VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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in partial fulfilment 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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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 202324. 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:

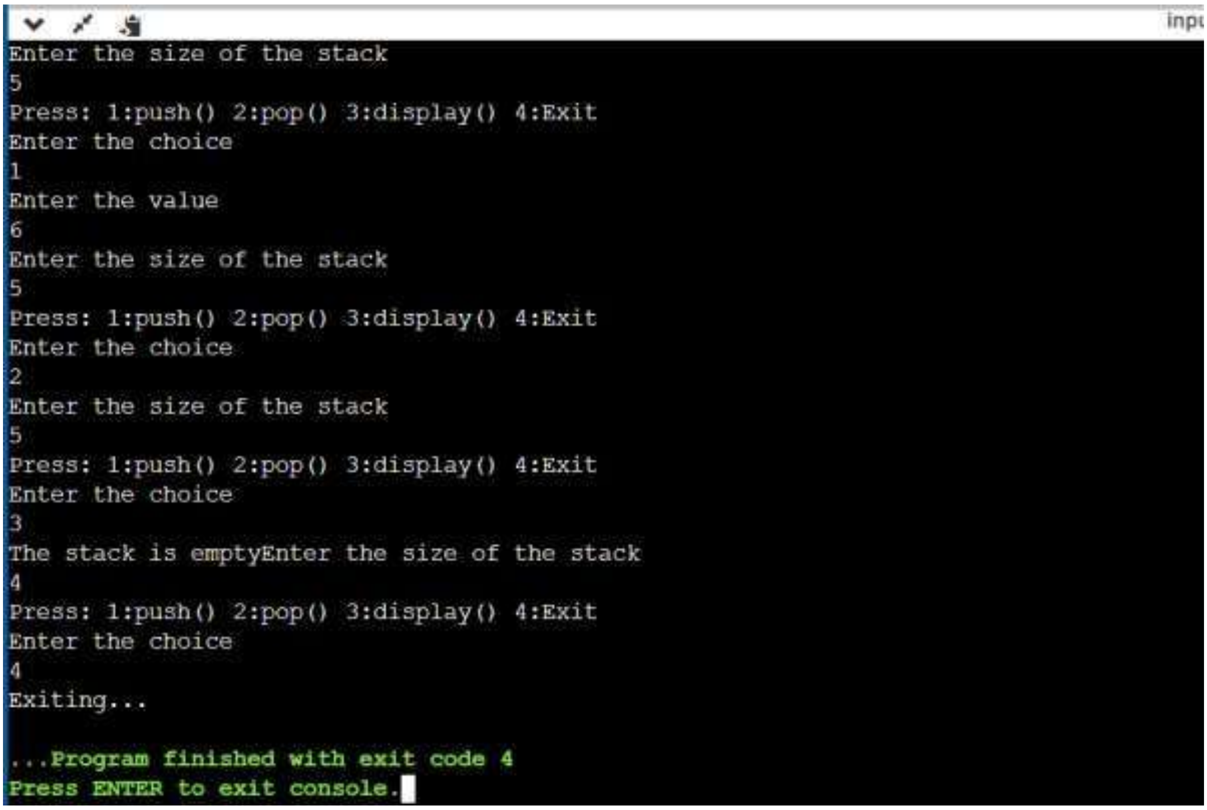
CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations 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
("Ent
er the
value
\n");
scanf
("%d
",&v
alue);
top=t
op+1
;
stack
[top]
=valu
e;
} } 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:



```
Enter the size of the stack
5
Press: 1:push() 2:pop() 3:display() 4:Exit
Enter the choice
1
Enter the value
6
Enter the size of the stack
5
Press: 1:push() 2:pop() 3:display() 4:Exit
Enter the choice
2
Enter the size of the stack
5
Press: 1:push() 2:pop() 3:display() 4:Exit
Enter the choice
3
The stack is emptyEnter the size of the stack
4
Press: 1:push() 2:pop() 3:display() 4:Exit
Enter the choice
4
Exiting...

...Program finished with exit code 4
Press ENTER to exit console.
```

Lab program 2:

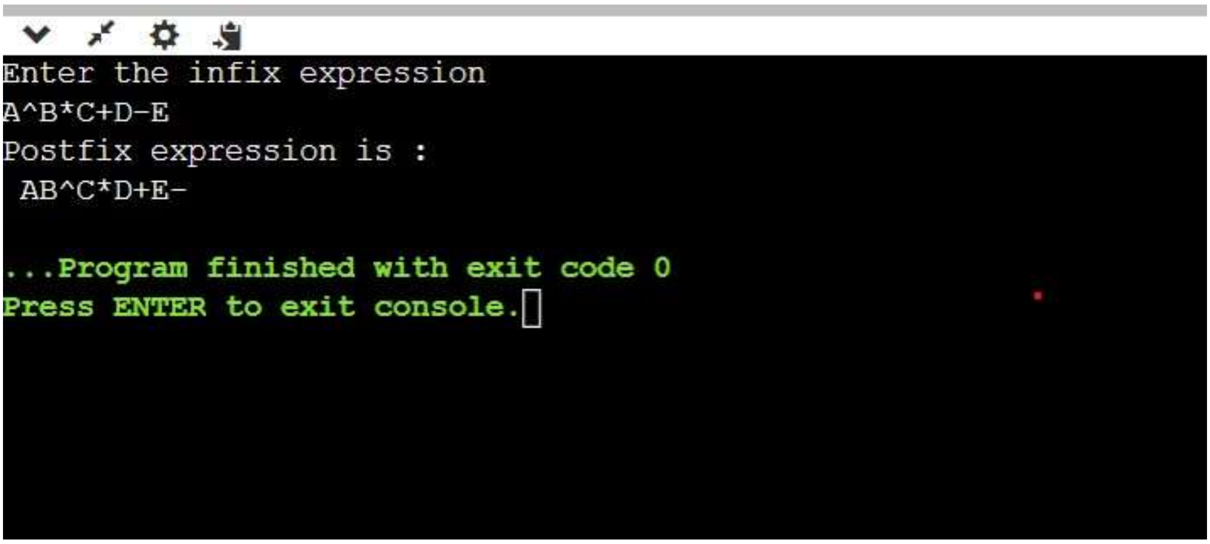
WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and /(divide)

```
#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:



```
Enter the infix expression
A^B*C+D-E
Postfix expression is :
 AB^C*D+E-

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

Output:

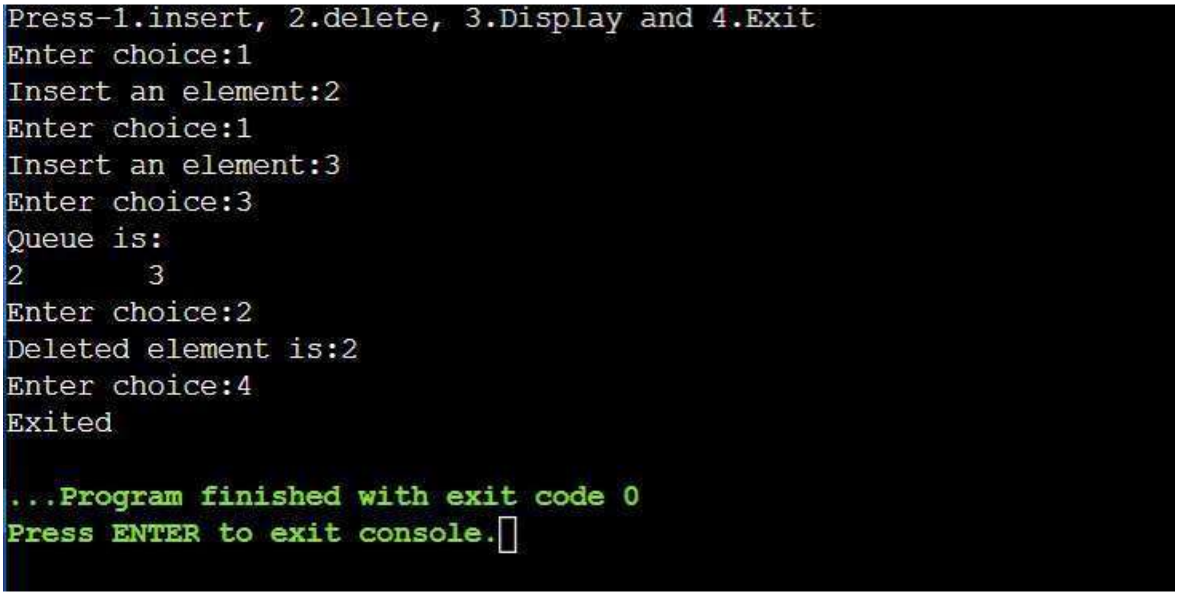
Lab program 3:

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.
```

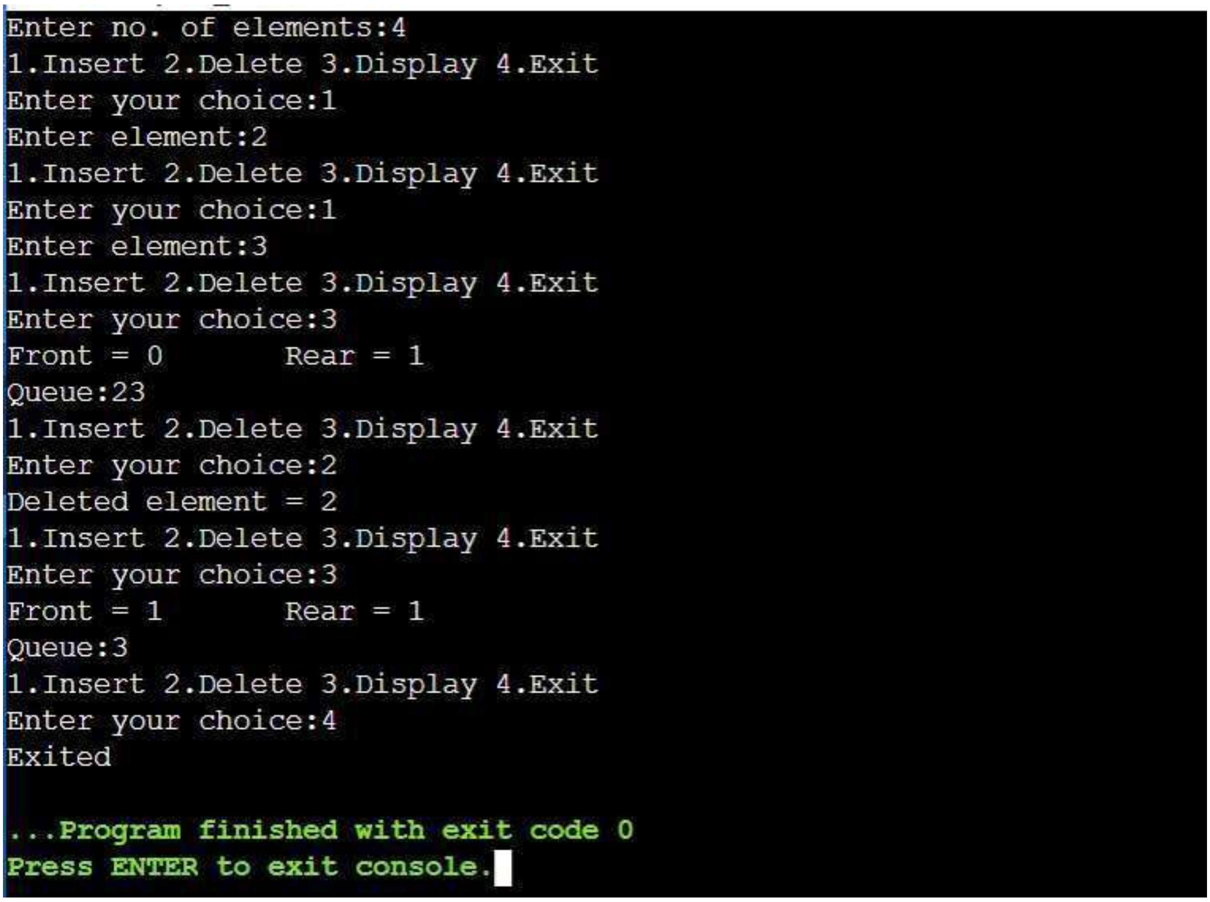
3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete &amp; Display The program should print appropriate messages for queue empty and queue overflow conditions

```
#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:



```
Enter no. of elements:4
1.Insert 2.Delete 3.Display 4.Exit
Enter your choice:1
Enter element:2
1.Insert 2.Delete 3.Display 4.Exit
Enter your choice:1
Enter element:3
1.Insert 2.Delete 3.Display 4.Exit
Enter your choice:3
Front = 0       Rear = 1
Queue:23
1.Insert 2.Delete 3.Display 4.Exit
Enter your choice:2
Deleted element = 2
1.Insert 2.Delete 3.Display 4.Exit
Enter your choice:3
Front = 1       Rear = 1
Queue:3
1.Insert 2.Delete 3.Display 4.Exit
Enter your choice:4
Exited

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

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.

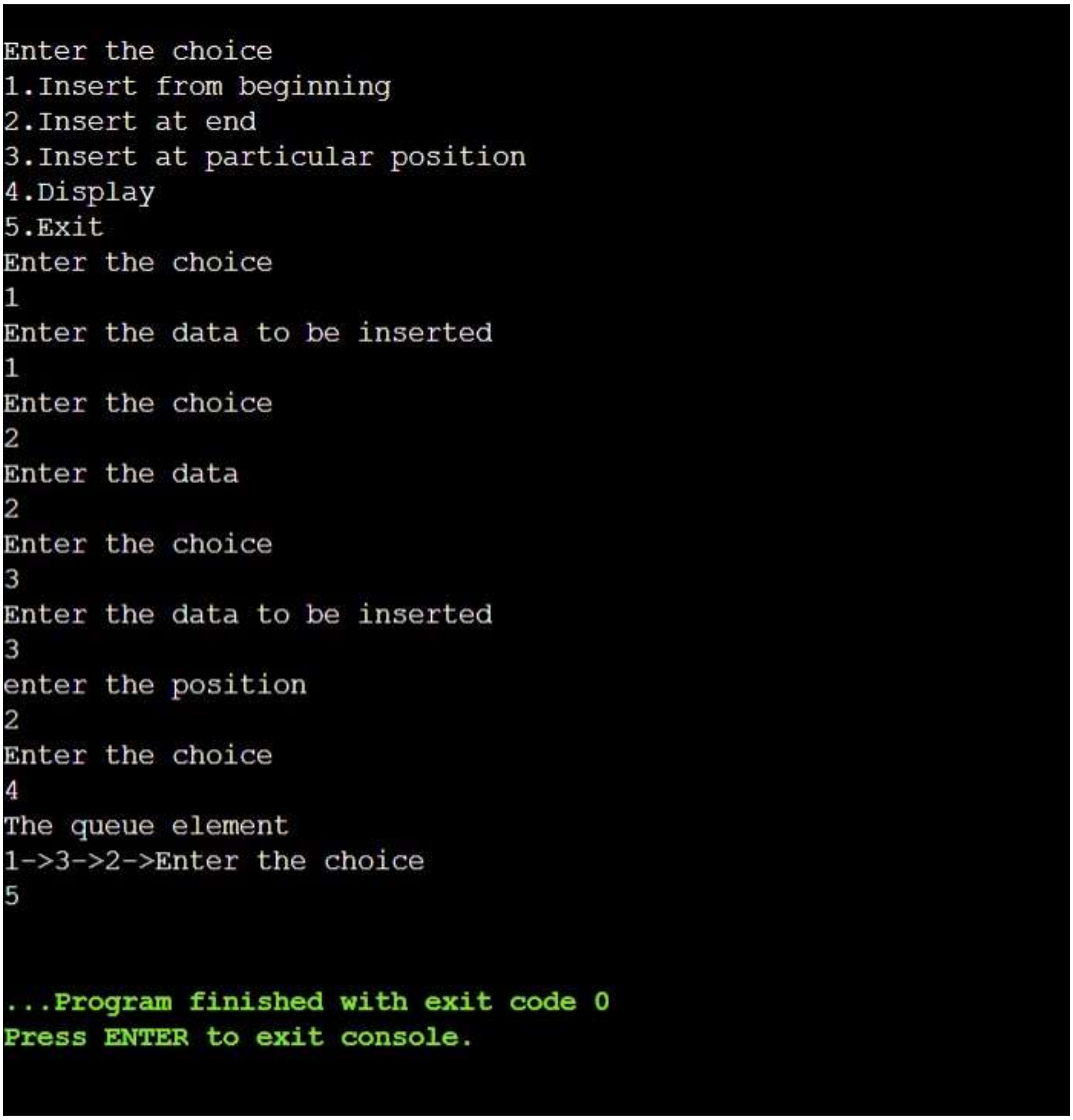
```
#include <stdio.h>
#include <stdlib.h> void
push();
```

```
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.
```

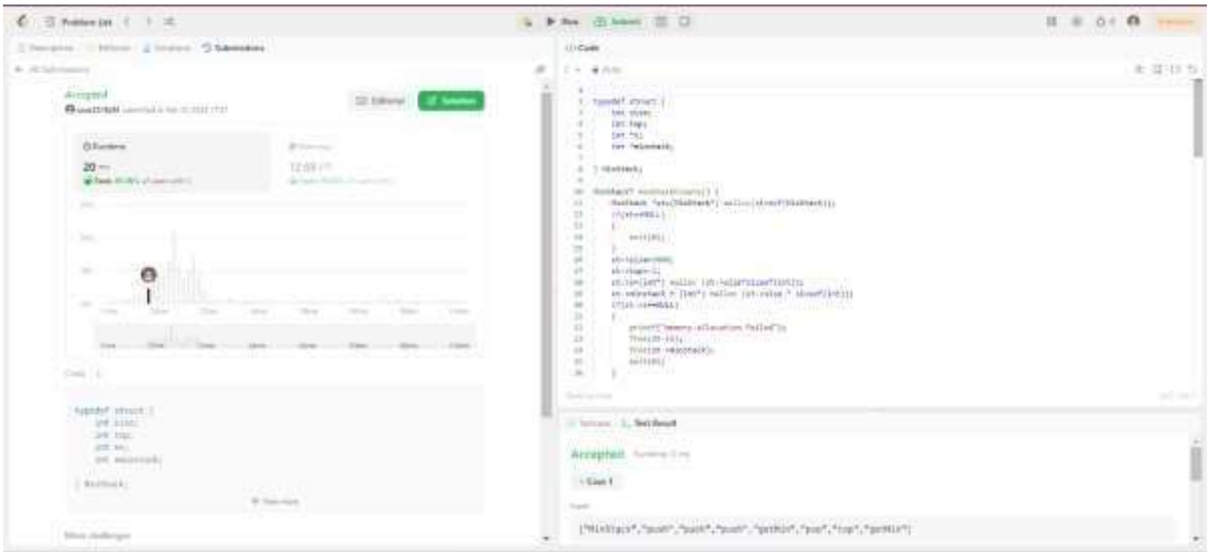
Program – Leetcode-1 platform(Minstack)

```
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:



Accepted

Runtime

20 ms

```
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);
    }
```

Accepted Runtime: 0 ms

Case 1

```
["MinStack","push","push","push","getMin","pop","top","getMin"]
```

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.

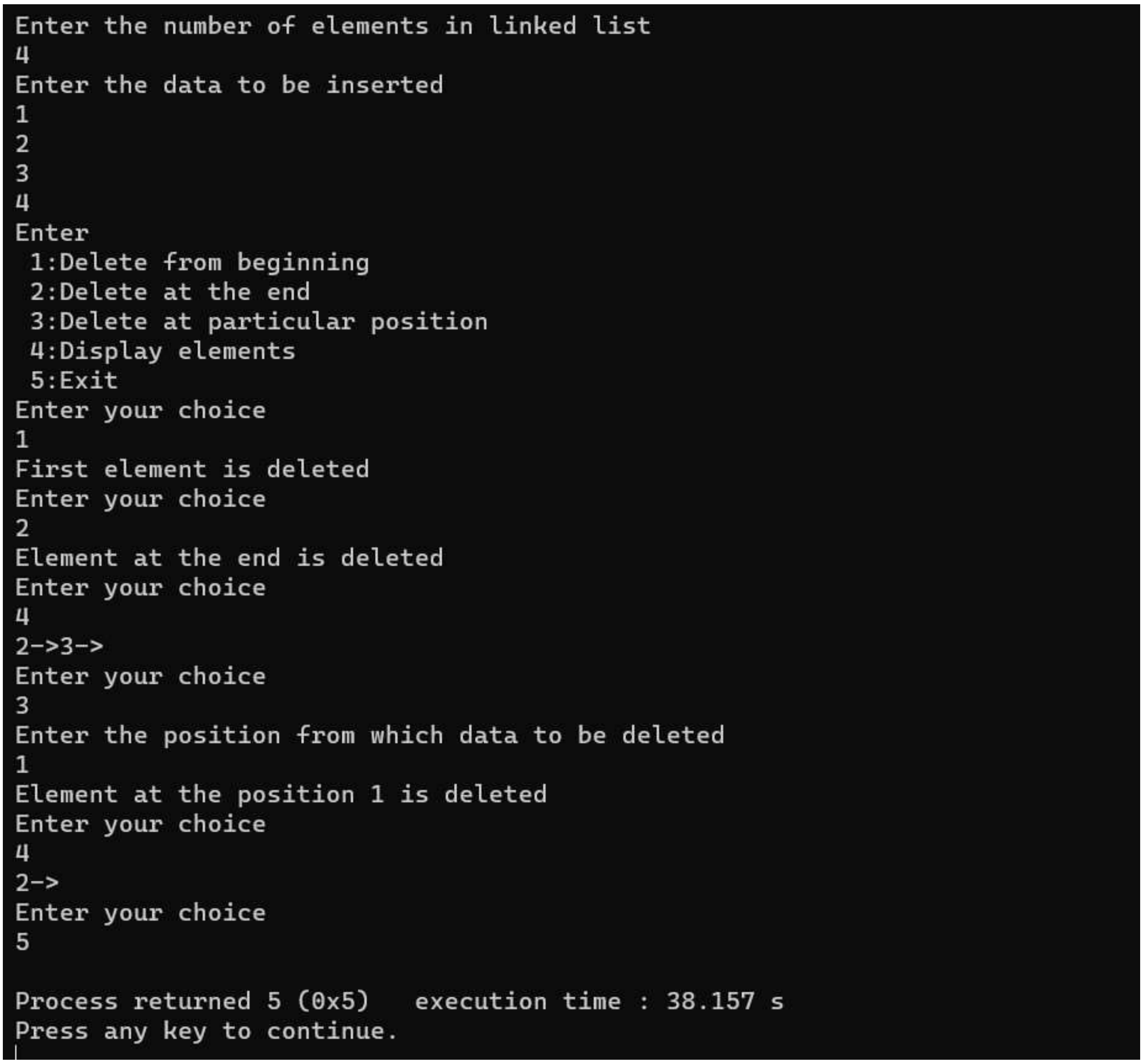
```
#include <stdio.h>

#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",&po
s); 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:



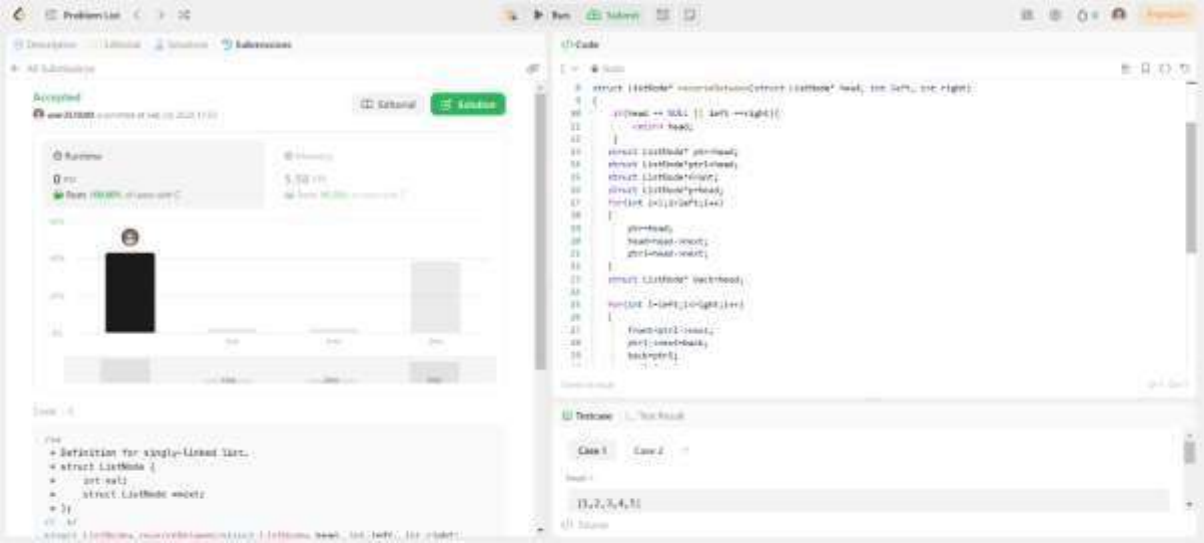
```
Enter the number of elements in linked list
4
Enter the data to be inserted
1
2
3
4
Enter
 1:Delete from beginning
 2:Delete at the end
 3:Delete at particular position
 4:Display elements
 5:Exit
Enter your choice
1
First element is deleted
Enter your choice
2
Element at the end is deleted
Enter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



Accepted

Runtime

0 ms

Memory

5.58 MB

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* reverseBetween(struct ListNode* head, int left, int right)
```

```
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;
```

head =

[1,2,3,4,5]

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)
```

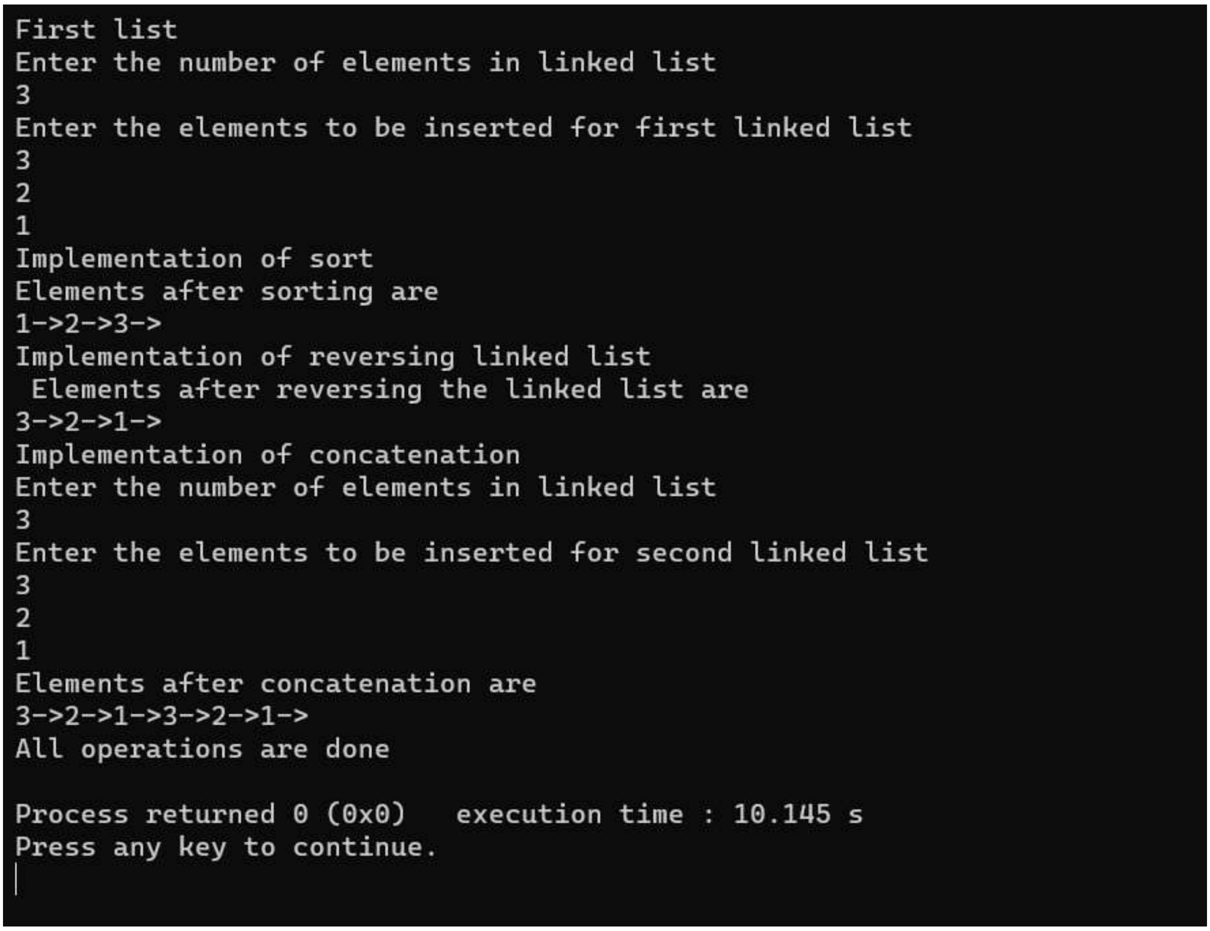
```
            {                  temp = curr-
>data;                  curr-
>data=ptr->data;                  ptr-
>data=temp;
            }


            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 &amp; Queue Operations.

Queue using LL:

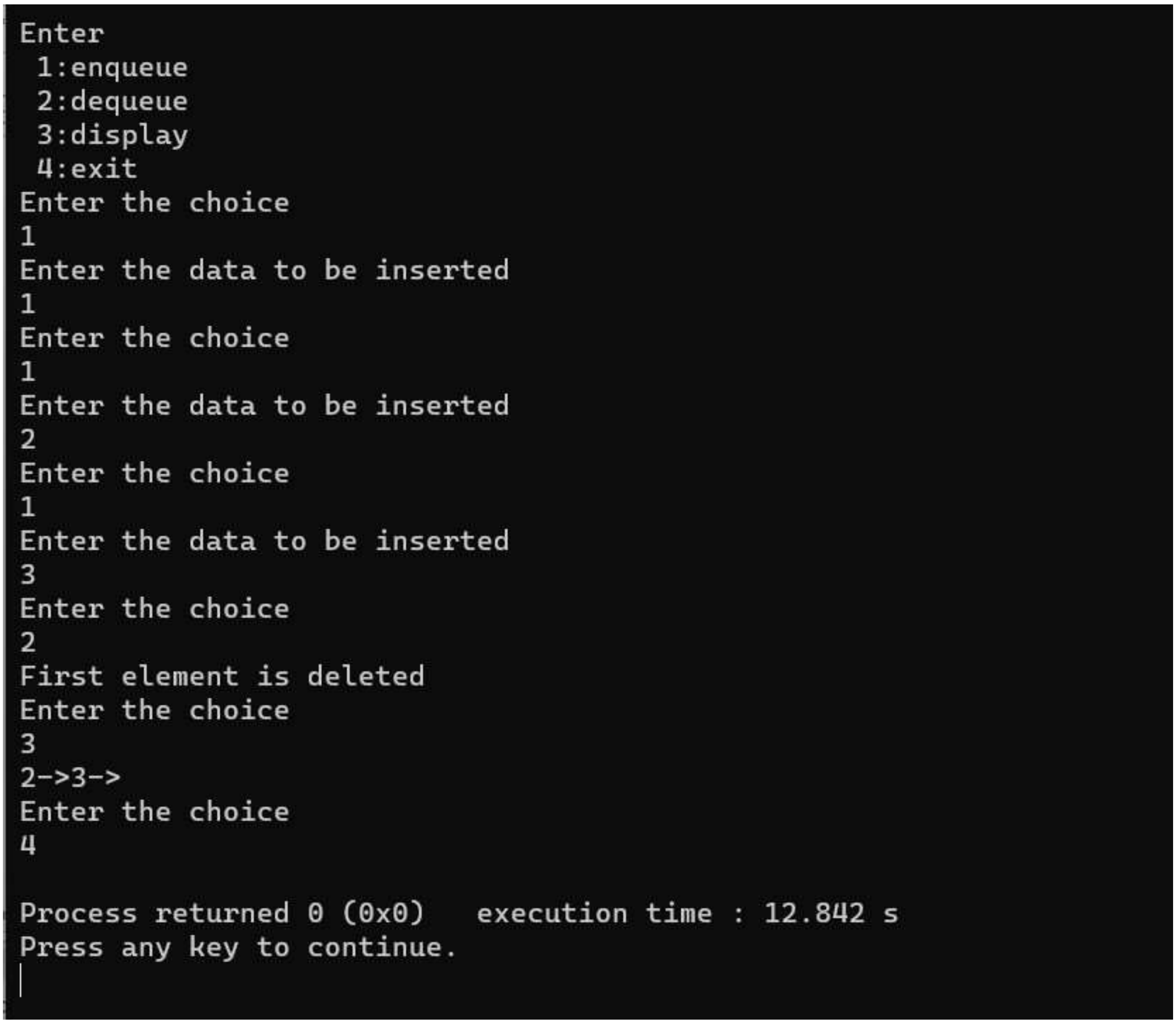
```
#include <stdio.h>

#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:



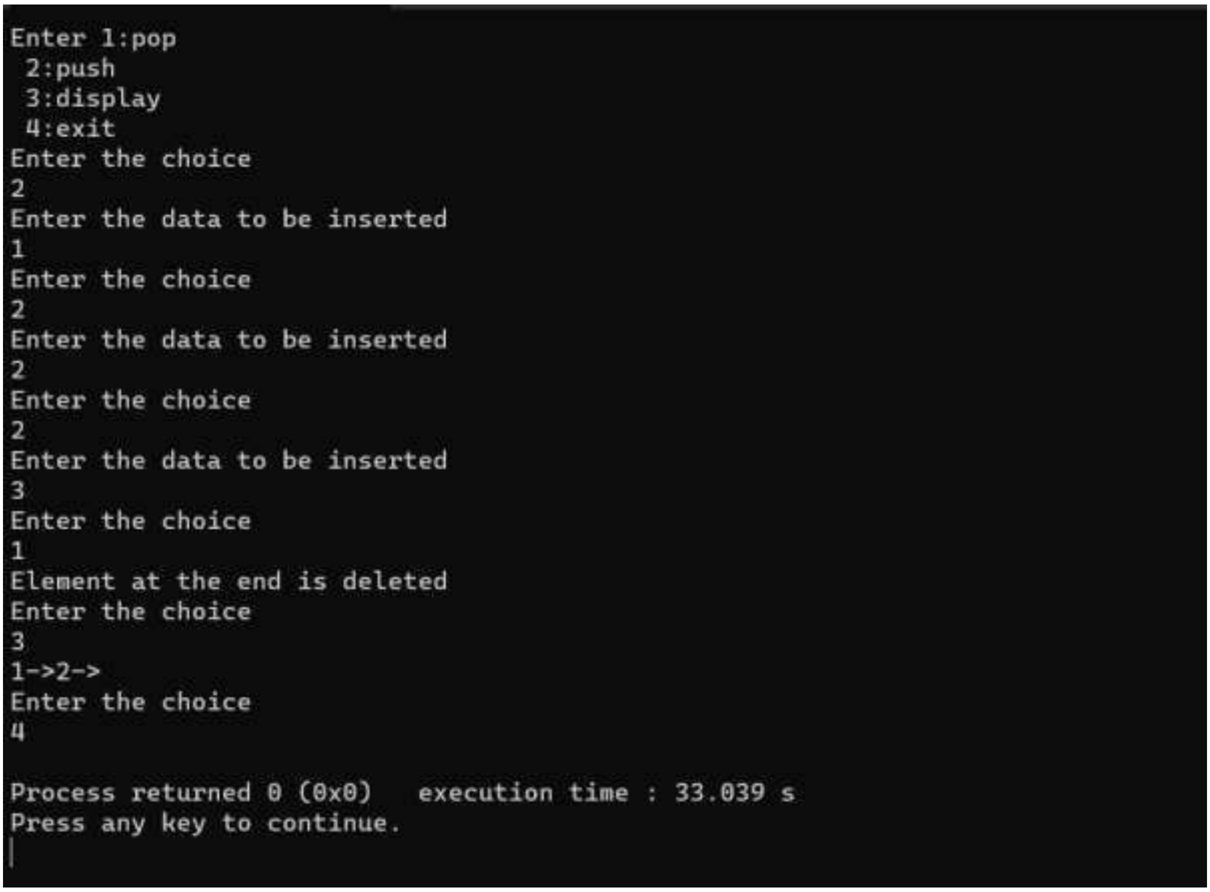
```
Enter
 1:enqueue
 2:dequeue
 3:display
 4:exit
Enter the choice
1
Enter the data to be inserted
1
Enter the choice
1
Enter the data to be inserted
2
Enter the choice
1
Enter the data to be inserted
3
Enter the choice
2
First element is deleted
Enter the choice
3
2->3->
Enter the choice
4

Process returned 0 (0x0)   execution time : 12.842 s
Press any key to continue.
```

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

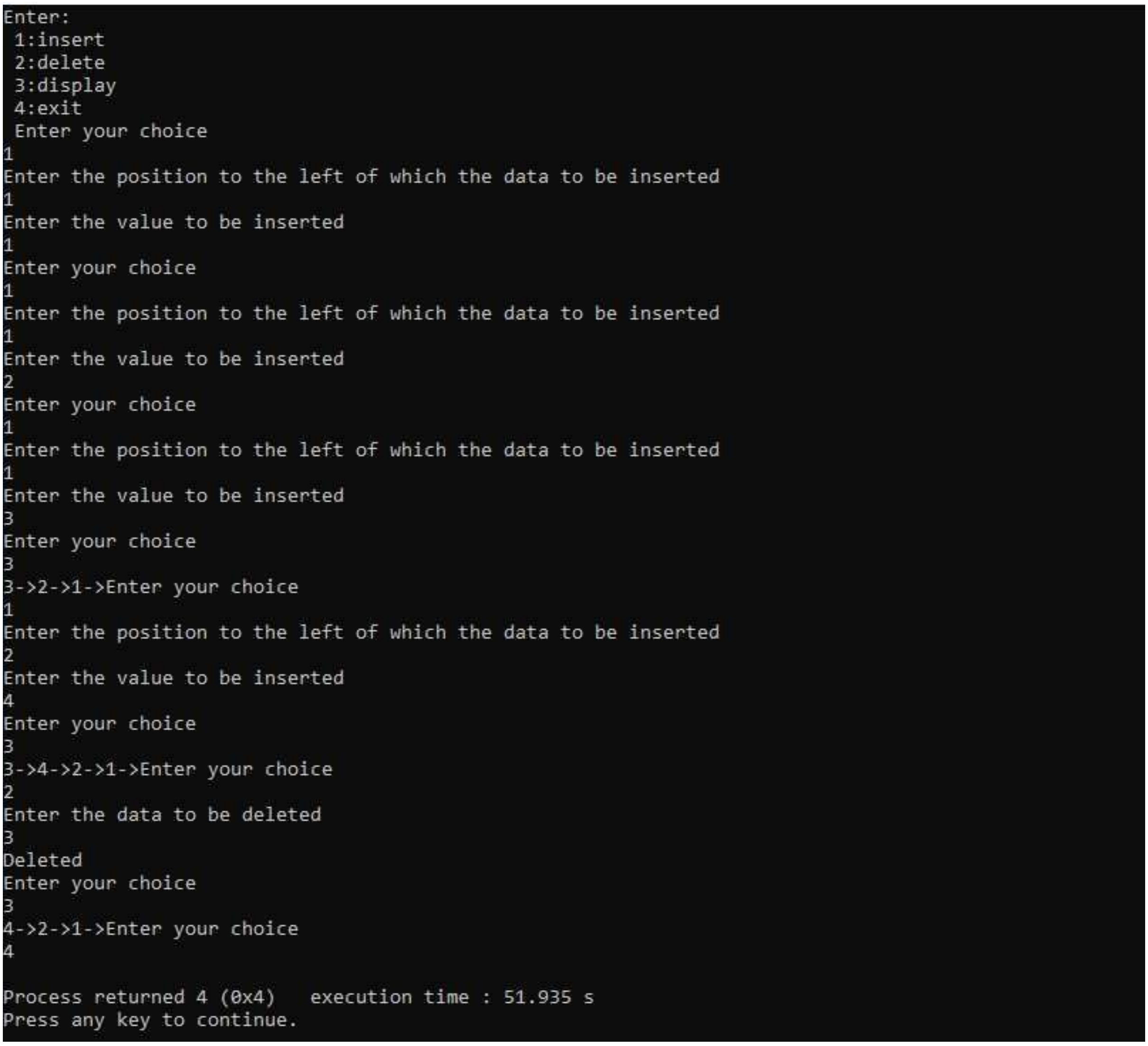
d) Display the contents of the list

```
#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:



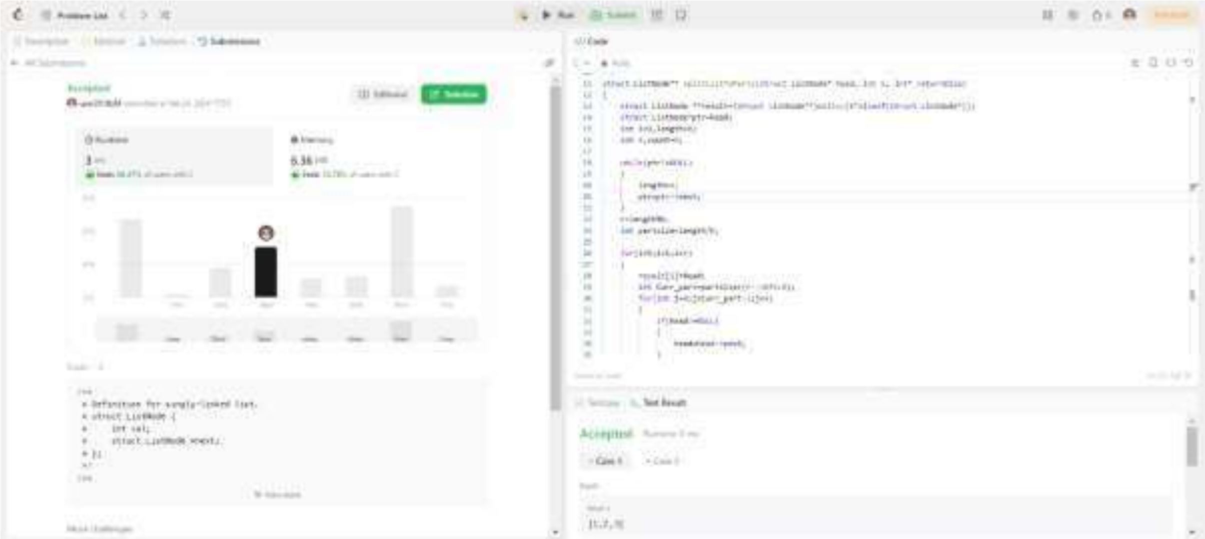
```
Enter:
 1:insert
 2:delete
 3:display
 4:exit
 Enter your choice
1
Enter the position to the left of which the data to be inserted
1
Enter the value to be inserted
1
Enter your choice
1
Enter the position to the left of which the data to be inserted
1
Enter the value to be inserted
2
Enter your choice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



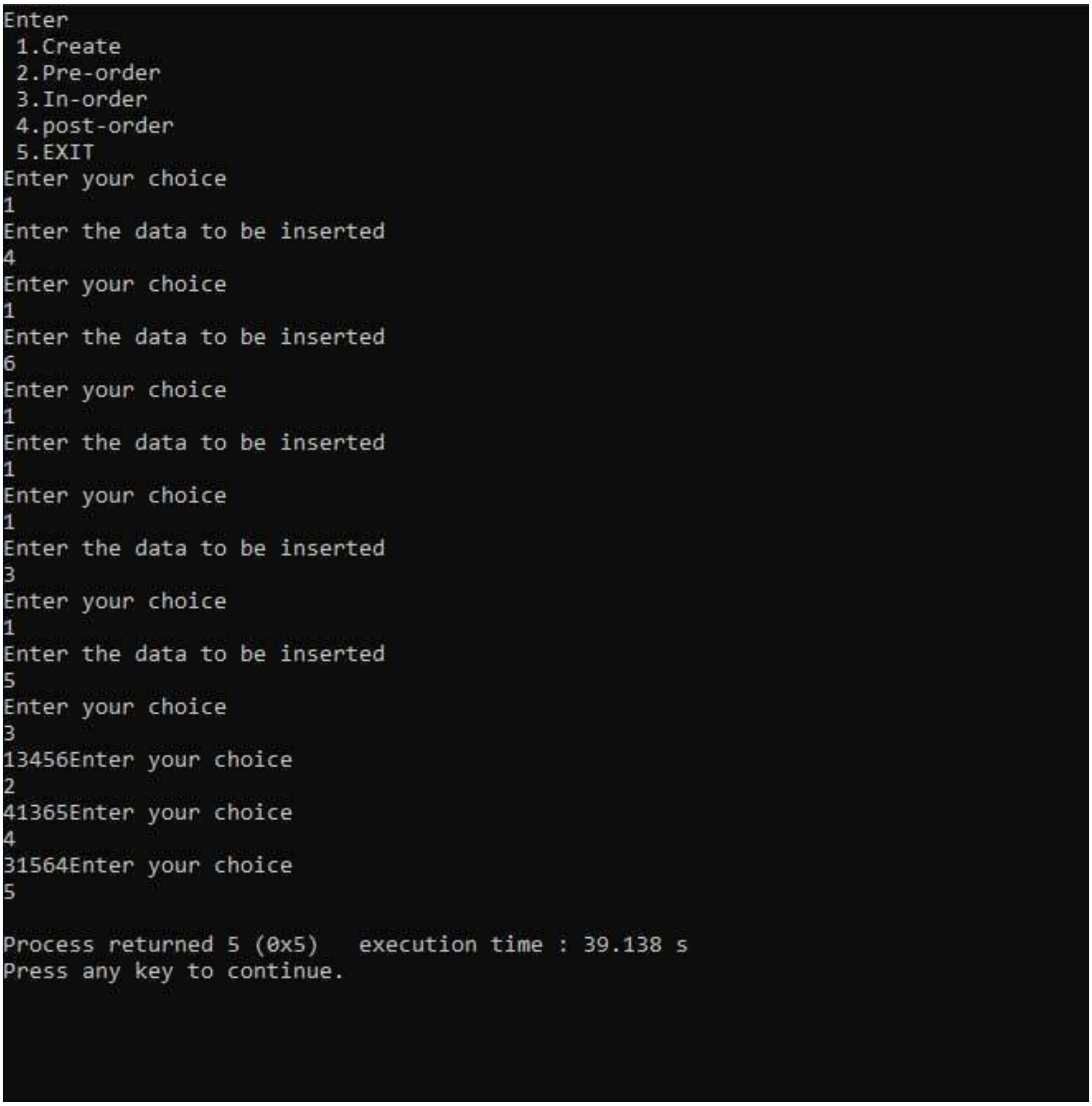
Lab program 8:

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:



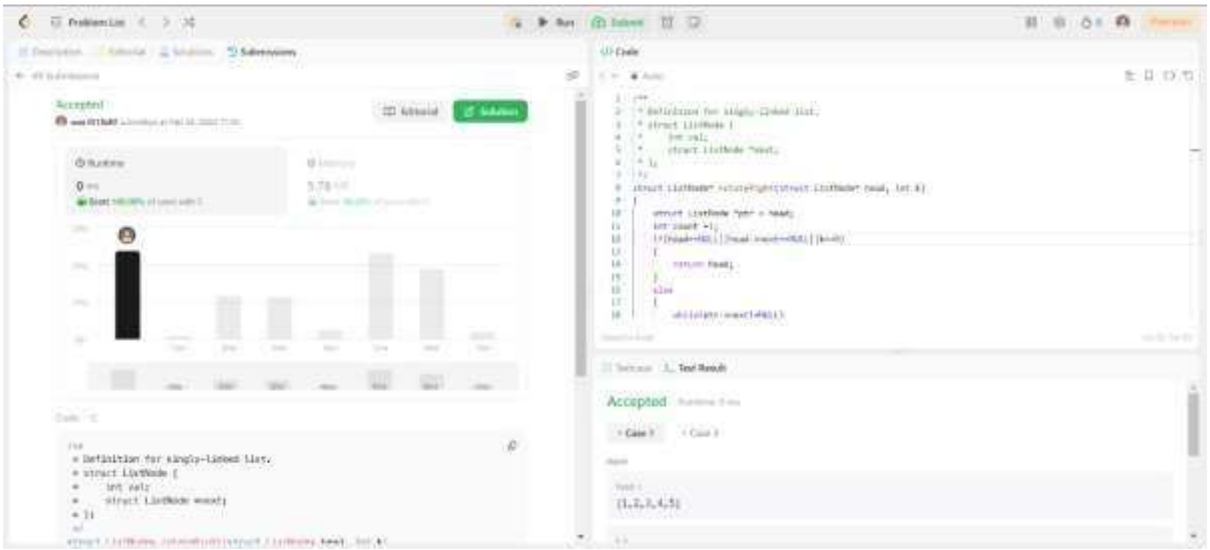
```
Enter
 1.Create
 2.Pre-order
 3.In-order
 4.post-order
 5.EXIT
Enter your choice
1
Enter the data to be inserted
4
Enter your choice
1
Enter the data to be inserted
6
Enter your choice
1
Enter the data to be inserted
1
Enter your choice
1
Enter the data to be inserted
3
Enter your choice
1
Enter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



Accepted

Runtime
0 ms

Memory
5.78 MB

```
/**
 * 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)
```

Test Result

Accepted

Case 1 Case 2

[1,2,3,4,5]

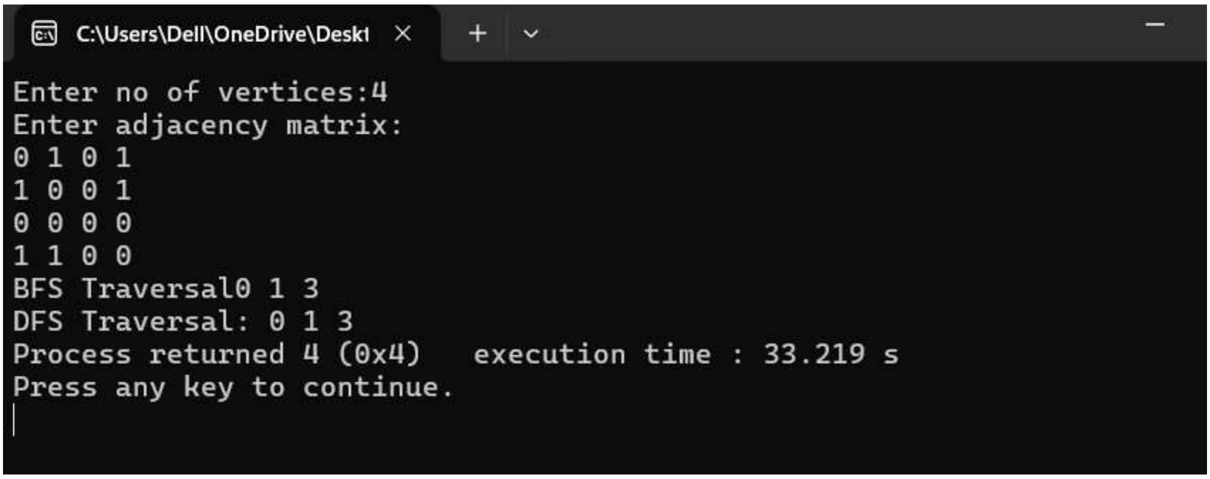
Lab program 9:

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:



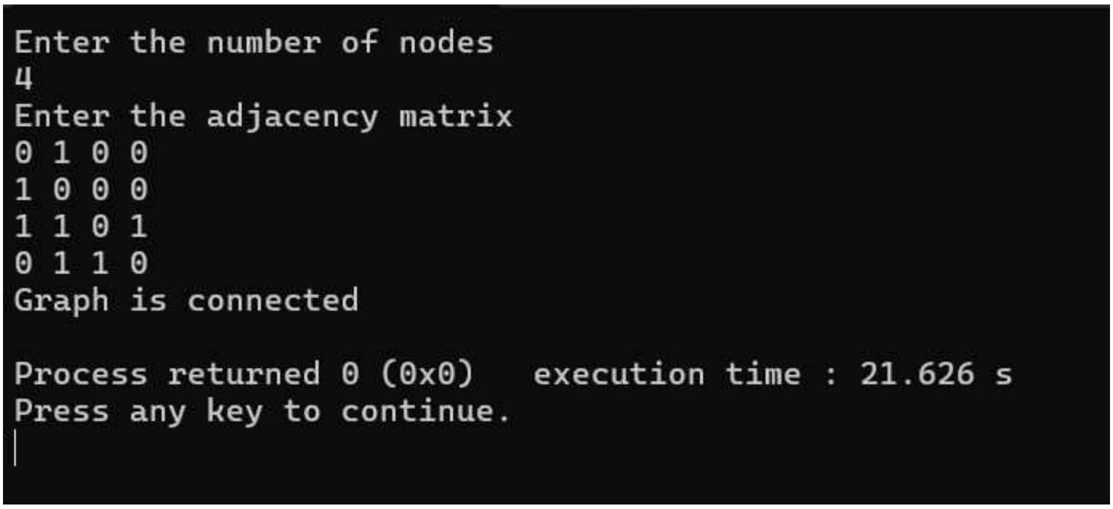
```
Enter no of vertices:4
Enter adjacency matrix:
0 1 0 1
1 0 0 1
0 0 0 0
1 1 0 0
BFS Traversal0 1 3
DFS Traversal: 0 1 3
Process returned 4 (0x4)   execution time : 33.219 s
Press any key to continue.
```

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");

}
```

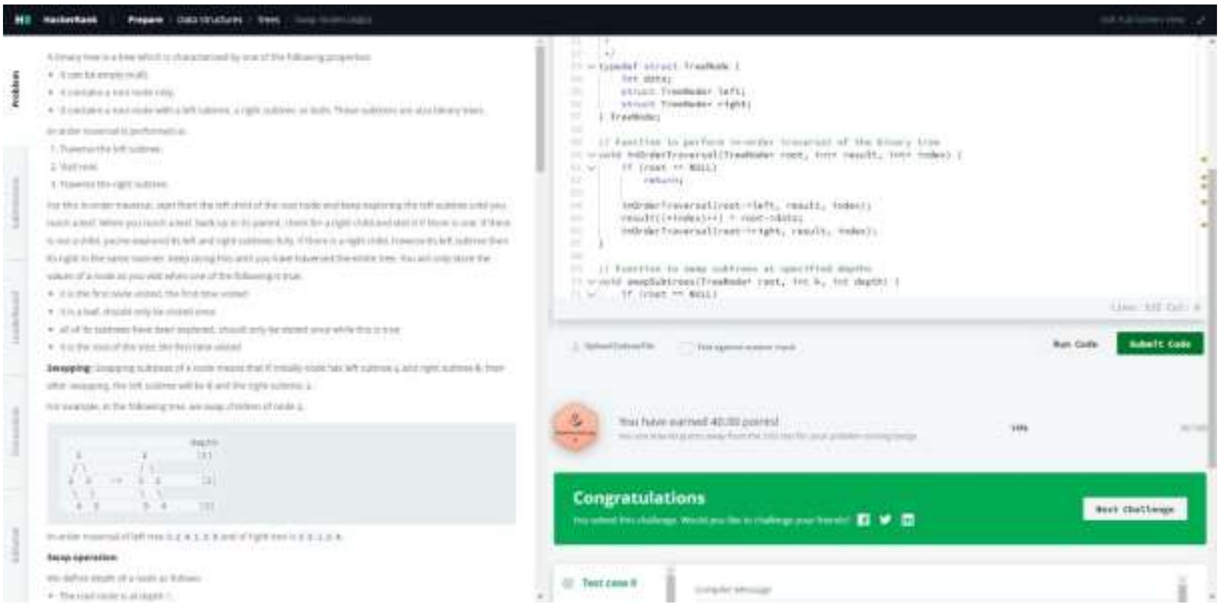
Output:



```
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;
}
```



A binary tree is a tree which is characterized by one of the following properties:

- It can be empty (null).
- It contains a root node only.
- It contains a root node with a left subtree, a right subtree, or both. These subtrees are also binary trees.

In-order traversal is performed as

1. Traverse the left subtree.
2. Visit root.
3. Traverse the right subtree.

For this in-order traversal, start from the left child of the root node and keep exploring the left subtree until you reach a leaf. When you reach a leaf, back up to its parent, check for a right child and visit it if there is one. If there is not a child, you've explored its left and right subtrees fully. If there is a right child, traverse its left subtree then its right in the same manner. Keep doing this until you have traversed the entire tree. You will only store the values of a node as you visit when one of the following is true:

- it is the first node visited, the first time visited
- it is a leaf, should only be visited once
- all of its subtrees have been explored, should only be visited once while this is true
- it is the root of the tree, the first time visited

Swapping: Swapping subtrees of a node means that if initially node has left subtree L and right subtree R, then after swapping, the left subtree will be R and the right subtree, L.

For example, in the following tree, we swap children of node 1.

```
                                depth
    1               1            [1]
   / \             / \
  2   3     ->    3   2          [2]
   \   \           \   \
    4   5           5   4        [3]
```

In-order traversal of left tree is 2 4 1 3 5 and of right tree is 3 5 1 2 4.

Swap operation:

We define depth of a node as follows:

- The root node is at depth 1.

```
    }
    */
typedef struct TreeNode {
    int data;
    struct TreeNode* left;
    struct TreeNode* right;
} TreeNode;

// Function to perform in-order traversal of the binary tree
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)
```

You have earned 40.00 points!

Congratulations

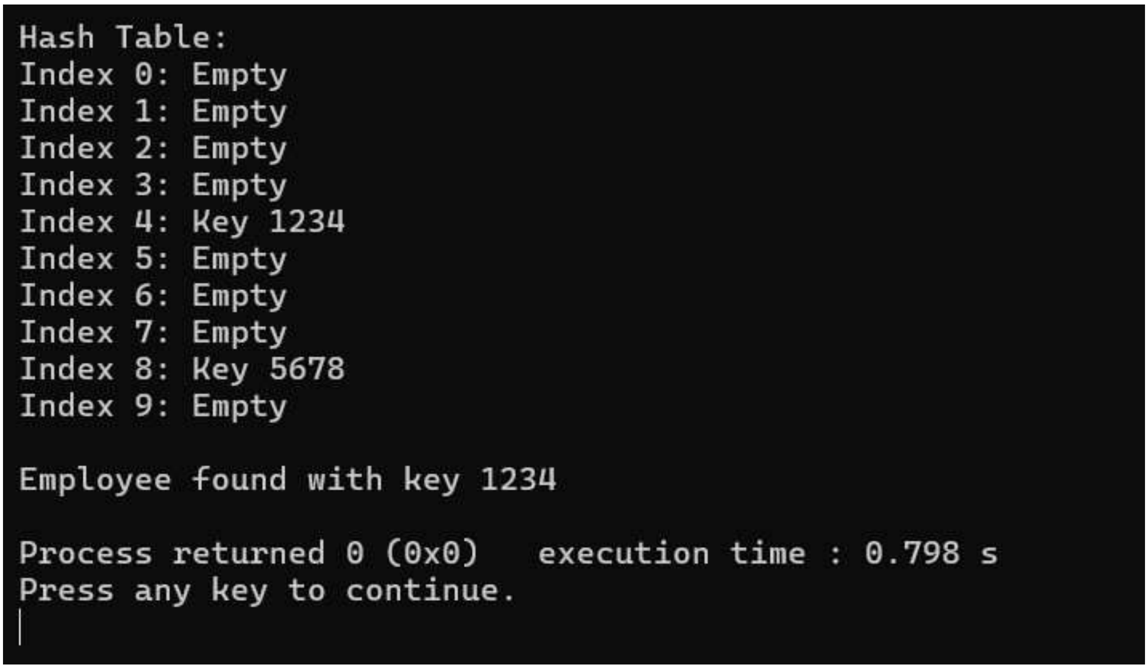
You solved this challenge. Would you like to challenge your friends?

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 -&gt; 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.
```