VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
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Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by NIKET DUGAR **(1BM22CS180)**, 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.

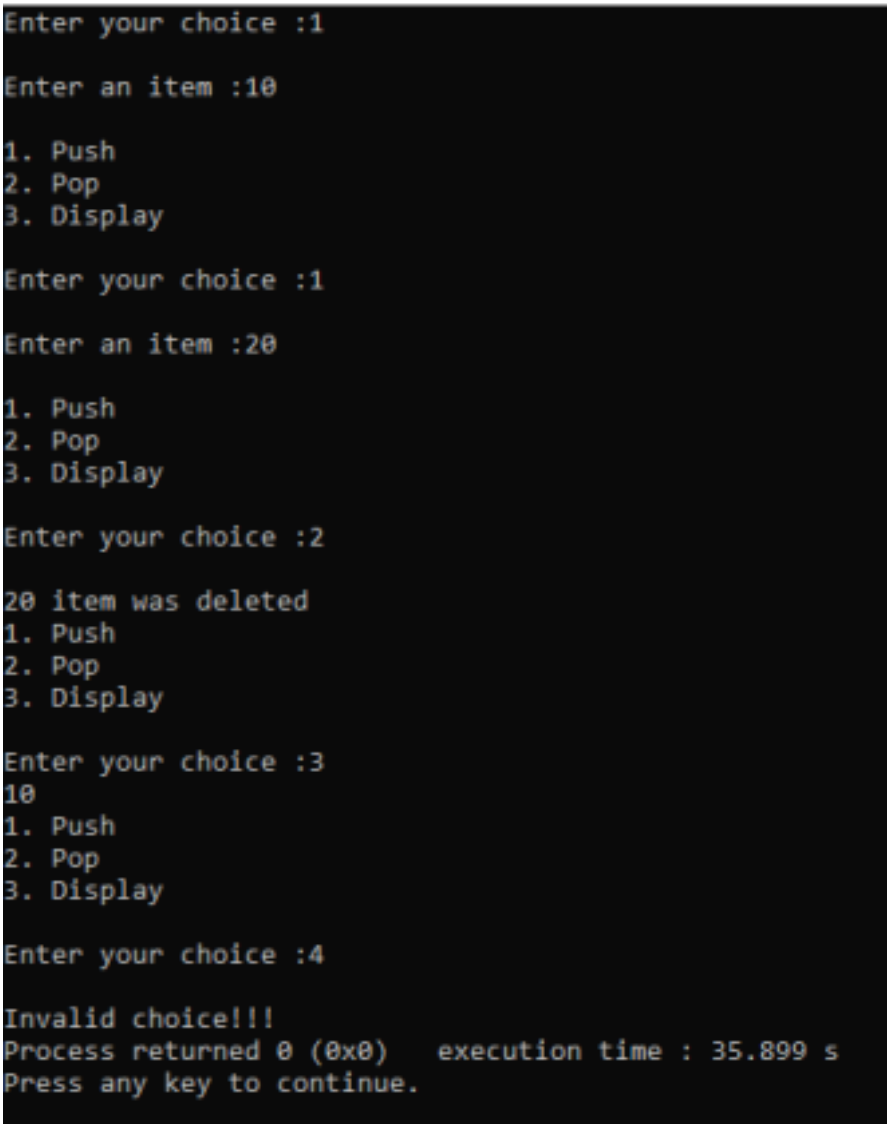
```
#include <stdio.h>
#include<stdlib.h>
#define STACK_SIZE 5
void push(int st[],int *top)
{
        int item;
        if(*top==STACK_SIZE-1)
                printf("Stack overflow\n");
        else
        {
                printf("\nEnter an item :");
                scanf("%d",&item);
                (*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:


Enter your choice :1
Enter an item :10
1. Push
2. Pop
3. Display
Enter your choice :1
Enter an item :20
1. Push
2. Pop
3. Display
Enter your choice :2
20 item was deleted
1. Push
2. Pop
3. Display
Enter your choice :3
10
1. Push
2. Pop
3. Display
Enter your choice :4
Invalid choice!!!
Process returned 0 (0x0) execution time : 35.899 s
Press any key to continue.

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>
int top;
char A[100];
void push(char x){
   if(top==9){
      printf("Stack overflow!");
   }
   else{
      A[++top] = x;
   }
}
char pop(){
   int x;
   if(top==-1){
      printf("Stack underflow!");
   }
   else{
      x = A[top];
      top--;
   }
   return x;
}
int pref(char x){
   if(x=='+' || x=='-'){
      return 1;
   }
   else if(x=='*' || x=='/'){
      return 2;
   }
   else if(x=='^'){
      return 3;
   }
   else
      return 0;
}
void main(){
   char s[] = "A*B+C*D-E", postfix[100], x, y;
```



```
   int j=0;
```

```
    for(int i=0;i<strlen(s);i++){
        if(s[i]!='+' && s[i]!='-' && s[i]!='*' && s[i]!='/'){
            postfix[j++]=s[i];
        }
        else{
            while(top!=-1 && pref(A[top]) >= pref(s[i])){
                x = pop();
                postfix[j++] = x;
            }
            push(s[i]);

        }
    }
    while(top!=-1){
        y = pop();
        postfix[j++] = y;
    }
    postfix[j] = '\0';
    printf("%s",postfix);
}
```

Output:

```
AB*CD*+E-
Process returned 9 (0x9)   execution time : 0.006 s
Press any key to continue.
```

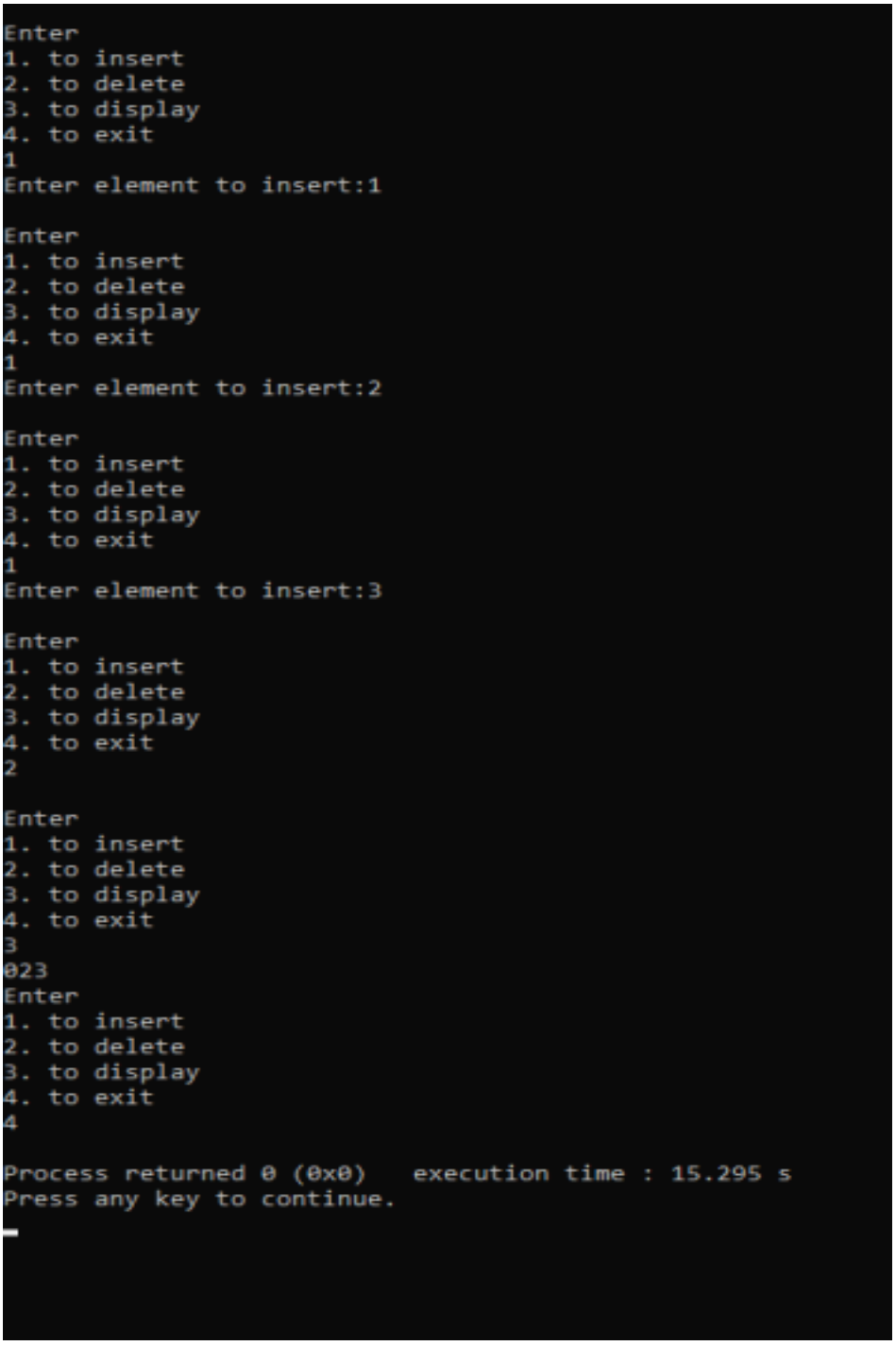
3a) WAP to simulate the working of a queue of integers using an array.Provide the following operations: Insert, Delete, Display. The program should print appropriate messages for queue empty and queue overflow conditions

```
#include <stdio.h>

int front=-1, rear=-1, Q[6];

void insert(int x){
   if(rear == 5){
      printf("Queue is full!\n");
   }
   else{
   rear++;
      Q[rear] = x;


   }
}


void delete(){
   if(front == rear){
      printf("Queue is empty\n");


   }
   else{
      for(int i = 0;i<rear;i++){
         Q[i] = Q[i+1];
      }
      rear--;
   }
}
```

```
void display(){
   if(front==rear){
      printf("Queue is empty\n");


   }
   else{
      for(int i = front;i<= rear;i++){
         printf("%d",Q[i]);
      }
   }
}


Int main()
{
   int n=0,ele,e=0;
   while(n!=4){
      printf("\nEnter\n1. to insert\n2. to delete\n3. to display\n4. to exit\n");
      scanf("%d",&n);
      switch(n){
         case 1:
            printf("Enter element to insert:");
            scanf("%d",&ele);
            insert(ele);
            break;
         case 2:
            delete();
            break;
         case 3:
            display();
            break;
```

```
    }
  }
  return 0;
}
```

Ouput



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 front=-1, rear=-1, Q[6];
void insert(int x){
   if((rear+1)%6 == 5){
      printf("Queue is full!\n");
   }
   else{
      rear = (rear + 1) %6;
      Q[rear] = x;
   }
}
void delete(){
   if(front == (rear+1)%6){
      printf("Queue is empty\n");
   }
   else{
      for(int i = 0;i<(rear+1)%6;i++){
         Q[i] = Q[i+1];
      }
      rear--;
   }
}
void display(){
   if(front == (rear+1)%6){
```

```
        printf("Queue is empty\n");
    }
    else{
        for(int i = front;i<= (rear+1)%6;i++){
            printf("%d",Q[i]);
        }
    }
}
void main()
{
    int n=0,ele;
    while(n!=4){
        printf("\nEnter\n1. to insert\n2. to delete\n3. to display\n4. to exit\n");
        scanf("%d",&n);
        switch(n){
            case 1:
                printf("Enter element to insert:");
                scanf("%d",&ele);
                insert(ele);
                break;
            case 2:
                delete();
                break;
            case 3:
                display();
                break;
        }
    }
```

Output

```
Enter
1. to insert
2. to delete
3. to display
4. to exit
1
Enter element to insert:1

Enter
1. to insert
2. to delete
3. to display
4. to exit
1
Enter element to insert:2

Enter
1. to insert
2. to delete
3. to display
4. to exit
1
Enter element to insert:3

Enter
1. to insert
2. to delete
3. to display
4. to exit
2

Enter
1. to insert
2. to delete
3. to display
4. to exit
3
0230
Enter
1. to insert
2. to delete
3. to display
4. to exit
4

Process returned 4 (0x4)   execution time : 13.126 s
Press any key to continue.
```

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>

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

Node* head = NULL;

void push();
void append();
void insert();
void display();

int main() {
    int choice;
    while (1) {
        printf("1. Insert at beginning\n");
        printf("2. Insert at end\n");
        printf("3. Insert at position\n");
        printf("4. Display\n");
        printf("5. Exit\n");
        printf("Enter choice: ");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                push();
                break;
            case 2:
                append();
                break;
            case 3:
                insert();
                break;
            case 4:
                display();
                break;
            default:
```

```
            printf("Exiting the program");
            return 0;
        }
    }
}

void push() {
    Node* temp = (Node*)malloc(sizeof(Node));
    int new_data;
    printf("Enter data in the new node:
    "); scanf("%d", &new_data);
    temp->data = new_data;
    temp->next = head;
    head = temp;
}

void append() {
    Node* temp = (Node*)malloc(sizeof(Node));
    int new_data;
    printf("Enter data in the new node:
    "); scanf("%d", &new_data);
    temp->data = new_data;
    temp->next = NULL;
    if (head == NULL) {
        head = temp;
        return;
    }
    Node* temp1 = head;
    while (temp1->next != NULL) {
        temp1 = temp1->next;
    }
    temp1->next = temp;
}

void insert() {
    Node* temp = (Node*)malloc(sizeof(Node));
    int new_data, pos;
    printf("Enter data in the new node:
    "); scanf("%d", &new_data);
    printf("Enter position of the new node:
    "); scanf("%d", &pos);
    temp->data = new_data;
    temp->next = NULL;
    if (pos == 0) {
        temp->next = head;
        head = temp;
        return;
    }
    Node* temp1 = head;
    while (pos--) {
```

```
        temp1 = temp1->next;
}
Node* temp2 = temp1->next;
temp->next = temp2;
temp1->next = temp;
}

void display() {
Node* temp1 = head;
while (temp1 != NULL) {
printf("%d -> ", temp1->data);
temp1 = temp1->next;
}
printf("NULL\n");
}
```

Output

```
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 1
Enter data in the new node: 10
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 1
Enter data in the new node: 20
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 2
Enter data in the new node: 30
1. Insert at beginning
2. Insert at end
3. Insert at position
4. Display
5. Exit
Enter choice: 3
Enter data in the new node: 2
Enter position of the new node: 40

Process returned -1073741819 (0xC0000005)   execution time : 29.477 s
Press any key to continue.
```

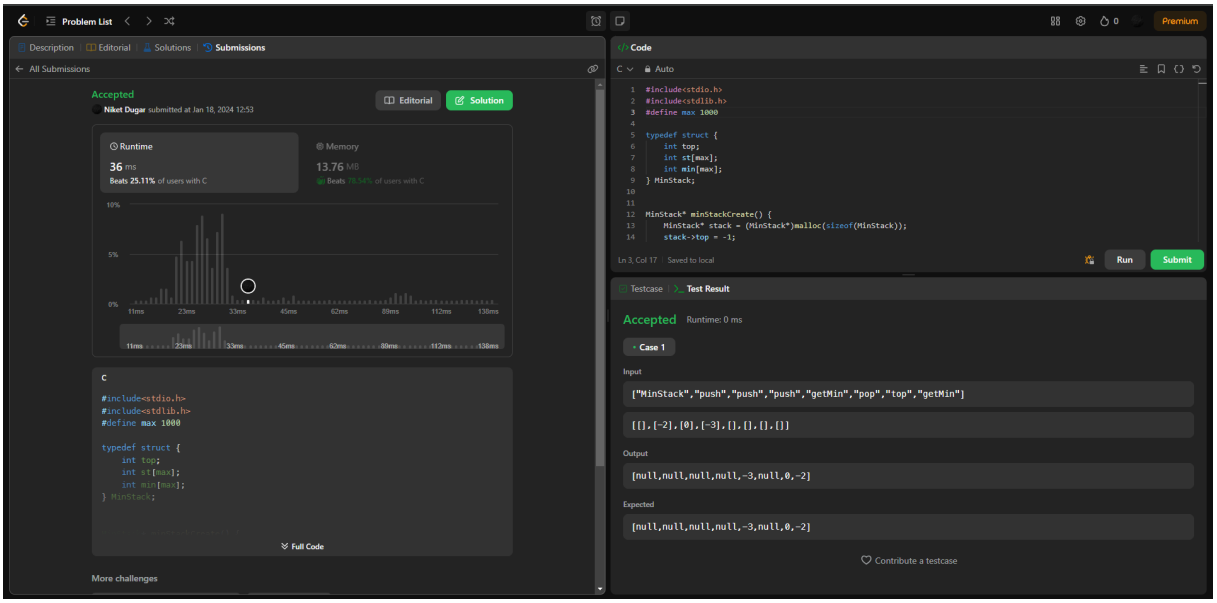
Leetcode

```
#include<stdio.h>
#include<stdlib.h>
#define max 1000

typedef struct {
    int top;
    int st[max];
    int min[max];
} MinStack;
MinStack* minStackCreate() {
    MinStack* stack = (MinStack*)malloc(sizeof(MinStack));
    stack->top = -1;
    return stack;}
void minStackPush(MinStack* obj, int val) {
    if(obj->top == max-1){
        printf("Stack Full\n");
        return;
    }
    obj->st[++obj->top] = val;
    if(obj->top > 0)
    {
        if(obj->min[obj->top - 1] < val)
            obj->min[obj->top] = obj->min[obj->top -1];
        else
            obj->min[obj->top] = val;
    }
    else
        obj->min[obj->top] = val;
```

```
}
void minStackPop(MinStack* obj) {
    if(obj->top == -1)
    {
        printf("Stack empty\n");
        return;
    }
    else {
        obj->top -= 1;
    }
}
int minStackTop(MinStack* obj) {
    if(obj->top == -1)
    {
        printf("Stack empty\n");
        return -1;
    }
    return obj->st[obj->top];
}
int minStackGetMin(MinStack* obj) {
    if(obj->top == -1)
    {
        printf("min Stack empty\n");
        return -1;
    }
    return obj->min[obj->top];
}
void minStackFree(MinStack* obj) {
```

```
    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;
}node;
struct node* head = NULL;

void create(int A[], int n){
   struct node *t, *last;
   head = (struct node*)malloc(sizeof(struct node));
   head->data = A[0];
   head->next = NULL;
   last = head;
   for(int i=1; i<n; i++){
      t = (struct node*)malloc(sizeof(struct node));
      t->data = A[i];
      t->next = NULL;
      last->next = t;
      last = t;
   }
}

void fdelete(){
   struct node* p;
   p = (struct node*)malloc(sizeof(struct node));
   p = head;
   head = head->next;
   free(p);
}

void ldelete(){
   struct node*p, *p1;
   p = (struct node*)malloc(sizeof(struct node));
   p = head;
   while(p->next!=NULL){
      p1 = p;
      p = p->next;
   }
```

```
    p1->next = NULL;
    free(p);
}

void delete(int pos){
    struct node *p, *p1;
    p = (struct node*)malloc(sizeof(struct node));
    p = head;
    for(int i=0;i<pos-1;i++){
        p = p->next;
    }
    p1 = p;
    p = p->next;
    p1->next = p->next;
    free(p);

}

void display(struct node*p){
    struct node *t = p;
    while(t!=NULL){
        printf("%d ",t->data);
        t = t->next;
    }
}

int main()
{
    int A[] = {2,4,6,5,1,8};
    create(A,6);
    fdelete();
    ldelete();
    delete(2);
    display(head);
    return 0;
}
```

Output

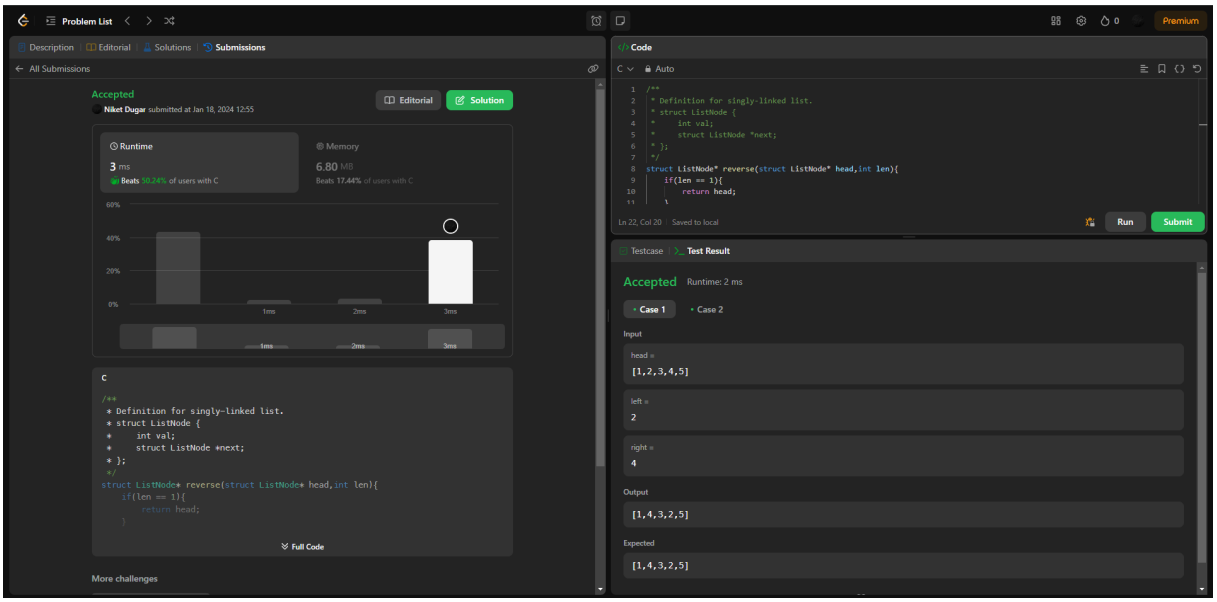
```
4 6 1
Process returned 0 (0x0)   execution time : 1.513 s
Press any key to continue.
```

LeetCode

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* reverse(struct ListNode* head,int len){
    if(len == 1){
        return head;
    }

    int count = 0;
    struct ListNode* p = head;
    while(count < len-1){
        p = p->next;
        count++;
    }
    struct ListNode* pEnd = p->next;

    struct ListNode* pPre = head;
    p = head->next;
    struct ListNode* pNext;

    count = 0;
    while(count < len-1){
        pNext = p->next;
        p->next = pPre;
        pPre = p;
        p = pNext;
        count++;
    }
    head->next = pEnd;

    return pPre;
}
struct ListNode* reverseBetween(struct ListNode* head, int
left, int right) {
    struct ListNode* p = head;struct ListNode* pPre = NULL;
    int count = 1;
    while(count < left){
        pPre = p;
        p = p->next;
        count++;
    }
    if(pPre){
        pPre->next = reverse(p,right-left+1);
    }
```

```
    else{
        head = reverse(p,right-left+1);
    }

    return head;
}
```

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* head = NULL;

void create(int A[], int n){
   struct node *t, *last;
   head = (struct node*)malloc(sizeof(struct node));
   head->data = A[0];
   head->next = NULL;
   last = head;
   for(int i=1; i<n; i++){
      t = (struct node*)malloc(sizeof(struct node));
      t->data = A[i];
      t->next = NULL;
      last->next = t;
      last = t;
   }
}

struct node* sort(head) {
   struct node *ptr1,*ptr2;
   ptr1=head;
   int temp,count=1;
   while(ptr1->next!=NULL){
      count++;
      ptr1=ptr1->next;
   }
   ptr1=head;
   while(--count){
      ptr1=head;
      while(ptr1->next!=NULL){
         ptr2=ptr1;
         ptr1=ptr1->next;
         if(ptr1->data<ptr2->data){
            temp=ptr2->data;
            ptr2->data=ptr1->data;
            ptr1->data=temp;
         }
      }
```

```
    }
    return head;
}

void main(){
    int A[]={2,1,3,5,4,8,6,7};
    create(A,8);
    head = sort(head);
    struct node* p = head;
    while(p!=NULL){
        printf("%d",p->data);
        p = p->next;
    }
}


#include <stdio.h>
#include <stdlib.h>
struct node{
    int data;
    struct node* next;
};
struct node* head = NULL;

void create(int A[], int n){
    struct node *t, *last;
    head = (struct node*)malloc(sizeof(struct node));
    head->data = A[0];
    head->next = NULL;
    last = head;
    for(int i=1; i<n; i++){
        t = (struct node*)malloc(sizeof(struct node));
        t->data = A[i];
        t->next = NULL;
        last->next = t;
        last = t;
    }
}

struct node* reverse(struct node* p, int len){
    p = head;
    int a[len];
    a[0] = p->data;
    for(int i=1; i<len; i++){
        p = p->next;
        a[i] = p->data;
    }
    p = head;
    for(int i = len-1; i>=0; i--){
        p->data = a[i];
```

```
        p = p->next;
    }
    return head;
}

void main(){
    int A[]={2,1,3,5,4,8,6,7};
    create(A,8);
    head = reverse(head,8);
    struct node* p = head;
    while(p!=NULL){
            printf("%d ",p->data);
            p = p->next;
    }
}


#include <stdio.h>
#include <stdlib.h>
struct node{
    int data;
    struct node* next;
};
struct node* head = NULL, *head1 = NULL;
void create()
{
    head = (struct node*)malloc(sizeof(struct node));
    head1 = (struct node*)malloc(sizeof(struct node));
   struct node *last, *last1;
   int a[] = {1,2,3,4};
   int b[] = {5,6,7,8};

   head->data = a[0];
   head->next = NULL;

   head1->data = b[0];
   head1->next = NULL;

   last = head;
   last1 = head1;

   for(int i=1;i<sizeof(a)/sizeof(a[0]);i++)
   {
      struct node *t;
      t = (struct node*)malloc(sizeof(struct node));
      t->data = a[i];
      t->next = NULL;
      last->next = t;
      last = t;
   }
```

```
  for(int i=1;i<sizeof(b)/sizeof(b[0]);i++)
  {
     struct node *t1;
     t1 = (struct node*)malloc(sizeof(struct node));
     t1->data = b[i];
     t1->next = NULL;
     last1->next = t1;
     last1 = t1;
  }

}

void display_a()
{
  struct node *n = head;

  printf("A:\n");
  while(n!=NULL)
  {
     printf("%d\n",n->data);
     n = n->next;
  }
  return;
}

void display_b()
{
  struct node *n1 = head1;

  printf("B:\n");
  while(n1!=NULL)
  {
     printf("%d\n",n1->data);
     n1 = n1->next;
  }
}

void concat()
{
  struct node *n, *n1;
  if(head == NULL || head1 == NULL)
  {
     if(head == NULL)
        display_b();
     else
        display_a();
  }
  else
  {
```

```
        n=head;
        while(n!=NULL)
        {
           n1 = n;
           n = n->next;
        }
        n1->next = head1;
        display_a();
    }

}
void main()
{
    create();
    printf("After Concatenation A and B\n");
    concat();
}
```

Output

```
12345678
Process returned 0 (0x0)   execution time : 1.179 s
Press any key to continue.
```

```
7 6 8 4 5 3 1 2
Process returned 0 (0x0)   execution time : 0.947 s
Press any key to continue.
```

```
After Concatenation A and B
A:
1 2 3 4 5 6 7 8
Process returned 0 (0x0)   execution time : 0.841 s
Press any key to continue.
```

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

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

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

struct node *head = NULL;

void push()
{
   int n;
   printf("Enter the insert element\n");
   scanf("%d",&n);

   struct node *new_node = (struct
node*)malloc(sizeof(struct node));
   new_node -> data = n;
   new_node->next = NULL;

   if(head == NULL)
      head = new_node;
   else
   {   struct node *p;
      p = head;
      while(p->next != NULL)
      {
         p = p->next;
      }
      p->next = new_node;
   }
   return;
}

void pop()
{
   struct node *ptr,*p2;
   if(head == NULL)
   {
      printf("List is empty\n");
      exit(0);
```

```
    }
    else
    {   if(head->next == NULL)
        {
            printf("Element %d deleted\n",head->data);
            free(head);
            head = NULL;
        }
        else
        {
            ptr = head;
            while(ptr->next != NULL)
            {
                p2 = ptr;
                ptr = ptr->next;
            }

            printf("Element %d deleted\n",ptr->data);
            p2->next = NULL;
            free(ptr);
        }
        return;
    }
}

void display()
{
    struct node *n;

    if(head == NULL)
    {
        printf("List is empty");
        exit(0);
    }

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

void main()
{
    int ch;
    printf("Stack Implementation using linked list\n\n");
    while(1){
```

```
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display\n");
        printf("4. Exit\n");
        printf("Enter your choice:\n");
        scanf("%d",&ch);
        switch(ch)
        {
           case 1:
              push();
              break;
           case 2:
              pop();
              break;
           case 3:
              display();
              break;
           case 4:
              printf("Program ends successfully!");
              exit(0);
           default:
              printf("Enter a valid number...\n");
        }
        continue;
    }
}

#include<stdio.h>
#include<stdlib.h>
void enqueue();
void dequeue();
void display();

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

struct node *head = NULL;

void enqueue()
{
    int n;
    printf("Enter the insert element\n");
    scanf("%d",&n);

    struct node *new_node =(struct node*)malloc(sizeof(struct
node));
    new_node->data = n;
    new_node->next = head;
```

```
   head = new_node;
}
void dequeue()
{
   if(head == NULL)
   {
      printf("List is empty");
      exit(0);
   }
   else
   {
      if(head->next == NULL)
      {
         printf("Element %d deleted\n",head->data);
         free(head);
         head = NULL;
      }
      else
      {
         struct node *p,*p1;
         p = head;
         while(p->next != NULL)
         {
            p1 = p;
            p = p->next;
         }
         p1->next = NULL;
         printf("Element %d deleted\n",p->data);
         free(p);
      }
   }
}

void display()
{
   struct node *n;

   if(head == NULL)
   {
      printf("List is empty");
      exit(0);
   }

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

```
    }
}

void main()
{
    int ch;
    printf("Queue Implementation using linked list\n\n");
    while(1){
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Display\n");
        printf("4. Exit\n");
        printf("Enter your choice:\n");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1:
                enqueue();
                break;
            case 2:
                dequeue();
                break;
            case 3:
                display();
                break;
            case 4:
                printf("Program ends successfully!");
                exit(0);
            default:
                printf("Enter a valid number...\n");
        }
        continue;
    }
}
```

Output

```
Stack Implementation using linked list

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
1
Enter the insert element
10
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
1
Enter the insert element
20
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
2
Element 20 deleted
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:

3
10
```

```
Queue Implementation using linked list

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
1
Enter the insert element
10
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
2
Element 10 deleted
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice:
3
List is empty
Process returned 0 (0x0)   execution time : 7.853 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<stdlib.h>
typedef struct Node{
   int val;
   struct Node *prev;
   struct Node *next;
}Node;

Node *head=NULL;

void insert(){
   int num,pos;
   printf("Enter value : ");
   scanf("%d",&num);
   printf("Enter node to insert left of: ");
   scanf("%d",&pos);

   Node *ptr=(Node*)malloc(sizeof(Node));
   ptr->val=num;

   if(pos==0){
   ptr->next=head;
   ptr->prev=NULL;
      if (head != NULL){
         head->prev = ptr;
      }
   head=ptr;

   }
   Node *ptr1=head;

   if(pos!=0){
      for(int i=0;i<pos;i++){
         ptr1=ptr1->next;
      }
      ptr->next=ptr1;
      ptr->prev=ptr1->prev;
      ptr1->prev->next=ptr;
      ptr1->prev=ptr;
```

```
    }
}

void delete(){
    printf("Enter value to delete: ");
    int loc=-1,len=1,val;
    scanf("%d",&val);
    Node *ptr=head,*ptr2;
    while(ptr->next!=NULL){
        len++;
        ptr=ptr->next;
    }
    ptr=head;
    for(int i=0;i<len;i++){
        if(ptr->val=val){
            loc=i;
        }
    }

    if(loc==-1){
        printf("Delete element not in list\n");
        return;
    }
    if(loc==0){
        printf("Deleted element: %d\n",head->val);
        ptr=head;
        head=head->next;
        free(ptr);
        return;
    }
    if(loc==len){
        ptr = head;
        while (ptr->next != NULL) {
            ptr = ptr->next;
        }
        printf("Deleted element: %d\n", ptr->val);
        ptr->prev->next = NULL;
        free(ptr);
        return;
    }
    ptr=head;
    for(int i=0;i<loc-1;i++){
        ptr2=ptr;
        ptr=ptr->next;
    }
    printf("Deleted element: %d\n",ptr->val);
    ptr2->next=ptr->next;
    ptr->next->prev=ptr2;
    free(ptr);
```

```
}

void display(){
   Node *ptr=head;
   while(ptr!=NULL){
      printf("%d<->",ptr->val);
      ptr=ptr->next;
   }
   printf("NULL\n");
}

void main(){
  int choice;
   printf("1. To insert into left of Doubly Linked List\n");
   printf("2. To Delete from any point of Doubly Linked
List\n");
   printf("Enter choice: ");
   while (1) {
      scanf("%d", &choice);
      switch (choice) {
         case 1:
            insert();
            break;
         case 2:
            delete();
            break;
         case 3:
            display();
            break;
         default:
            printf("Exiting the program");
            return;
      }
      printf("Enter choice: ");
   }
}
```

Output

```
1. To insert into left of Doubly Linked List
2. To Delete from any point of Doubly Linked List
Enter choice: 1
Enter value : 10
Enter node to insert left of: 0
Enter choice: 1
Enter value : 20
Enter node to insert left of: 0
Enter choice: 2
Enter value to delete: 10
Deleted element: 10
```

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>

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

tree* insert(tree* t, int val) {
   if (t == NULL) {
      tree* pt = (tree*)malloc(sizeof(tree));
      pt->data = val;
      pt->left = pt->right = NULL;
      return pt;
   }

   if (t->data > val) {
      t->left = insert(t->left, val);
   } else if (t->data < val) {
      t->right = insert(t->right, val);
   }

   return t;
}


void inorder(tree* t){
   if(t==NULL){
      return;
   }
   inorder(t->left);
   printf("%d ",t->data);
   inorder(t->right);
```

```
}

void preorder(tree* t){
   if(t==NULL){
      return;
   }
   printf("%d ",t->data);
   preorder(t->left);
   preorder(t->right);

}

void postorder(tree* t){
   if(t==NULL){
      return;
   }
   postorder(t->left);
   postorder(t->right);
   printf("%d ",t->data);

}
void main(){
   int A[] = {8,1,5,3,9,4,6,7};
   root = insert(root,A[0]);
   for(int i=1; i<8; i++){
      root = insert(root,A[i]);
   }
   printf("Inorder traversal\n");
   inorder(root);
   printf("\nPreorder traversal\n");
   preorder(root);
   printf("\nPostorder traversal\n");
   postorder(root);
}
```

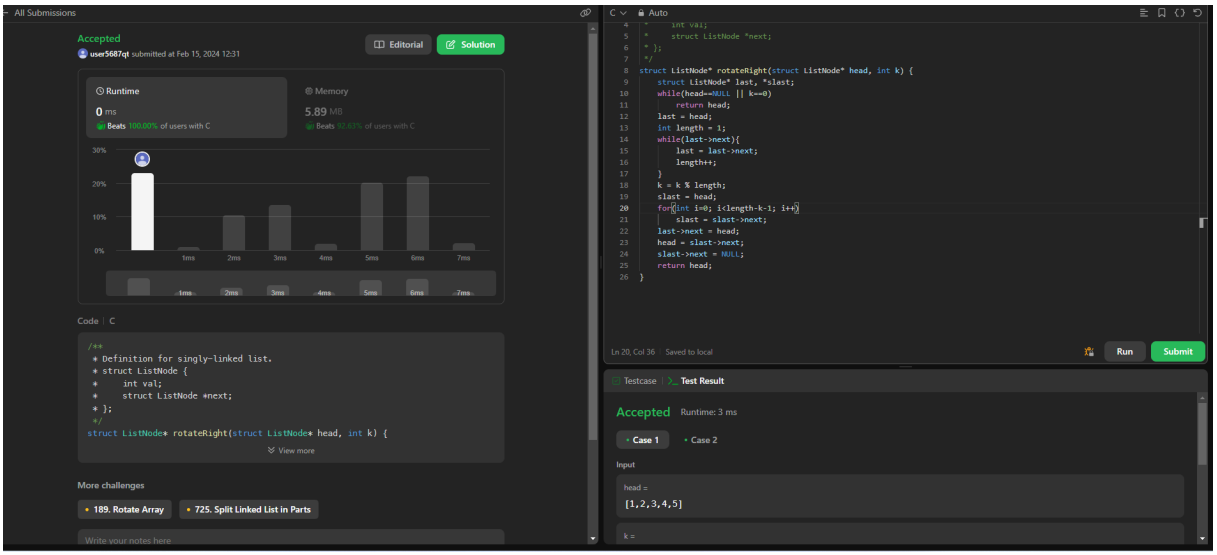
Output

```
Inorder traversal
1 3 4 5 6 7 8 9
Preorder traversal
8 1 5 3 4 6 7 9
Postorder traversal
4 3 7 6 5 1 9 8
Process returned 2 (0x2)   execution time : 1.515 s
Press any key to continue.
```

Leetcode

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
struct ListNode* rotateRight(struct ListNode* head, int k) {
    struct ListNode* last, *slast;
    while(head==NULL || k==0)
        return head;
    last = head;
    int length = 1;
    while(last->next){
        last = last->next;
        length++;
    }
    k = k % length;
    slast = head;
    for(int i=0; i<length-k-1; i++)
        slast = slast->next;
    last->next = head;
    head = slast->next;
    slast->next = NULL;
    return head;
}
```

Output



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

a)

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

#define MAX_VERTICES 50

typedef struct Graph_t {
        int V;
        bool adj[MAX_VERTICES][MAX_VERTICES];
} Graph;
Graph* Graph_create(int V)
{
        Graph* g = malloc(sizeof(Graph));
        g->V = V;

        for (int i = 0; i < V; i++) {
                for (int j = 0; j < V; j++) {
                        g->adj[i][j] = false;
                }
        }
        return g;
}

void Graph_addEdge(Graph* g, int v, int w)
{
        g->adj[v][w] = true;
        g->adj[w][v] = true;
}
void Graph_BFS(Graph* g, int s)
{
        bool visited[MAX_VERTICES];
        for (int i = 0; i < g->V; i++) {
                visited[i] = false;
        }
        int queue[MAX_VERTICES];
        int front = 0, rear = 0;
        visited[s] = true;
        queue[rear++] = s;

        while (front != rear) {
                s = queue[front++];
```

```
                printf("%d ", s);
                for (int adjacent = 0; adjacent < g->V;
                        adjacent++) {
                        if (g->adj[s][adjacent] &&
!visited[adjacent]) {
                                visited[adjacent] = true;
                                queue[rear++] = adjacent;
                        }
                }
        }
}

int main()
{

        Graph* g = Graph_create(4);
        Graph_addEdge(g, 0, 1);
        Graph_addEdge(g, 0, 2);
        Graph_addEdge(g, 1, 2);
        Graph_addEdge(g, 2, 0);
        Graph_addEdge(g, 2, 3);
        Graph_addEdge(g, 3, 3);

        printf("Following is Breadth First Traversal "
                "(starting from vertex 2) \n");
        Graph_BFS(g, 2);

        return 0;
}
```

b)

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

#define N 100000

int g[N][N];
bool vis[N];

void Add_edge(int u, int v){
   g[u][v] = true;
}

bool is_connected(int n){
   for(int i=1; i<=n; i++){
      vis[i] = false;
      dfs(i,n);
   }
```

```
    for(int i=1; i<=n; i++){
        if(!vis[i])
            return false;
    }
    return true;
}

void dfs(int x, int n){
    vis[x]= true;
    for (int i = 1; i <= n; i++)
        if (g[x][i] && !vis[i])
            dfs(i, n);
}

void main()
{
    int n = 4;
    for (int i = 1; i <= n; i++)
        for (int j = 1; j <= n; j++)
            g[i][j] = 0;
    Add_edge(1, 2);
    Add_edge(2, 3);
    Add_edge(3, 4);
    if (is_connected(n))
        printf("Yes");
    else
        printf("No");
}
```

Output

```
Following is Breadth First Traversal (starting from vertex 2)
2 0 1 3
Process returned 0 (0x0)   execution time : 1.650 s
Press any key to continue.
```

```
Yes
Process returned 3 (0x3)   execution time : 1.112 s
Press any key to continue.
```

Lab program 10:
Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F. Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT.
Let the keys in K and addresses in L are integers. Design and develop a Program in C that uses Hash function H: K > L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing.

```
#include <stdio.h>
#define size 10

int H[size];

void insert(int val){
   int i = 0;
   int hkey = (val + i) % size;
   while (H[hkey] != -1) {
      i++;
      hkey = (val + i) % size;
   }
   H[hkey] = val;
}
void search(int v){
   for(int i=0; i<size; i++){
      if(H[i]==v){
         printf("Employee %d is found at position %d\n\n",
v,i);
      }
   }
}
int main(){
   int val[size] = {1345, 2347, 4642, 9871, 9855, 2638, 9853,
2986, 9874, 5530};
   for (int j = 0; j < size; j++) {
      H[j] = -1;
   }
   for (int i = 0; i < size; i++) {
      insert(val[i]);
   }
```

```
    int x;
    printf("Enter employee you want to find:");
    scanf("%d",&x);
    search(x);
    for (int i = 0; i < size; i++) {
        printf("%d %d \n",i, H[i]);
    }
    return 0;
}
```

Output

```
Enter employee you want to find:9871
Employee 9871 is found at position 1

0 5530
1 9871
2 4642
3 9853
4 9874
5 1345
6 9855
7 2347
8 2638
9 2986

Process returned 0 (0x0)   execution time : 7.371 s
Press any key to continue.
```