VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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(1BM22CS208)

in partial fulfilment 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)
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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 Preeti T Korishettar **(1BM22CS208)**, who is a bonafied student of **B. M. S. College of Engineering**. It is in partial fulfilment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 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.

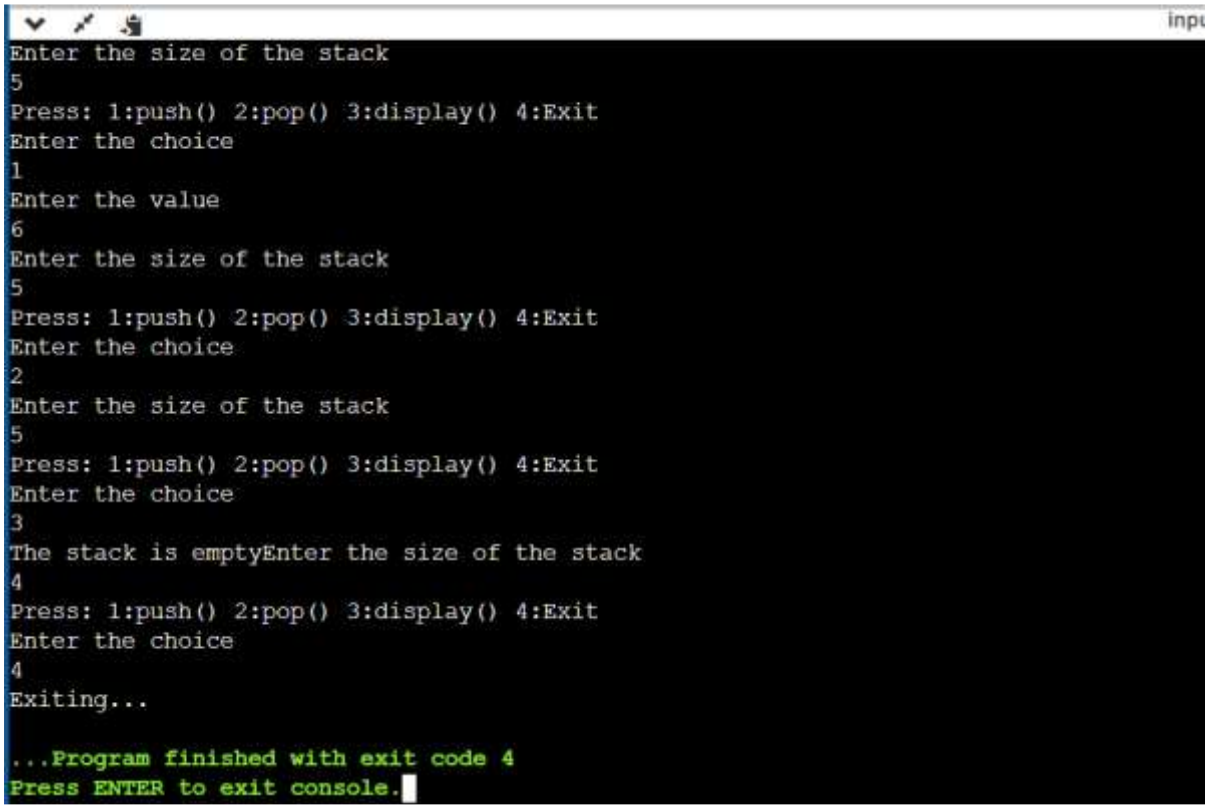
Lab program 1:

Write a program to simulate the working of stack using an array with the following:
a) Push
b) Pop
c) Display

```
#include <stdio.h>
int stack[100],i,n,ch=0,top=-1;
void push();
void pop();
void display();
void main()
{
while(ch!=4)
{
printf("Enter the size of the stack\n");
scanf("%d",&n);
printf("Press:\n1:push()\n2:pop()\n3:display()\n4:Exit\n");
printf("Enter the choice\n");
scanf("%d",&ch);
switch(ch)
{
case 1: push();
break;
case 2: pop();
break;
case 3:display();
break;
case 4:printf("Exiting...");
break;
default : printf("Press valid choice");
}
}
}
void push()
{
if(top==n)
{
printf("The stack is full\n");
}
else
```

```
{
int value;
printf("Enter the value\n");
scanf("%d",&value);
top=top+1;
stack[top]=value;
}
}
void pop()
{
if(top==-1)
{
printf("Underflow");
}
else
{
top=top-1;
}
}
void display()
{
if(top==-1)
{
printf("The stack is empty");
}
else
{
for(i=top;i>=0;i--)
printf("%d\n",stack[i]);
}
}
```

Output:



Lab program 2:

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

```
#include <stdio.h>

#include <string.h>

#include <ctype.h>

char st[100];

#define max 100

int top=-1;

char ele;

void push(char ele)

{
```

```
if(top== (max)-1)
{
printf("Stack is full");
}
else
{
top++;
st[top]=ele;
}
}
char pop()
{
if(top==-1)
{
printf("Stack is empty");
}
else
{
top=top-1;
return(st[top+1]);
}
}
char pre( char a)
{
if(a=='^')
{
return(5);
```

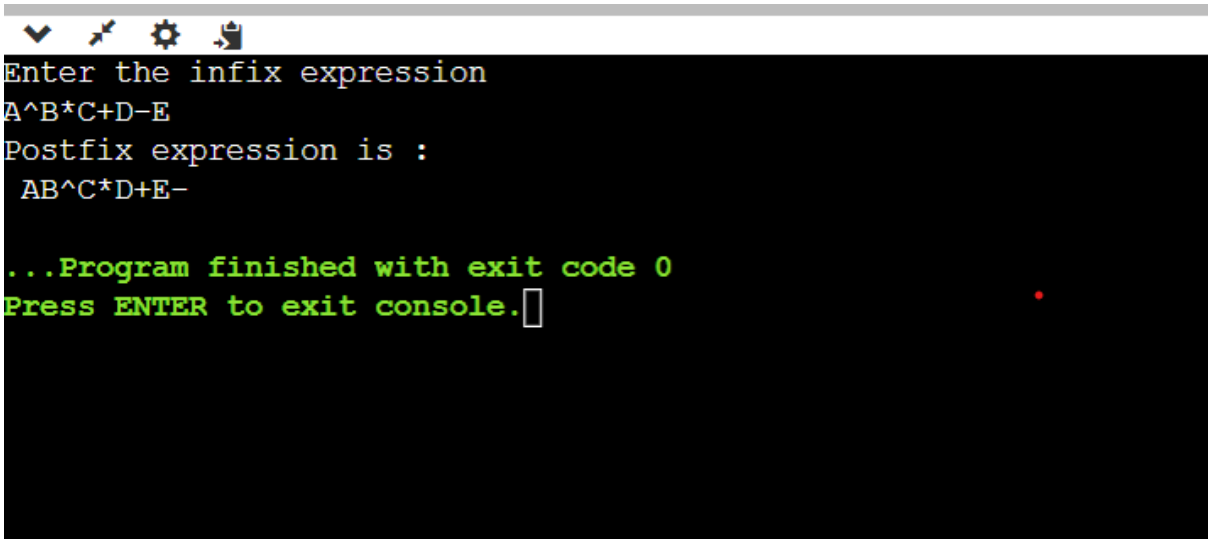
```
}
else if(a=='*')
{
return(4);
}
else if(a=='/')
{
return(3);
}
else if(a=='+')
{
return(2);
}
else if(a=='-')
{
return(1);
}
else
{
return(0);
}
}
int main()
{
char postfix[100];
char infix[100];
int i=0;
```

```
printf("Enter the infix expression\n");
scanf("%s",infix);
while(infix[i]!='\0')
{
if(isalpha(infix[i]))
{
postfix[i]=infix[i];
}
else if(infix[i]=='^'||infix[i]=='*'||infix[i]=='/'||infix[i]=='+'||infix[i]=='-')
{
if(pre(st[top])>pre(infix[i]))
{
postfix[i]=pop();
push(infix[i]);
}
else
{
push(infix[i]);
}
}
i++;
}
postfix[i]=st[top];
printf(“Postfix expression is : \n”);
for(i=0;i<=strlen(infix)+1;i++)
{
printf("%c",postfix[i]);
```

}

}

Output:



Output:

Lab program 3:

3a) WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display The program should print appropriate messages for queue empty and queue overflow conditions

```
#include <stdio.h>
int q[50],rear=-1,front=-1,max=50;
void enqueue();
void dequeue();
void display();
void main()
{
int ch;
printf("Press-1.insert, 2.delete, 3.Display and 4.Exit\n");
while(ch!=4)
{
printf("Enter choice:");
scanf("%d",&ch);
switch(ch){
case 1:
enqueue();
break;
case 2:
```

```
dequeue();
break;
case 3:
display();
break;
}
}
printf("Exited");
}
void enqueue()
{
int item;
if(rear==max-1)
printf("Queue overflow\n");
else
{ if(front==-1)
front=0;
printf("Insert an element:");
scanf("%d",&item);
rear+=1;
q[rear]=item;
}
}
void dequeue()
{
if(front==-1||front>rear)
printf("Queue underflow\n");
else
{
printf("Deleted element is:%d\n",q[front]);
front+=1;
}
}
void display()
{
int i;
if(front==-1)
printf("Queue is empty");
else
{
printf("Queue is:\n");
for(i=front;i<=rear;i++)
printf("%d\t",q[i]);
printf("\n");
}
}
```

Output:

```
Press-1.insert, 2.delete, 3.Display and 4.Exit
Enter choice:1
Insert an element:2
Enter choice:1
Insert an element:3
Enter choice:3
Queue is:
2       3
Enter choice:2
Deleted element is:2
Enter choice:4
Exited

...Program finished with exit code 0
Press ENTER to exit console.
```

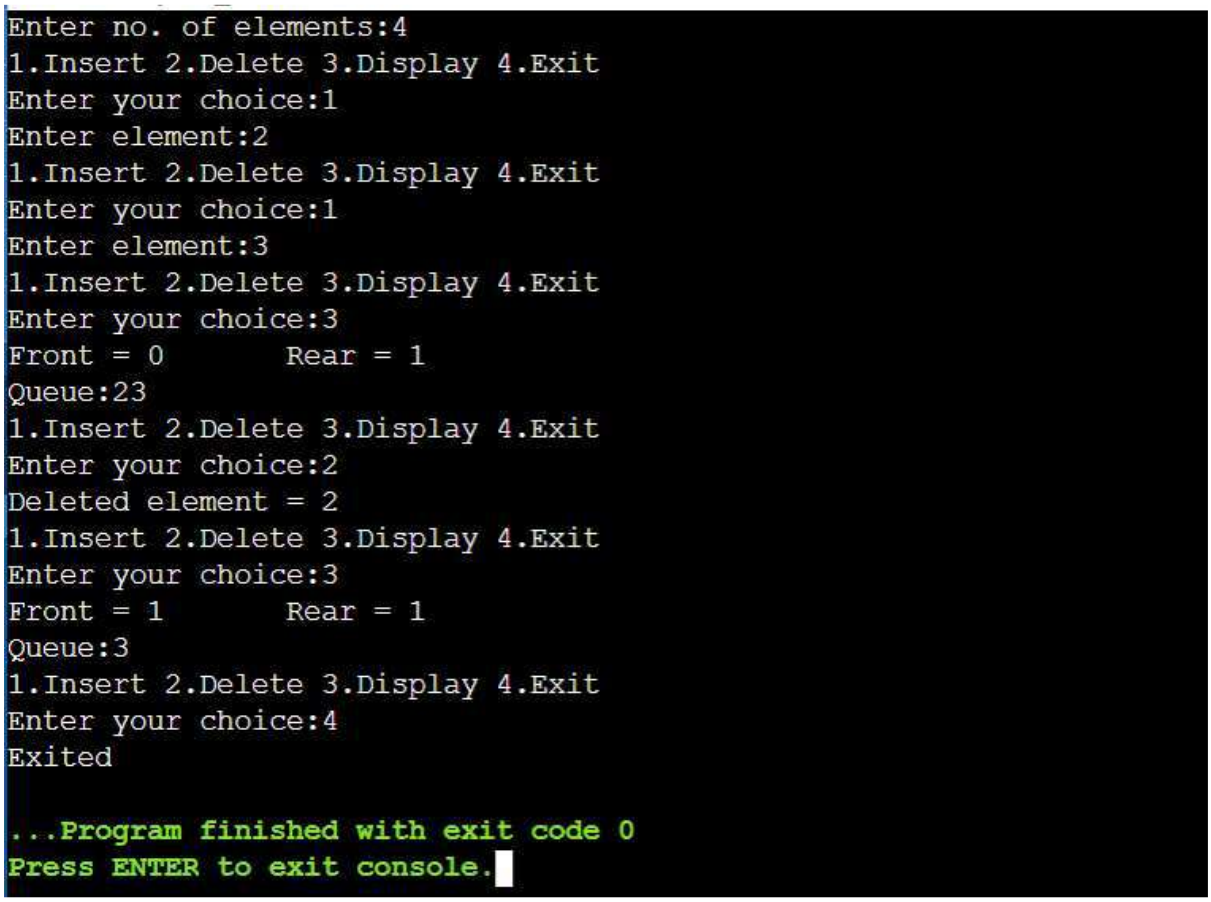
3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The program should print appropriate messages for queue empty and queue overflow conditions

```
#include <stdio.h>
int q[50],front=-1,rear=-1,size;
void display();
void enqueue();
void dequeue();
void main()
{
int ch;
printf("Enter no. of elements:");
scanf("%d",&size);
while(ch!=4)
{
printf("1.Insert 2.Delete 3.Display 4.Exit\n");
printf("Enter your choice:");
scanf("%d",&ch);
switch (ch)
{
case 1:
enqueue();
break;
case 2:
dequeue();
break;
case 3:
```

```
display();
break;
}
}
printf("Exited");
}
void enqueue()
{
int item;
if((front == rear+1)||(front==0 && rear==size-1))
printf("ueue is full\n");
else
{
if(front == -1)
front=0;
printf("Enter element:");
scanf("%d",&item);
rear=(rear + 1)%size;
q[rear] = item;
}
}
void dequeue()
{
int ele;
if(front==-1)
printf("Queue is empty\n");
else
{
ele = q[front];
if(front==rear)
{
front = -1;
rear = -1;
}
else
front = (front+1) % size;
printf("Deleted element = %d\n",ele);
}
}
void display()
{
int i;
if(front == -1)
printf("Queue is empty");
else
{
printf("Front = %d\t",front);
```

```
printf("Rear = %d\n",rear);
printf("Queue:");
for(i=front;i!=rear;i=(i+1)%size)
printf("%d",q[i]);
printf("%d\n",q[i]);
}
```

Output:



Lab program 4:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

b) Insertion of a node at first position, at any position and at end of list.

Display the contents of the linked list.

```
#include <stdio.h>
#include <stdlib.h>
void push();
```

```
void append();
void display();
void insert_at_pos();
struct node
{
int data;
struct node *next;
};
struct node *head=NULL;
void main()
{
int ch;
printf("\nEnter the choice\n1.Insert from beginning\n2.Insert at end\n3.Insert at particular
position\n4.Display\n5.Exit\n");
while(ch!=6)
{
printf("Enter the choice\n");
scanf("%d",&ch);
switch(ch)
{
case 1:
push();
break;
case 2:
append();
break;
case 3:
insert_at_pos();
break;
case 4:
display();
break;
case 5:exit(0);
default: printf("Invalid choise");
break;
}
}
}
void push()
{
int data;
struct node *new_node;
new_node=(struct node*)malloc(sizeof(struct node));
printf("Enter the data to be inserted\n");
scanf("%d",&data);
new_node->data=data;
new_node->next=head;
head=new_node;
}
void append()
{
```

```
int data;
struct node *last=head;
struct node *new_node;
new_node=(struct node*)malloc(sizeof(struct node));
printf("Enter the data\n");
scanf("%d",&data);
new_node->data=data;
new_node->next=NULL;
if(head==NULL)
{
head=new_node;
return;
}
while(last->next!=NULL)
{
last=last->next;
}
last->next=new_node;
}
void insert_at_pos()
{
int data,i;
int pos;
struct node *temp=head;
struct node *new_node;
struct node *temp1;
new_node = (struct node*) malloc(sizeof(struct node));
printf("Enter the data to be inserted\n");
scanf("%d",&data);
new_node->data=data;
printf("enter the position\n");
scanf("%d",&pos);
if(pos==1)
{
new_node->next=temp;
head=new_node;
}
else
{
for(i=2;i<pos-1;i++)
{
temp=temp->next;
}
Temp1=temp->next;
new_node->next=temp1;
temp->next=new_node;
}
}
void display()
{
struct node *p=head ;
```

```
printf("The queue element\n");
while(p!=NULL)
{
printf("%d->",p->data);
p=p->next;
}
}
```

Output:

```
Enter the choice
1.Insert from beginning
2.Insert at end
3.Insert at particular position
4.Display
5.Exit
Enter the choice
1
Enter the data to be inserted
1
Enter the choice
2
Enter the data
2
Enter the choice
3
Enter the data to be inserted
3
enter the position
2
Enter the choice
4
The queue element
1->3->2->Enter the choice
5


...Program finished with exit code 0
Press ENTER to exit console.
```

Program – Leetcode-1 platform(Minstack)

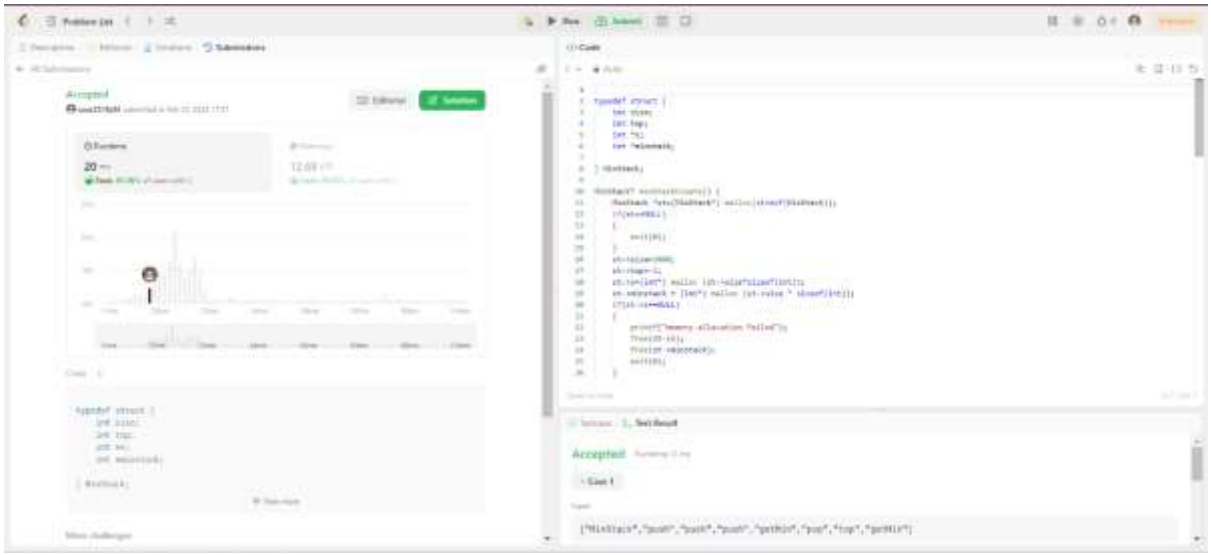
```
typedef struct {
    int size;
    int top;
    int *s;
    int *minstack;

} 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:

WAP to Implement Singly Linked List with following operations

a) Create a linked list.

b) Deletion of first element, specified element and last element in the list.

c) Display the contents of the linked list.

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

```
{
int data;
struct node *next;
};
struct node *head=NULL;
void dbegin()
{
struct node*ptr;
if(head==NULL)
{
printf("List is empty\n");
}
else
{
ptr=head;
head=head->next;
free(ptr);
printf("First element is deleted\n");
}
}
void dend()
{
struct node*ptr;
struct node*ptr1;
if(head==NULL)
```

```
{
printf("List is empty\n");
}
else if(head->next==NULL)
{
free(head);
}
else
{
ptr=head;
while(ptr->next!=NULL)
{
ptr1=ptr;
ptr=ptr->next;
}
free(ptr);
ptr1->next=NULL;
printf("Element at the end is deleted\n");
}
}
void dpos()
{
struct node*ptr;
struct node*ptr1;
int pos,i;
```

```
printf("Enter the position from which data to be deleted\n");
scanf("%d",&pos);
ptr=head;
if(head==NULL)
{
printf("List is empty\n");
}
else if(head->next==NULL)
{
free(head);
}
for(i=0;i<pos;i++)
{
ptr1=ptr;
ptr=ptr->next;
}
ptr1->next=ptr->next;
free(ptr);
printf("Element at the position %d is deleted\n",pos);
}
void display()
{
struct node *node=head;
if(head==NULL)
{
```

```
printf("List is empty\n");
}
else
{
while(node!=NULL)
{
printf("%d->",node->data);
node=node->next;
}
printf("\n");
}
}
void main()
{
int n,i,data;
printf("Enter the number of elements in linked list\n");
scanf("%d",&n);
printf("Enter the data to be inserted\n");
for(i=0;i<n;i++)
{
struct node *last=head;
struct node *new_node;
new_node=(struct node*)malloc(sizeof(struct node));
scanf("%d",&data);
new_node->data=data;
```

```
new_node->next=NULL;
if(head==NULL)
{
head=new_node;
}
else
{
while(last->next!=NULL)
{
last=last->next;
}
last->next=new_node;
}
}
int ch;
printf("Enter\n 1:Delete from beginning\n 2:Delete at the end\n 3:Delete at particular
position\n 4:Display elements\n 5:Exit\n");
while(ch!=5)
{
printf("Enter your choice\n");
scanf("%d",&ch);
switch(ch)
{
case 1:dbegin();
break;
```

```
case 2:dend();

break;

case 3:dpos();

break;

case 4:display();

break;

}

}

}
```

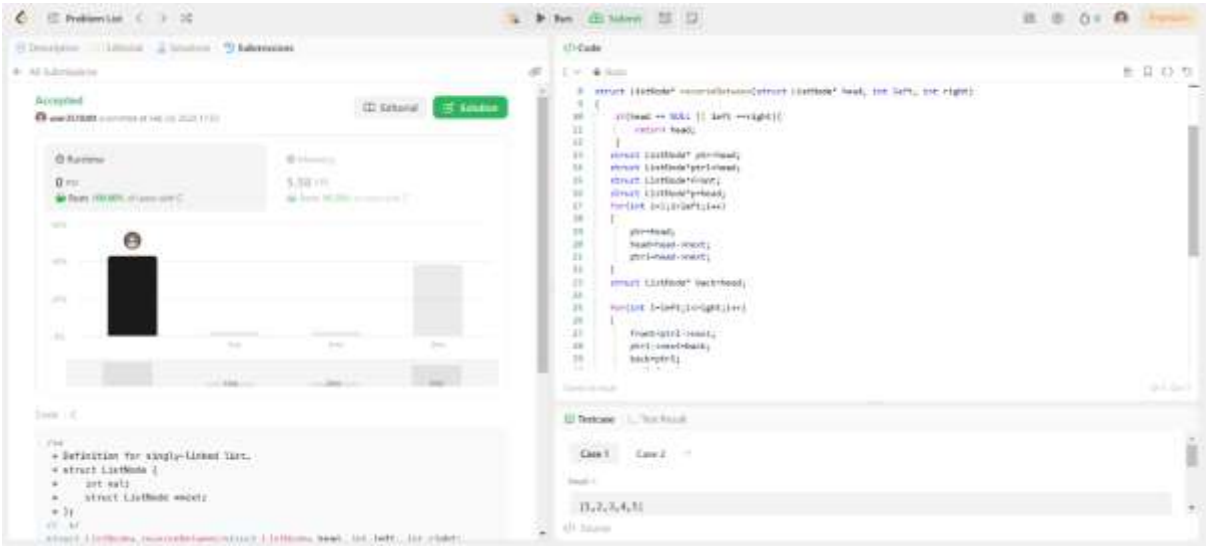
Ouput:

```
Enter the number of elements in linked list
4
Enter the data to be inserted
1
2
3
4
Enter
 1:Delete from beginning
 2:Delete at the end
 3:Delete at particular position
 4:Display elements
 5:Exit
Enter your choice
1
First element is deleted
Enter your choice
2
Element at the end is deleted
Enter your choice
4
2->3->
Enter your choice
3
Enter the position from which data to be deleted
1
Element at the position 1 is deleted
Enter your choice
4
2->
Enter your choice
5

Process returned 5 (0x5)   execution time : 38.157 s
Press any key to continue.
```

Program – Leetcode-2 platform(Reversing List)

```
/**
 * 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;
}
```

Output:



Lab program 6:

6a) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

```
#include <stdio.h>

#include <stdlib.h>


struct node

{

   int data;

   struct node *next;

};


struct node *head1=NULL;

struct node *head2=NULL;

void linklist1()

{

   int n,i,data;
```

```
    printf("Enter the number of elements in linked list\n");
    scanf("%d",&n);
    printf("Enter the elements to be inserted for first linked list\n");
    for(i=0;i<n;i++)
    {
    struct node *last1=head1;
    struct node *new_node1;
    new_node1=(struct node*)malloc(sizeof(struct node));
    scanf("%d",&data);
    new_node1->data=data;
    new_node1->next=NULL;
    if(head1==NULL)
    {
       head1=new_node1;
    }
    else
    {
    while(last1->next!=NULL)
    {
       last1=last1->next;
    }
    last1->next=new_node1;
    }
    }
}
```

```
void linklist2()
{
   int n,i,data;
   printf("Enter the number of elements in linked list\n");
   scanf("%d",&n);
   printf("Enter the elements to be inserted for second linked list\n");
   for(i=0;i<n;i++)
   {
   struct node *last2=head2;
   struct node *new_node2;
   new_node2=(struct node*)malloc(sizeof(struct node));
   scanf("%d",&data);
   new_node2->data=data;
   new_node2->next=NULL;
   if(head2==NULL)
   {
      head2=new_node2;
   }
   else
   {
   while(last2->next!=NULL)
   {
      last2=last2->next;
   }
   last2->next=new_node2;
```

```
    }
    }
}
void sort()
{
    struct node *curr = head1;
    struct node *ptr = NULL;
    int temp;
    while(curr != NULL)
    {
        ptr = curr->next;
        while(ptr !=NULL)
        {
            if(curr->data > ptr->data)
            {
                temp = curr->data;
                curr->data=ptr->data;
                ptr->data=temp;
            }

            ptr = ptr->next;
        }
        curr = curr->next;
    }
    display();
```

```
}
void reverse()
{
   struct node* prev=NULL;
   struct node* ptr=NULL;
   while(head1!=NULL)
   {
      ptr=head1->next;
      head1->next=prev;
      prev=head1;
      head1=ptr;
   }
   head1=prev;
   display();
}
void concate()
{
   struct node*temp=head1;
   if(head1==NULL)
   {
     struct node *node=head2;
      while(node!=NULL)
      {
         printf("%d->",node->data);
```

```
            node=node->next;
        }
        printf("\n");
    }
    else
    {
        while(temp->next!=NULL)
        {
            temp=temp->next;
        }
        temp->next=head2;
    }
    struct node *node=head1;
        while(node!=NULL)
        {
            printf("%d->",node->data);
            node=node->next;
        }
        printf("\n");
}
void display()
{
    struct node *node=head1;
    if(head1==NULL)
    {
```

```
        printf("List is empty\n");
    }
    else
    {
        while(node!=NULL)
        {
            printf("%d->",node->data);
            node=node->next;
        }
        printf("\n");
    }
}
void main()
{
    printf("First list\n");
    linklist1();
    printf("Implementation of sort\n");
    printf("Elements after sorting are\n");
    sort();
    printf("Implementation of reversing linked list\n ");
    printf("Elements after reversing the linked list are\n");
    reverse();
    printf("Implementation of concatenation\n");
    linklist2();
    printf("Elements after concatenation are\n");
```

```
    concate();
    printf("All operations are done\n");

}
```

Output:

```
First list
Enter the number of elements in linked list
3
Enter the elements to be inserted for first linked list
3
2
1
Implementation of sort
Elements after sorting are
1->2->3->
Implementation of reversing linked list
 Elements after reversing the linked list are
3->2->1->
Implementation of concatenation
Enter the number of elements in linked list
3
Enter the elements to be inserted for second linked list
3
2
1
Elements after concatenation are
3->2->1->3->2->1->
All operations are done

Process returned 0 (0x0)   execution time : 10.145 s
Press any key to continue.
```

6b) WAP to Implement Single Link List to simulate Stack & Queue Operations.

Queue using LL:

```
#include <stdio.h>

#include <stdlib.h>


struct node

{
```

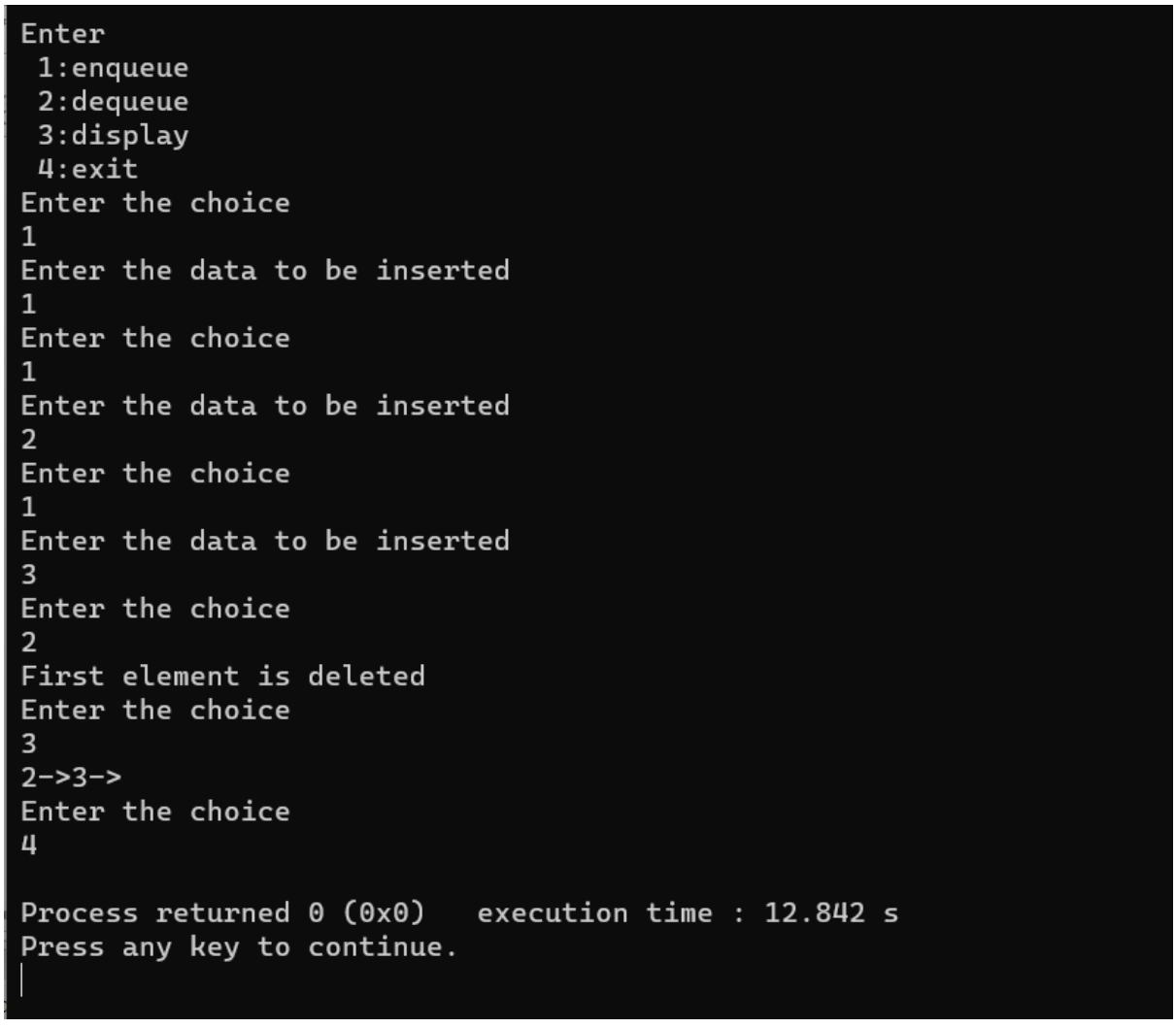
```
    int data;
    struct node *next;
};

struct node *head=NULL;
void enqueue()
{
    int i,data;
    printf("Enter the data to be inserted\n");
    struct node *last=head;
    struct node *new_node;
    new_node=(struct node*)malloc(sizeof(struct node));
    scanf("%d",&data);
    new_node->data=data;
    new_node->next=NULL;
    if(head==NULL)
    {
        head=new_node;
    }
    else
    {
    while(last->next!=NULL)
    {
        last=last->next;
    }
```

```
    last->next=new_node;
    }
}
void dequeue()
{
    struct node*ptr;
    if(head==NULL)
    {
        printf("List is empty\n");
    }
    else
    {
        ptr=head;
        head=head->next;
        free(ptr);
        printf("First element is deleted\n");
    }
}
void display()
{
    struct node *node=head;
    if(head==NULL)
    {
        printf("List is empty\n");
    }
```

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

void main()
{
    int ch;
    printf("Enter\n 1:enqueue \n 2:dequeue \n 3:display \n 4:exit\n");
    while(ch!=4)
    {
    printf("Enter the choice\n");
    scanf("%d",&ch);
        switch(ch)
    {
        case 1:enqueue();
        break;
        case 2:dequeue();
        break;
```

```
        case 3:display();
        break;
        case 4:exit(0);
    }
    }
}
```

Output:



Stack using LL:

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

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

struct node *head=NULL;
void push()
{
   int i,data;
   printf("Enter the data to be inserted\n");
   struct node *last=head;
   struct node *new_node;
   new_node=(struct node*)malloc(sizeof(struct node));
   scanf("%d",&data);
   new_node->data=data;
   new_node->next=NULL;
   if(head==NULL)
   {
      head=new_node;
```

```
    }
    else
    {
    while(last->next!=NULL)
    {
       last=last->next;
    }
    last->next=new_node;
    }
}
void pop()
{
    struct node*ptr;
    struct node*ptr1;
    if(head==NULL)
    {
       printf("List is empty\n");
    }
    else if(head->next==NULL)
    {
       free(head);
    }
    else
    {
```

```
        ptr=head;
        while(ptr->next!=NULL)
        {
            ptr1=ptr;
            ptr=ptr->next;
        }
        free(ptr);
        ptr1->next=NULL;
        printf("Element at the end is deleted\n");
    }
}
void display()
{
    struct node *node=head;
    if(head==NULL)
    {
        printf("List is empty\n");
    }
    else
    {
        while(node!=NULL)
        {
            printf("%d->",node->data);
            node=node->next;
```

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

void main()
{
    int ch;
    printf("Enter 1:pop \n 2:push \n 3:display \n 4:exit\n");
    while(ch!=4)
    {
    printf("Enter the choice\n");
    scanf("%d",&ch);
        switch(ch)
    {
        case 1: pop();
        break;
        case 2:push();
        break;
        case 3:display();
        break;
        case 4:exit(0);
    }
    }
```

}

Output:

```
Enter 1:pop
 2:push
 3:display
 4:exit
Enter the choice
2
Enter the data to be inserted
1
Enter the choice
2
Enter the data to be inserted
2
Enter the choice
2
Enter the data to be inserted
3
Enter the choice
1
Element at the end is deleted
Enter the choice
3
1->2->
Enter the choice
4

Process returned 0 (0x0)   execution time : 33.039 s
Press any key to continue.
```

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 <ctype.h>

struct node
```

```
{
    int val;
    struct node * prev;
    struct node * next;
};
struct node *head=NULL;
void insert_left()
{
   int pos;
   struct node* ptr1=head;
   printf("Enter the position to the left of which the data to be inserted\n");
   scanf("%d",&pos);
   struct node*new_node = (struct node*)malloc(sizeof(struct node));
   printf("Enter the value to be inserted\n");
   scanf("%d",&new_node->val);

   if(head==NULL)
   {
      head=new_node;
      head->prev=NULL;
      head->next=NULL;
   }
   else if(pos==1)
   {
      new_node->next=head;
```

```
        new_node->prev=NULL;
        head->prev=new_node;
        head=new_node;
    }
    else
    {
    for(int i=0;i<pos-1;i++)
    {
        ptr1=ptr1->next;
    }
    new_node->prev=ptr1->prev;
    new_node->next=ptr1;
    ptr1->prev->next=new_node;
    ptr1->prev=new_node;
    }
}
void delete_pos()
{
    int data;
    struct node* ptr=head;
    printf("Enter the data to be deleted\n");
    scanf("%d",&data);
    if(ptr->val==data)
    {
      head=head->next;
```

```
    free(ptr);
    printf("Deleted\n");
    return;
   }
   else
  {
   while(ptr->val!=data)
   {
      ptr=ptr->next;
      if(ptr->next==NULL)
      {
         ptr->prev->next=NULL;
         free(ptr);
         printf("deleted\n");
         return;
      }
   }
   ptr->next->prev=ptr->prev;
   ptr->prev->next=ptr->next;
   head=ptr;
   printf("Deleted");
  }
}
void display()
{
```

```
  struct node*p=head;
  while(p!=NULL)
  {
     printf("%d->",p->val);
     p=p->next;
  }
}
void main()
{
   int ch;
   printf("Enter:\n 1:insert\n 2:delete\n 3:display \n 4:exit\n ");
   while(ch!=4)
   {
      printf("Enter your choice\n");
      scanf("%d",&ch);
      switch(ch)
      {
         case 1:insert_left();
         break;
         case 2:delete_pos();
         break;
         case 3:display();
         break;
      }
   }
```

}

Output:

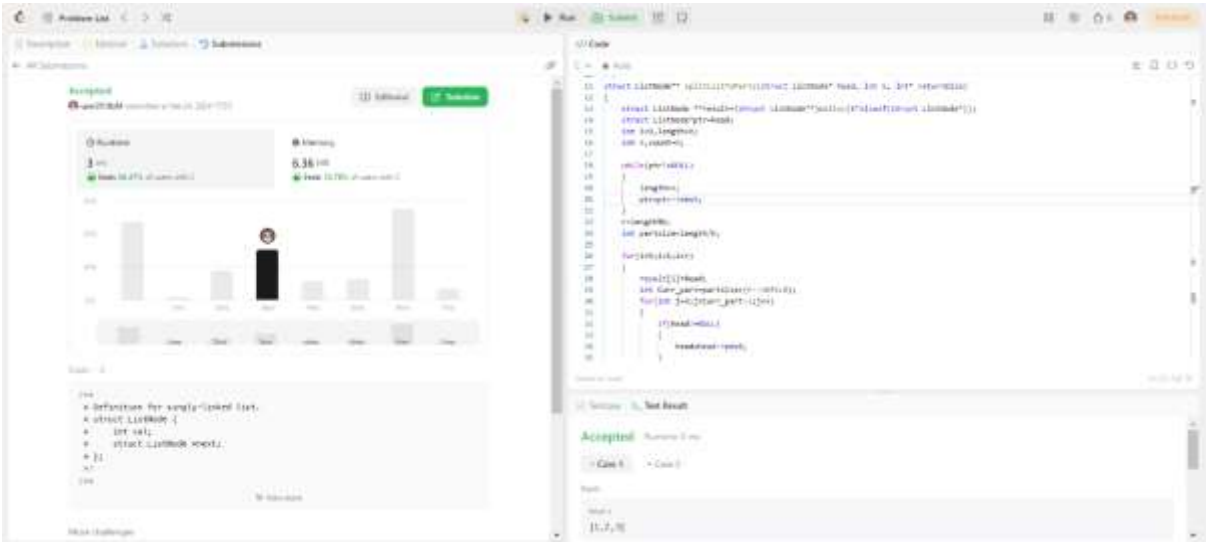
```
Enter:
 1:insert
 2:delete
 3:display
 4:exit
 Enter your choice
1
Enter the position to the left of which the data to be inserted
1
Enter the value to be inserted
1
Enter your choice
1
Enter the position to the left of which the data to be inserted
1
Enter the value to be inserted
2
Enter your choice
1
Enter the position to the left of which the data to be inserted
1
Enter the value to be inserted
3
Enter your choice
3
3->2->1->Enter your choice
1
Enter the position to the left of which the data to be inserted
2
Enter the value to be inserted
4
Enter your choice
3
3->4->2->1->Enter your choice
2
Enter the data to be deleted
3
Deleted
Enter your choice
3
4->2->1->Enter your choice
4

Process returned 4 (0x4)   execution time : 51.935 s
Press any key to continue.
```

Program – Leetcode-3 platform(Spliting Linked list)

```
**
 * 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:



Lab program 8:

Write a program

a) To construct a binary Search tree.
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>
#include <stdlib.h>

struct node
{
   int data;
   struct node* left;
   struct node*right;
};
struct node*root=NULL;

void create()
{
   struct node* new_node=(struct node*)malloc(sizeof(struct node));
   printf("Enter the data to be inserted\n");
   scanf("%d",&new_node->data);
   struct node*ptr=root;
   struct node*ptr1;
   new_node->left=NULL;
```

```
    new_node->right=NULL;

    if(root==NULL)
    {
       root=new_node;
    }
    else
    {
       while(ptr->left!=NULL || ptr->right!=NULL)
       {
          if(new_node->data > ptr->data)
          {
             if(ptr->right!=NULL)
             {
               ptr=ptr->right;
             }
             else
             {
                break;
             }
          }
          else
          {
             if(ptr->left!=NULL)
             {
               ptr=ptr->left;
             }
             else
             {
                break;
             }
          }
       }
       if(new_node->data > ptr->data)
       {
         ptr->right=new_node;
       }
       else
       {
          ptr->left=new_node;
       }
    }
}
```

```
void pre_order(struct node*ptr)
{
   struct node* trav=ptr;
   if(ptr!=NULL)
   {
      printf("%d",ptr->data);
      pre_order(ptr->left);
      pre_order(ptr->right);
   }
}

void inorder(struct node*ptr)
{
   struct node* trav=ptr;
   if(ptr!=NULL)
   {
      inorder(ptr->left);
      printf("%d",ptr->data);
      inorder(ptr->right);
   }
}

void post_order(struct node*ptr)
{
   struct node* trav=ptr;
   if(ptr!=NULL)
   {
      post_order(ptr->left);
      post_order(ptr->right);
      printf("%d",ptr->data);
   }
}


void main()
{
   printf("Enter\n 1.Create\n 2.Pre-order\n 3.In-order\n 4.post-order\n 5.EXIT\n");
   int ch;
   do{
      printf("Enter your choice\n");
      scanf("%d",&ch);
      switch(ch)
      {
         case 1:create();
```

```
        break;
        case 2:pre_order(root);
        break;
        case 3:inorder(root);
        break;
        case 4:post_order(root);
        break;
      }
   }while(ch!=5);
}
```

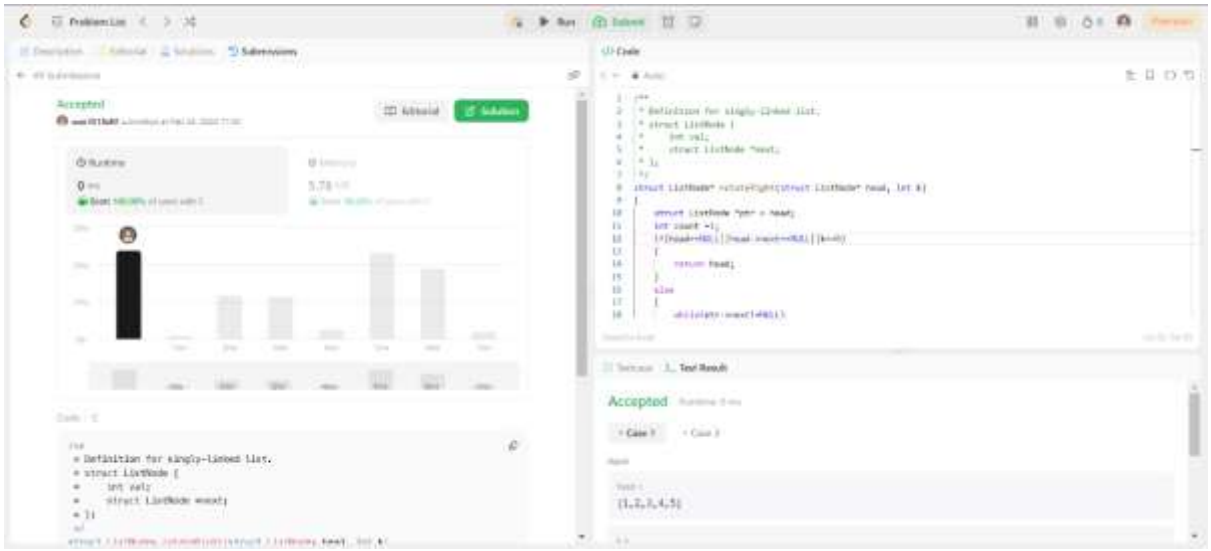
Output:

```
Enter
 1.Create
 2.Pre-order
 3.In-order
 4.post-order
 5.EXIT
Enter your choice
1
Enter the data to be inserted
4
Enter your choice
1
Enter the data to be inserted
6
Enter your choice
1
Enter the data to be inserted
1
Enter your choice
1
Enter the data to be inserted
3
Enter your choice
1
Enter the data to be inserted
5
Enter your choice
3
13456Enter your choice
2
41365Enter your choice
4
31564Enter your choice
5

Process returned 5 (0x5)   execution time : 39.138 s
Press any key to continue.
```

Program – Leetcode-4 platform(Rotating Linked list)

```
/**
 * 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:



Lab program 9:

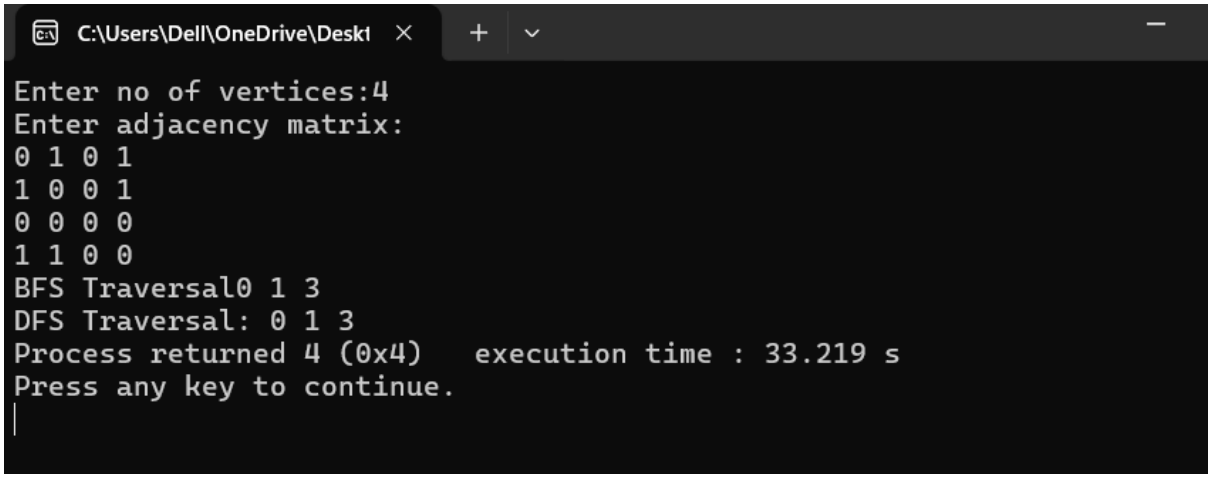
9a) Write a program to traverse a graph using BFS method.

```
#include<stdio.h>

int queue[100];
int front=0,rear=0;
//int n=6;

int a[10][10];
void enqueue(int var)
{
   queue[rear] = var;
   rear++;
}
void dequeue()
{
   front++;
}

void bfs(int n)
{
   int visited[10] = {0};
   enqueue(0);
   visited[0] = 1;
   while(front != rear)
   {
      int current = queue[front];
```

```
        printf("%d ", current);
        dequeue();
        for(int i=0;i<n;i++)
        {
            if((a[current][i] == 1) && (visited[i] == 0))
            {
                visited[i] = 1;
                enqueue(i);
            }
        }
    }
}


void dfs(int a[][10], int n, int start , int visited2[10]) {

   visited2[start] = 1;
   printf("%d ", start);

   for(int i=0; i<n; i++) {
      if(a[start][i] && !visited2[i]) {
         dfs(a,n,i,visited2);
      }
   }
}
void main()
{
    int n;
    int start=0;
    int visited2[10];
    printf("Enter no of vertices:");
    scanf("%d",&n);
    printf("Enter adjacency matrix:\n");
    for(int i=0;i<n;i++)
    {
        for(int j=0;j<n;j++)
            scanf("%d",&a[i][j]);
    }
    bfs(n);
   for(int i = 0; i < 10; ++i) {
      visited2[i] = 0;
   }

   printf("\nDFS Traversal: ");
```

```
   dfs(a, n, start,visited2);

   //dfs(a,n,start);
}
```

Output:



9b) Write a program to check whether given graph is connected or not using DFS method.

```
#include<stdio.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");

}
```

Output:

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

Process returned 0 (0x0)   execution time : 21.626 s
Press any key to continue.
```

Hacker rank-1

```
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;
}
```

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>
#define TABLE_SIZE 10 // 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;
}
```

Output:

```
Hash Table:
Index 0: Empty
Index 1: Empty
Index 2: Empty
Index 3: Empty
Index 4: Key 1234
Index 5: Empty
Index 6: Empty
Index 7: Empty
Index 8: Key 5678
Index 9: Empty

Employee found with key 1234

Process returned 0 (0x0)   execution time : 0.798 s
Press any key to continue.
```