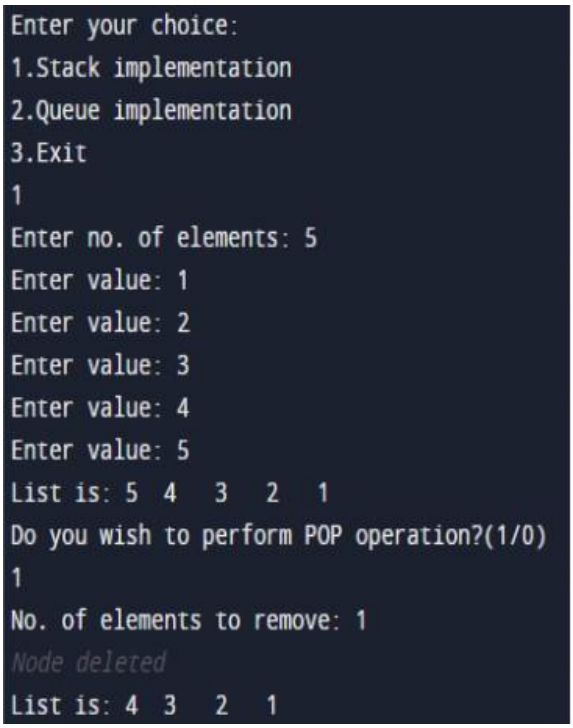
```
        node->next = NULL;
        if (*head == NULL) {
            *head = node;
        }
        else {
            struct node *t;
            t = *head;
            while (t->next != NULL) {
                t = t->next;
            }
            t->next = node;
        }
    }
}

void dequeue(struct node **head) {
    struct node *node;
    if (*head == NULL) {
        printf("Queue is empty\n");
    }
    else {
        node = *head;
        *head = node->next;
        free(node);
        printf("Node deleted\n");
    }
}
```

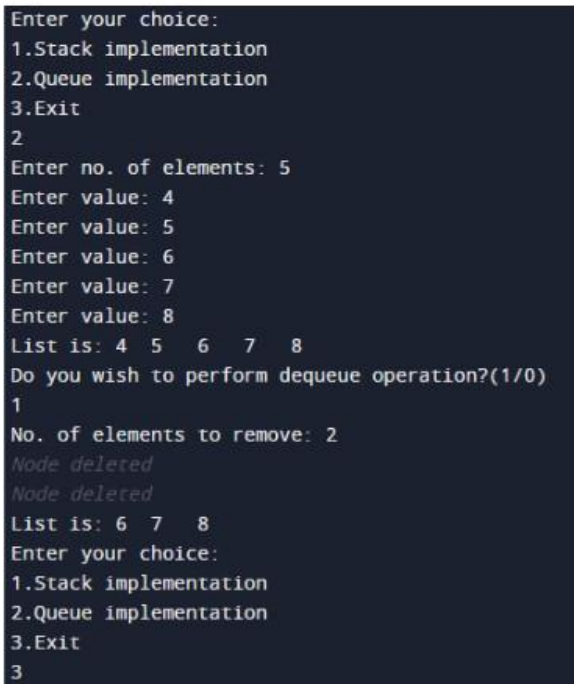
```
void display(struct node *head) {
    struct node *ptr;
    ptr =  head;
    printf("List is: ");
    while (ptr != NULL) {
        printf("%d\t", ptr->data);
        ptr = ptr->next;
    }
    printf("\n");
}

int main() {
    struct node *head1 = NULL, *head2 = NULL;
    int ch;
    while (1) {
        printf("Enter your choice:\n1.Stack implementation\n2.Queue
implementation\n3.Exit\n");
        scanf("%d", &ch);
        switch (ch) {
            case 1: {
                printf("Enter no. of elements: ");
                int n, i, c;
                scanf("%d",  &n);
                for (i = 0; i < n; i++)
                    PUSH(&head1);
                display(head1);
```

```
    printf("Do you wish to perform POP operation?(1/0)\n");
    scanf("%d", &c);
    if (c == 1) {
        printf("No. of elements to remove: ");
        scanf("%d", &n);
        for (i = 0; i < n; i++)
            POP(&head1);
        display(head1);
    }
}
break;
case 2: {
    printf("Enter no. of elements: ");
    int n, i, c;
    scanf("%d",  &n);
    for (i = 0; i < n; i++)
        enqueue(&head2);
    display(head2);
    printf("Do you wish to perform dequeue operation?(1/0)\n");
    scanf("%d", &c);
    if (c == 1) {
        printf("No. of elements to remove: ");
        scanf("%d", &n);
        for (i = 0; i < n; i++)
            dequeue(&head2);
        display(head2);
    }
```

```
        }
        break;
        case 3: {
                printf("Name:RACHANA H D \tUSN:1BM22CS212");
                exit(0);
              }
      }
   }
   return 0;
}
```

Output:





Program 7: Write a program to Implement doubly link list with primitive operations

1. **Create a doubly linked list.**
2. **Insert a new node to the left of the node.**
3. **Delete the node based on a specific value**
4. **Display the contents of the list**

Solution:

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

struct node
{
   struct node *next, *prev;
   int data;
};
struct node *head;
void display()
{
   struct node *temp = head;
   if (temp == NULL)
   {
      printf("List is empty.\n");
      return;
   }
   while (temp != NULL)
   {
      printf("%d ", temp->data);
```

```
        temp = temp->next;
    }
    printf("\n");
}
void push()
{
    struct node *new_node = (struct node *)malloc(sizeof(struct node));
    int data;
    if(new_node==NULL)
        printf("Overflow\n");
    else
    {
        printf("Enter the data: ");
        scanf("%d", &data);
        new_node->data = data;
        if (head == NULL)
        {
            new_node->next = NULL;
            new_node->prev = NULL;
            head = new_node;
        }
        else
        {
            head->prev = new_node;
            new_node->next = head;
            new_node->prev = NULL;
            head = new_node;
```

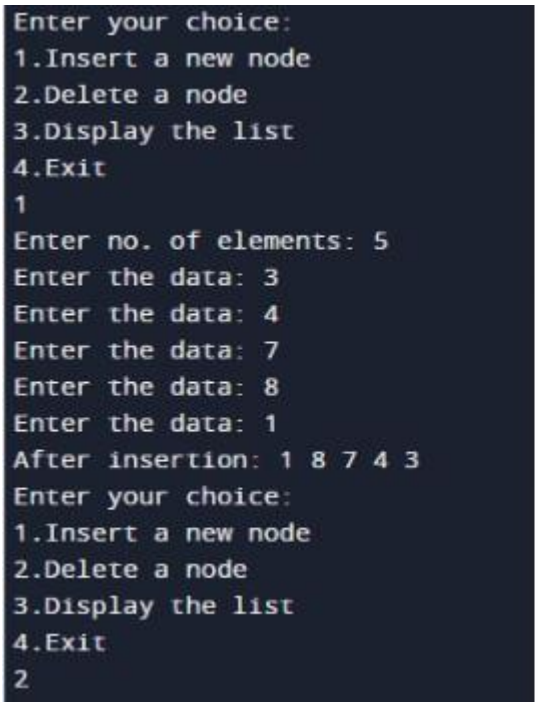
```
        }
    }
}

void delete_specified()
{
    int loc=1,val;
    printf("Enter the value to delete: ");
    scanf("%d", &val);
    struct node *temp = head;
    if (temp == NULL)
    {
        printf("List is empty. Nothing to delete.\n");
        return;
    }
    while(temp->data!=val)
    {
        loc++;
        temp=temp->next;
    }
    temp=head;
    if (loc == 1)
    {
        head = temp->next;
        if (head != NULL)
            head->prev = NULL;
        free(temp);
```

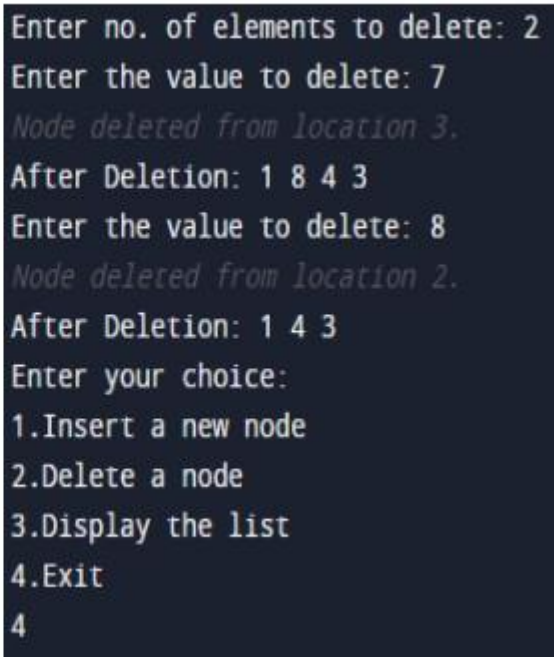
```
        printf("Node deleted from the beginning.\n");
        return;
    }
    for (int i = 1; i < loc; i++)
    {
        temp = temp->next;
        if (temp == NULL)
        {
            printf("Specified position does not exist.\n");
            return;
        }
    }
    if (temp->next == NULL)
    {
        temp->prev->next = NULL;
        free(temp);
        printf("Node deleted from the end.\n");
        return;
    }
    temp->prev->next = temp->next;
    temp->next->prev = temp->prev;
    free(temp);
    printf("Node deleted from location %d.\n", loc);
    printf("After Deletion: ");
    display();
}
int main()
```

```
{
   int ch;
   while (1)
   {
      printf("Enter your choice:\n1.Insert a new node\n2.Delete a node\n3.Display the
list\n4.Exit\n");
      scanf("%d", &ch);
      switch (ch)
      {
         case 1:{
                  printf("Enter no. of elements: ");
                  int n, i;
                  scanf("%d",&n);
                  for(i=0; i<n; i++)
                     push();
                  printf("After insertion: ");
                  display();
               }break;
         case 2:{
                  printf("Enter no. of elements to delete: ");
                  int n,i;
                  scanf("%d",&n);
                  for(i=0; i<n; i++)
                     delete_specified();
               }break;
         case 3:display(); break;
         case 4:{
```

```
                printf("Name: RACHANA H D\tUSN:1BM22CS212");
                exit(0);
            }
        }
    }
    return 0;
}
```

OUTPUT:



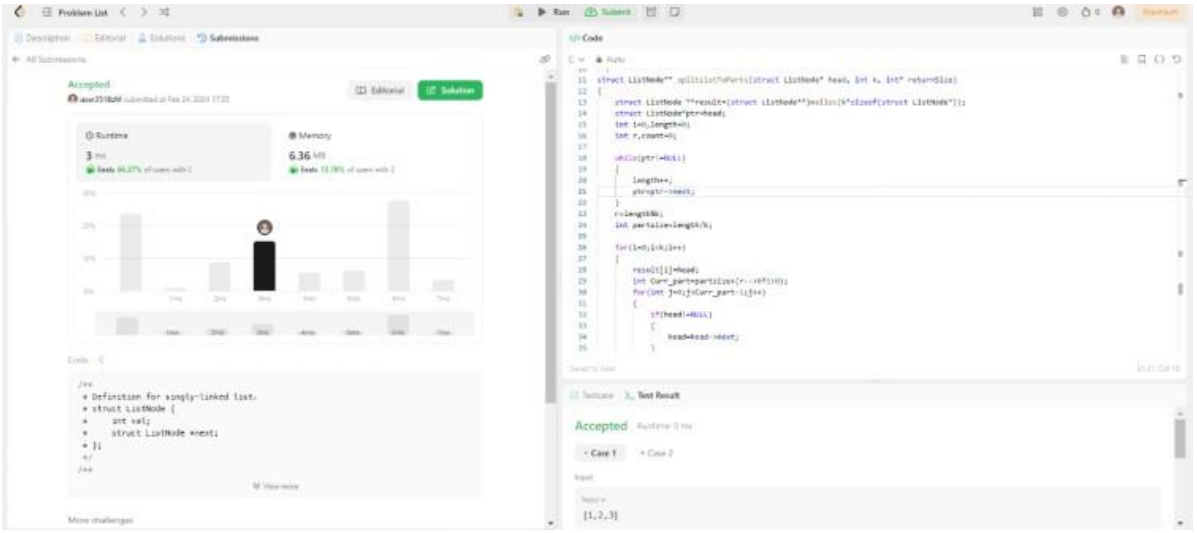


Program - Leetcode platform

```
**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
/**
 * Note: The returned array must be malloced, assume caller calls free().
 */
struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize)
{
    struct ListNode **result=(struct ListNode**)malloc(k*sizeof(struct ListNode*));
    struct ListNode*ptr=head;
    int i=0,length=0;
    int r,count=0;

    while(ptr!=NULL)
    {
        length++;
        ptr=ptr->next;
    }
    r=length%k;
```

```
int partsize=length/k;


for(i=0;i<k;i++)
{
   result[i]=head;
   int Curr_part=partsize+(r-->0?1:0);
   for(int j=0;j<Curr_part-1;j++)
   {
      if(head!=NULL)
      {
         head=head->next;
      }
   }
   if(head!=NULL)
   {
      struct ListNode*temp=head;
      head=head->next;
      temp->next=NULL;
   }
}
*returnSize=k;
return result;
```

Output:



Program 8: Write a program

1. To construct a binary Search tree.

2. To traverse the tree using all the methods i.e., in-order, preorder and post order To display the elements in the tree.

Solution:

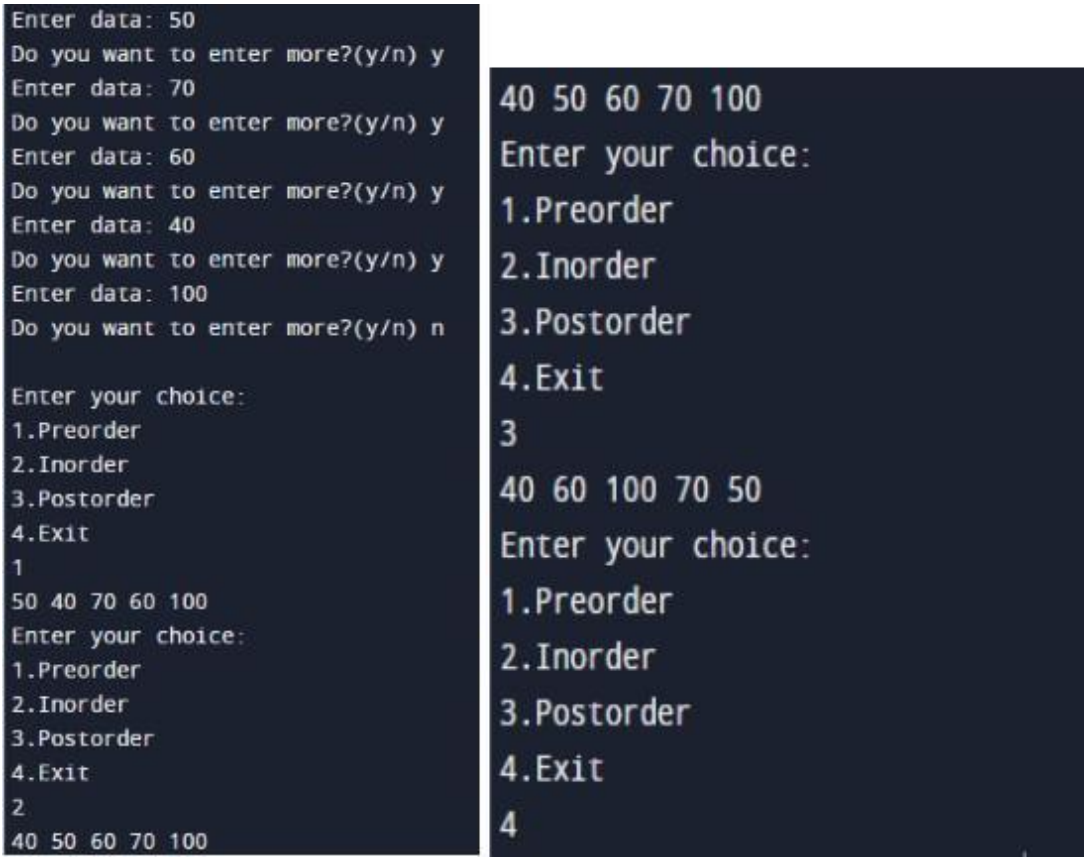
```
#include<stdio.h>
#include<stdlib.h>
typedef struct BST
{
   int data;
   struct BST *left;
   struct BST *right;
}node;
node *create()
{
   node  *t;
   printf("Enter data: ");
```

```
    t=(node*)malloc(sizeof(node));
    scanf("%d",&t->data);
    t->left=t->right=NULL;
    return t;
}
void insert(node *root,node*t)
{
    if(t->data<root->data)
    {
        if(root->left!=NULL)
            insert(root->left,t);
        else
            root->left=t;
    }
    if(t->data>root->data)
    {
        if(root->right!=NULL)
            insert(root->right,t);
        else
            root->right=t;
    }
}
void preorder(node *root)
{
    if(root!=NULL)
    {
        printf("%d ",root->data);
```

```
        preorder(root->left);
        preorder(root->right);
    }
}
void inorder(node *root)
{
    if(root!=NULL)
    {
        inorder(root->left);
        printf("%d ",root->data);
        inorder(root->right);
    }
}
void postorder(node *root)
{
    if(root!=NULL)
    {
        postorder(root->left);
        postorder(root->right);
        printf("%d ",root->data);
    }
}
int main()
{
    char ch;
    node *root=NULL,*t;
    do{
```

```
        t=create();
        if(root==NULL)
            root=t;
        else
            insert(root,t);
        printf("Do you want to enter more?(y/n) ");
        getchar();
        scanf("%c",&ch);
    }while(ch=='y'||ch=='Y');
    int c;
    while(1)
    {
        printf("\nEnter your choice:\n1.Preorder\n2.Inorder\n3.Postorder\n4.Exit\n");
        scanf("%d",&c);
        switch(c)
        {
            case 1:{preorder(root);}break;
            case 2:{inorder(root);}break;
            case 3:{postorder(root);}break;
            case 4:{
                    printf("Name: RACHANA H D\tUSN:1BM22CS212");
                       exit(0);
                   }
        }
    }
    return 0;
}
```

Output:

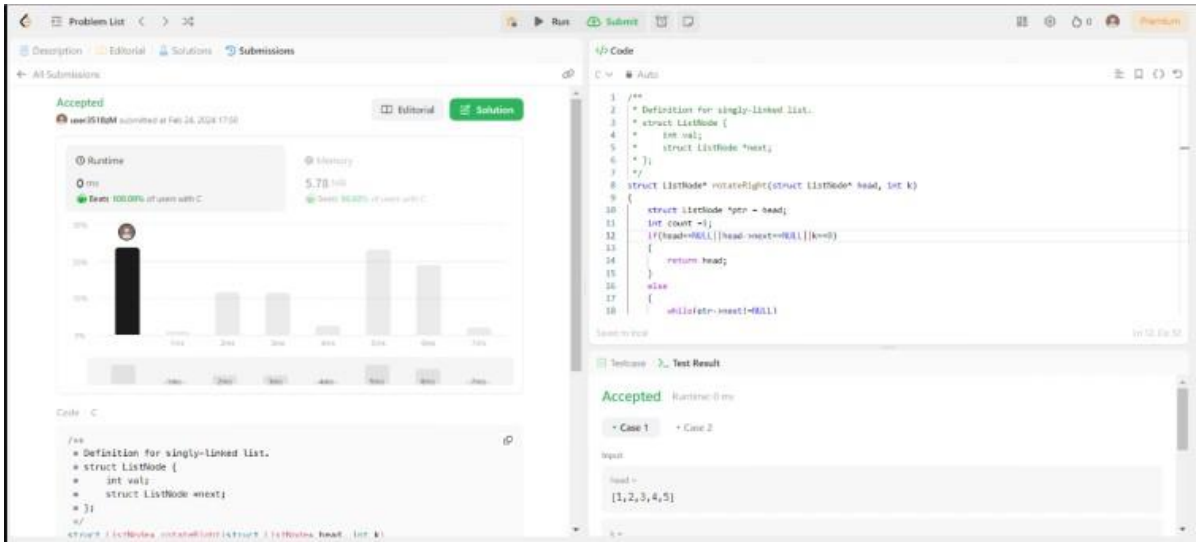

Enter data: 50
Do you want to enter more?(y/n) y
Enter data: 70
Do you want to enter more?(y/n) y
Enter data: 60
Do you want to enter more?(y/n) y
Enter data: 40
Do you want to enter more?(y/n) y
Enter data: 100
Do you want to enter more?(y/n) n
Enter your choice:
1.Preorder
2.Inorder
3.Postorder
4.Exit
1
50 40 70 60 100
Enter your choice:
1.Preorder
2.Inorder
3.Postorder
4.Exit
2
40 50 60 70 100
40 50 60 70 100
Enter your choice:
1.Preorder
2.Inorder
3.Postorder
4.Exit
3
40 60 100 70 50
Enter your choice:
1.Preorder
2.Inorder
3.Postorder
4.Exit
4

Program - Leetcode platform

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* rotateRight(struct ListNode* head, int k)
{
    struct ListNode *ptr = head;
    int count =1;
    if(head==NULL||head->next==NULL||k==0)
    {
        return head;
    }
    else
    {
        while(ptr->next!=NULL)
        {
            ptr=ptr->next;
            count++;
        }
        if(k%count==0)
        {
            return head;
```

```
        }
        ptr->next=head;
        for(int i=k%count;i<count;i++)
        {
            ptr=ptr->next;
        }
        head=ptr->next;
        ptr->next=NULL;
        return head;

    }
}
```

Output:



Program 9a: Write a program to traverse a graph using the BFS method.

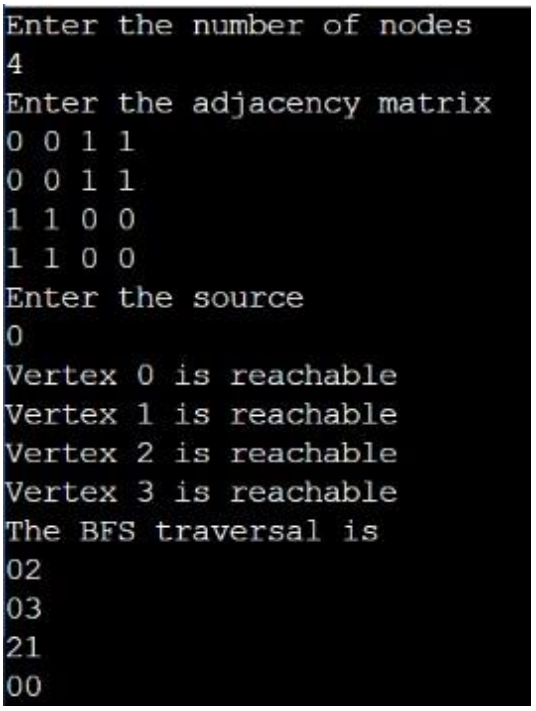
Solution:

```
#include<stdio.h>
#include<conio.h>
void bfs(int a[20][20], int n, int src, int t[20][2], int s[])
{
	int f,r,q[20],u,v,k=0,i;
	for(i=1;i<=n;i++)
		s[i]=0;
	f=r=k=0;
	q[r]=src;
	s[src]=1;
	while(f<=r)
	{
		u=q[f++];
		for(v=1;v<=n;v++)
		{
			if(a[u][v]==1 && s[v]==0)
			{
				s[v]=1;
				q[++r]=v;
				t[k][0]=u;
				t[k][1]=v;
				k++;
			}
		}
	}
```

```
}
void main()
{
	int n,a[20][20],src,t[20][2],flag,s[20],i,j;
	printf("Enter the number of nodes\n");
	scanf("%d", &n);
	printf("Enter the adjacency matrix\n");
	for(i=0;i<n;i++)
	{
		for(j=0;j<n;j++)
			scanf("%d", &a[i][j]);
	}
	printf("Enter the source\n");
	scanf("%d", &src);
	bfs(a,n,src,t,s);
	flag=0;
	for(i=0;i<n;i++)
	{
		if(s[i]==0)
		{
			printf("Vertex %d is not reachable\n", i);
			flag=1;
		}
		else
			printf("Vertex %d is reachable\n", i);
	}
	if(flag==1)
```

```
            printf("Some nodes are not visited\n");
        else
        {
            printf("The BFS traversal is\n");
            for(i=0;i<n;i++)
                printf("%d%d\n", t[i][0], t[i][1]);
        }
        getch();
}
```

Output:



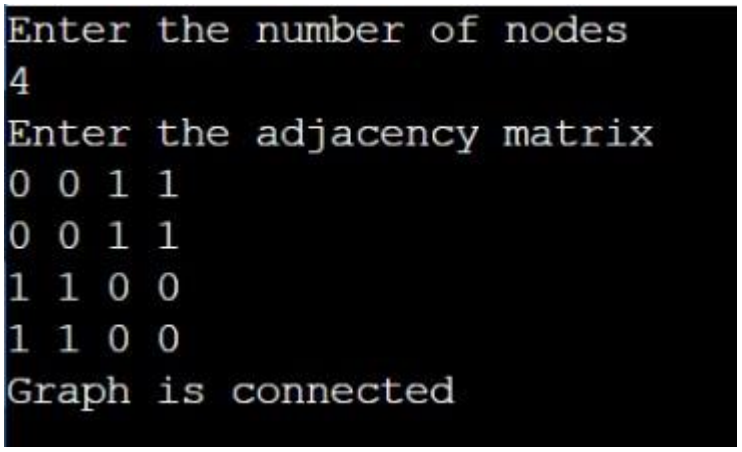
Program 9b: Write a program to check whether a graph is connected or not using the DFS method.

Solution:

```
#include<stdio.h>
#include<conio.h>
int a[1][10];
void dfs(int n, int cost[10][10], int u, int s[])
{
        int v;
        s[u]=1;
        for(v=0;v<n;v++)
        {
                if((cost[u][v]==1) && (s[v]==0))
                        dfs(n,cost,v,s);
        }
}
void main()
{
        int n,i,j,cost[10][10],s[10],con,flag;
        printf("Enter the number of nodes\n");
        scanf("%d", &n);
        printf("Enter the adjacency matrix\n");
        for(i=0;i<n;i++)
        {
                for(j=0;j<n;j++)
                        scanf("%d", &cost[i][j]);
```

```
        }
        con=0;
        for(j=0;j<n;j++)
        {
                for(i=0;i<n;i++)
                s[i]=0;
                dfs(n,cost,j,s);
                flag=0;
                for(i=0;i<n;i++)
                {
                        if(s[i]==0)
                                flag=1;
                }
                if(flag==0)
                        con=1;
        }
        if(con==1)
                printf("Graph is connected\n");
        else
                printf("Graph is not connected\n");
        getch();
}
```

Output:


Enter the number of nodes
4
Enter the adjacency matrix
0 0 1 1
0 0 1 1
1 1 0 0
1 1 0 0
Graph is connected

Lab program 10:

Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F.Assume that file F is maintained in memory by a Hash Table (HT) of 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 -> Las H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L.Resolve the collision (if any) using linear probing.

```
#include <stdio.h>

#include <stdlib.h>


#define TABLE_SIZE 100 // Size of hash table

#define EMPTY -1 // Indicates empty cell in hash table


// Employee structure

struct Employee {

    int key; // Unique key

    // Add other employee data here

};


// Hash table structure

struct HashTable {

    struct Employee* table[TABLE_SIZE];

};


// Hash function using remainder method

int hash(int key, int m) {
```

```
    return key % m;
}

// Function to initialize hash table
void initHashTable(struct HashTable* ht) {
    for (int i = 0; i < TABLE_SIZE; i++) {
        ht->table[i] = NULL;
    }
}

// Function to insert employee record into hash table
void insert(struct HashTable* ht, struct Employee* emp) {
    int index = hash(emp->key, TABLE_SIZE);

    // Linear probing to resolve collisions
    while (ht->table[index] != NULL && ht->table[index]->key != EMPTY) {
        index = (index + 1) % TABLE_SIZE;
    }

    ht->table[index] = emp;
}

// Function to search for an employee record using key
struct Employee* search(struct HashTable* ht, int key) {
    int index = hash(key, TABLE_SIZE);
```

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

    return NULL; // Employee not found
}

// Function to display hash table contents
void displayHashTable(struct HashTable* ht) {
    printf("Hash Table:\n");
    for (int i = 0; i < TABLE_SIZE; i++) {
        if (ht->table[i] != NULL && ht->table[i]->key != EMPTY) {
            printf("Index %d: Key %d\n", i, ht->table[i]->key);
        } else {
            printf("Index %d: Empty\n", i);
        }
    }
}

int main() {
    struct HashTable ht;
```

```
    initHashTable(&ht);

    // Example employee records
    struct Employee emp1 = {1234}; // Key: 1234
    struct Employee emp2 = {5678}; // Key: 5678

    // Insert employee records into hash table
    insert(&ht, &emp1);
    insert(&ht, &emp2);

    // Display hash table
    displayHashTable(&ht);

    // Search for an employee
    int keyToSearch = 1234;
    struct Employee* foundEmp = search(&ht, keyToSearch);
    if (foundEmp != NULL) {
        printf("\nEmployee found with key %d\n", foundEmp->key);
    } else {
        printf("\nEmployee with key %d not found\n", keyToSearch);
    }

    return 0;
}
```


Index 74: Empty
Index 75: Empty
Index 76: Empty
Index 77: Empty
Index 78: Key 5678
Index 79: Empty
Index 80: Empty
Index 81: Empty
Index 82: Empty
Index 83: Empty
Index 84: Empty
Index 85: Empty
Index 86: Empty
Index 87: Empty
Index 88: Empty
Index 89: Empty
Index 90: Empty
Index 91: Empty
Index 92: Empty
Index 93: Empty
Index 94: Empty
Index 95: Empty
Index 96: Empty
Index 97: Empty
Index 98: Empty
Index 99: Empty
Employee found with key 1234
Process returned 0 (0x0) execution time : 13.766 s

Output:

HACKER RANK:

```
void inOrderTraversal(TreeNode* root, int* result, int* index) {     if (root == NULL)
        return;

    inOrderTraversal(root->left, result, index);     result[(*index)++] = root->data;
    inOrderTraversal(root->right, result, index); }

// Function to swap subtrees at specified depths void swapSubtrees(TreeNode* root, int k, int
depth) {     if (root == NULL)
        return;

    if (depth % k == 0) {
        TreeNode* temp = root->left;         root->left = root->right;
        root->right = temp;
    }

    swapSubtrees(root->left, k, depth + 1);     swapSubtrees(root->right, k, depth + 1);
}

// Function to build the binary tree from the given indexes
TreeNode* buildTree(int indexes_rows, int indexes_columns, int** indexes) {
    TreeNode* root = (TreeNode*)malloc(sizeof(TreeNode));     root->data = 1;     root->left =
NULL;
    root->right = NULL;

    TreeNode* nodes[indexes_rows + 1];
    nodes[1] = root;

    for (int i = 0; i < indexes_rows; i++) {
        TreeNode* curr = nodes[i + 1];

        if (indexes[i][0] != -1) {
            curr->left = (TreeNode*)malloc(sizeof(TreeNode));
            curr->left->data = indexes[i][0];             curr->left->left = NULL;             curr->left-
>right = NULL;
            nodes[indexes[i][0]] = curr->left;
        }

        if (indexes[i][1] != -1) {
            curr->right = (TreeNode*)malloc(sizeof(TreeNode));
            curr->right->data = indexes[i][1];             curr->right->left = NULL;             curr-
>right->right = NULL;
```

```
            nodes[indexes[i][1]] = curr->right;
        }
    }

    return root;
}

int** swapNodes(int indexes_rows, int indexes_columns, int** indexes, int queries_count, int*
queries, int* result_rows, int* result_columns) {
    int** result = (int*)malloc(queries_count * sizeof(int));
    *result_rows = queries_count;
    *result_columns = indexes_rows;

    TreeNode* root = buildTree(indexes_rows, indexes_columns, indexes);

    for (int i = 0; i < queries_count; i++) {
        int k = queries[i];
        swapSubtrees(root, k, 1);

        int* traversal = (int*)malloc(indexes_rows * sizeof(int));        int index = 0;
        inOrderTraversal(root, traversal, &index);
        result[i] = traversal;
    }

    return result;
}
```