SUBMITTED BY:

DEEPALI

ID: BTBTI20137

ROLL NO.: 2016736

BRANCH: B.TECH IT (A)

BATCH: 2

DATA STRUCTURES LAB RECORD

SUBMITTED TO:

DR. VAIBHAV VYAS

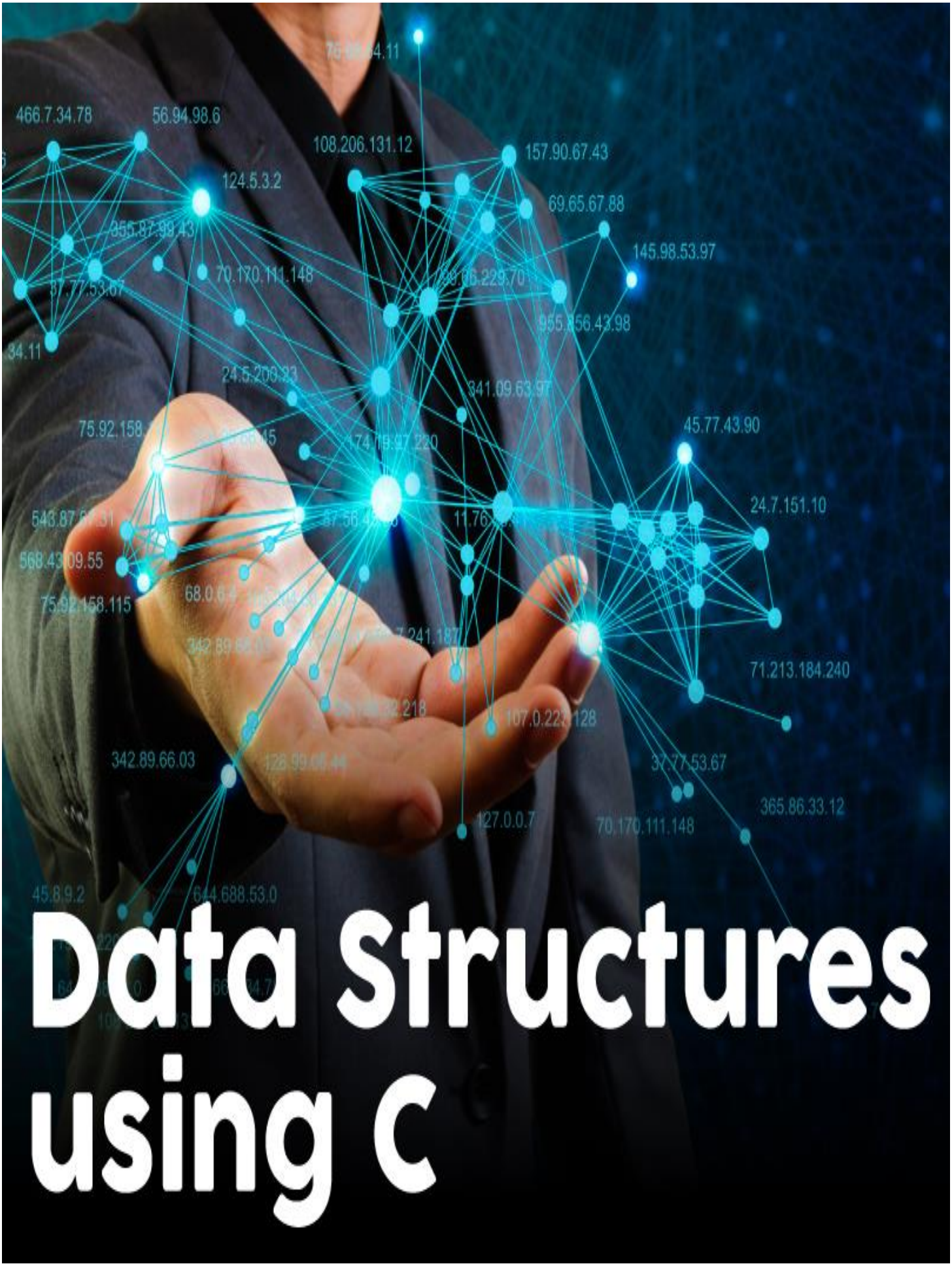
(ASSOCIATE PROFESSOR, COMPUTER SCIENCE)

SUBJECT: DS LAB

SUBJECT CODE: CS209L

TOTAL PAGES SUBMITTED: 160

SUBMISSION DATE: 07-12-2021


Data Structures
using C

INDEX

<table>
<tr><td></td><td></td><td>and display
1.Array
2.Linked List</td><td></td></tr>
<tr><td rowspan="4">9.</td><td rowspan="4">PROGRAM BASED ON BINARY SEARCH TREE</td><td>BST with all basic operations and non-recursive traversals</td><td>123-130</td></tr>
<tr><td>BST with all basic operations and recursive traversals</td><td>130-136</td></tr>
<tr><td>BST create, traversal and other remaining operations
1.Non-Recursive
2. Recursive</td><td>136-157</td></tr>
<tr><td>Heap sort</td><td>157-159</td></tr>
</table>

PROGRAMS BASED ON ARRAY

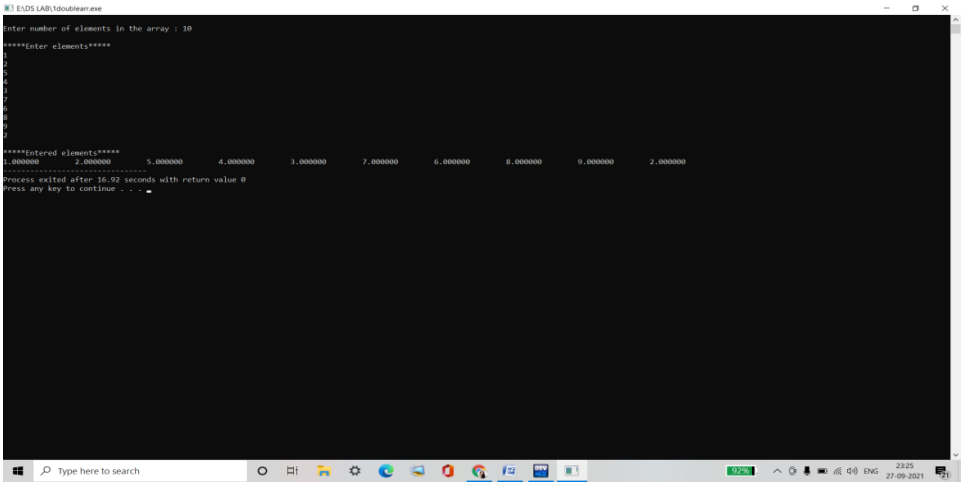
Q1. WAP for reading and writing of double datatype array.

Ans1.

C PROGRAM –

```
#include<stdio.h>
int main()
{
   double a[20];
   int i,num;
   printf("\nEnter number of elements in the array : ");
   scanf("%d",&num);
   printf("\n*****Enter elements*****\n");
   for(i=0;i<num;i++)
   scanf("%lf",&a[i]);
   printf("\n*****Entered elements*****\n");
   for(i=0;i<num;i++)
   printf("%lf\t",a[i]);
   return 0;
}
```

OUTPUT -



Q2. WAP for reversing an array's element.

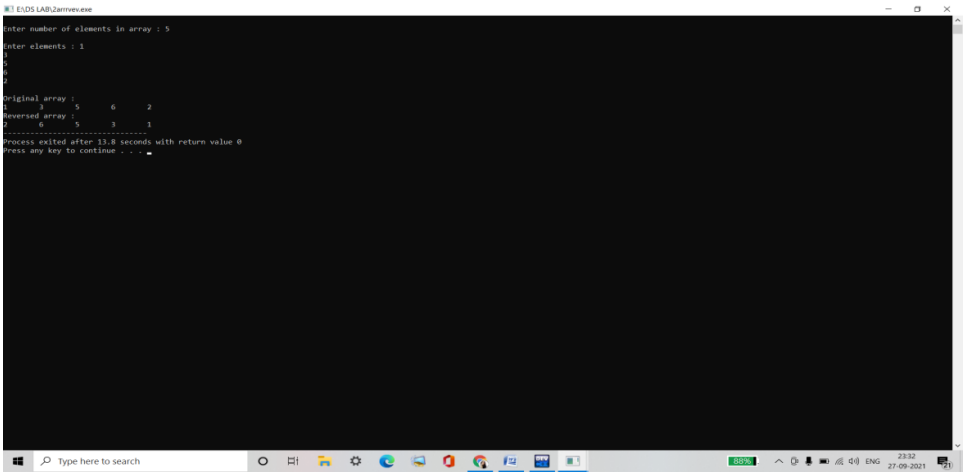
Ans2.

C PROGRAM –

```
#include<stdio.h>
int main()
{
   int a[10],b[10],i,j,n;
   printf("\nEnter number of elements in array : ");
   scanf("%d",&n);
   printf("\nEnter elements : ");
   for (i=0;i<n;i++)
     scanf("%d",&a[i]);
   printf("\nOriginal array : \n");
```

```
   for (i=0;i<n;i++)
     printf("%d\t",a[i]);
   for (i=0,j=n-1;i<n;i++,j--)
     b[j]=a[i];
   printf("\nReversed array : \n");
   for(j=0;j<n;j++)
     printf("%d\t",b[j]);
   return 0;
}
```

OUTPUT-



Q3.WAP to implement array as Data Structures with following operations:

(use switch case for menu driven program)

(i) Creation

(ii) Insert First, Last and Random

(iii) Delete First, Last and Random

(iv) Display

(v) Searching

(vi) Sort (using Insertion Sort Algorithm)

Optional-

(vii)Splitting (into 2 equal parts)

(viii) Merging (two arrays into 1).

Ans3.

C PROGRAM –

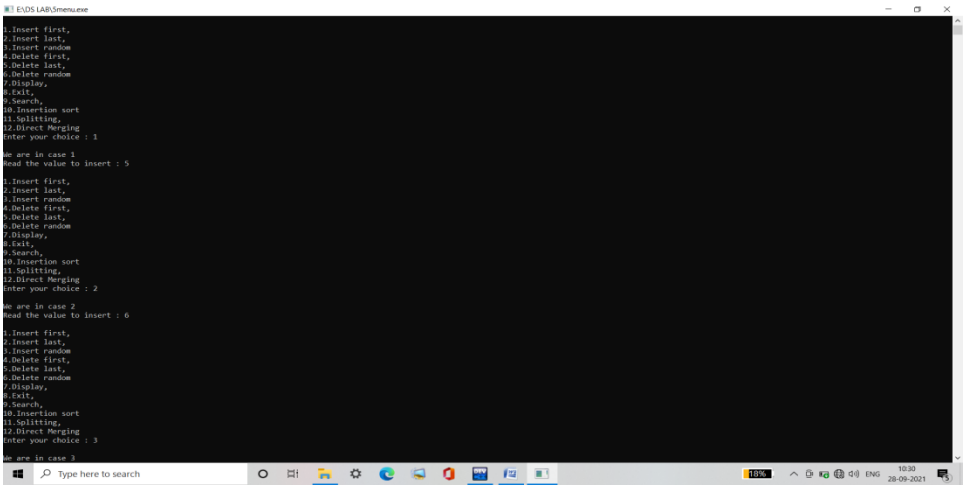
```
#include<stdio.h>
void main()
{
    int A[20],B[20],C[40],n=0,i,j,x,pos,ch,t,found=0,m;
    do
    {
        printf("\n1.Insert first, \n2.Insert last, \n3.Insert random");
        printf("\n4.Delete first, \n5.Delete last, \n6.Delete random");
        printf("\n7.Display, \n8.Exit, \n9.Search, \n10.Insertion sort");
        printf("\n11.Splitting, \n12.Direct Merging");
        printf("\nEnter your choice : ");
        scanf("%d",&ch);
        switch(ch)
```

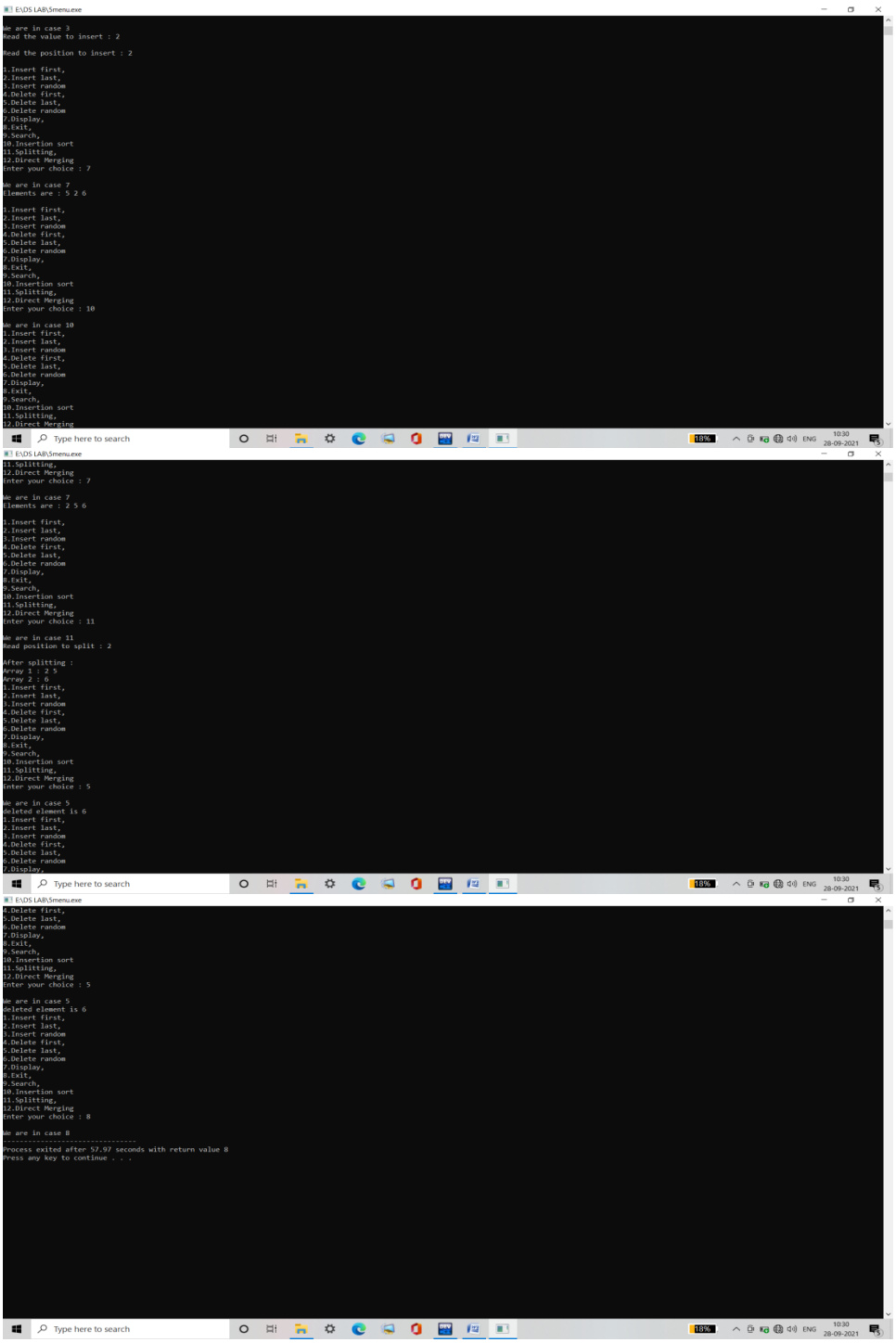
```
{
        case 1:
                printf("\nWe are in case 1");
                printf("\nRead the value to insert : ");
        scanf("%d",&x);
                for(i=n;i>0;i--)
                {
                        A[i]=A[i-1];
                }
                A[0]=x;
                n++;
                break;
   case 2:
        printf("\nWe are in case 2");
        printf("\nRead the value to insert : ");
        scanf("%d",&x);
        A[n++]=x;
                break;
        case 3:
                printf("\nWe are in case 3");
                printf("\nRead the value to insert : ");
        scanf("%d",&x);
                printf("\nRead the position to insert : ");
        scanf("%d",&pos);
                for(i=n;i>(pos-1);i--)
                   A[i]=A[i-1];
                A[pos-1]=x;
                n++;
                break;
        case 4:
                printf("\nWe are in case 4");
                x=A[0];
        for(i=0;i<(n-1);i++)
           A[i]=A[i+1];
     printf("\ndeleted element is %d",x);
        n--;
                break;
        case 5:
                printf("\nWe are in case 5");
                x=A[n-1];
     printf("\ndeleted element is %d",x);
        n--;
                break;
        case 6:
                printf("\nWe are in case 6");
                printf("\nRead the position to delete : ");
        scanf("%d",&pos);
                for(i=pos-1;i<n-1;i++)
                {
```

```
                x=A[pos-1];
                A[i]=A[i+1];
            }
printf("\ndeleted element is %d",x);
            n--;
            break;
    case 7:
            printf("\nWe are in case 7\n");
            if(n==0)
              printf("\nNo element to display");
       else
            printf("Elements are : ");
         for(i=0;i<n;i++)
              printf("%d ",A[i]);
       printf("\n");
            break;
    case 8:
            printf("\nWe are in case 8");
            break;
    case 9:
            printf("\nWe are in case 9");
            printf("\nEnter element to search : ");
            scanf("%d",&x);
            for(i=0;i<n;i++)
      {
            if(A[i]==x)
            {
             printf("\nElement found at location %d",++i);
             found=1;
          }
    }
            if(found==0)
            printf("\nElement not found");
            break;
    case 10:
            printf("\nWe are in case 10");
            for(i=1;i<n;i++)
            {
                    t=A[i];
                    j=i-1;
                    while((j>=0)&&(A[j]>t))
                    {
                            A[j+1]=A[j];
                            j--;
                    }
                    A[j+1]=t;
            }
            break;
    case 11:
```

```
                printf("\nWe are in case 11");
                printf("\nRead position to split : ");
                scanf("%d",&x);
                for(i=0;i<x;i++)
                   B[i]=A[i];
                for(i=x;i<n;i++)
                   C[i]=A[i];
                printf("\nAfter splitting : ");
                printf("\nArray 1 : ");
                for(i=0;i<x;i++)
                   printf("%d ",B[i]);
                printf("\nArray 2 : ");
             for(i=x;i<n;i++)
                   printf("%d ",C[i]);
                break;
          case 12:
                printf("\nWe are in case 12");
                printf("\nEnter size of array : ");
                scanf("%d",&m);
                printf("\nEnter elements : ");
                for(i=0;i<m;i++)
                scanf("%d",&B[i]);
             for(i=0;i<n;i++)
                C[i]=A[i];
                for(i=n,j=0;i<(m+n);i++,j++)
                   C[i]=B[j];
                printf("\nMerged array becomes : ");
             for(i=0;i<(m+n);i++)
                printf("%d ",C[i]);
                break;
          default:
                printf("\nIt is a default case");
       }
   }while(ch!=0);
}
```

OUTPUT-





Q4. WAP to read/print 10 unique array elements (no duplicate elements are allowed).

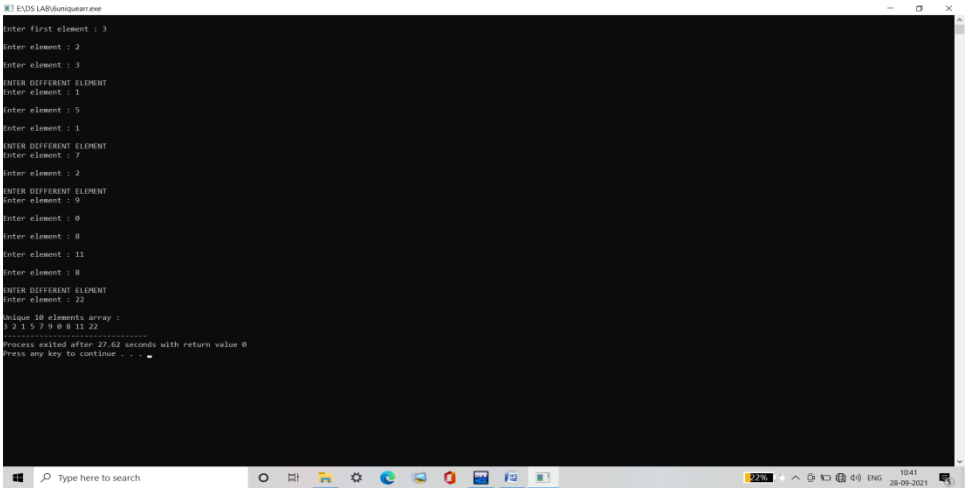
Ans4.

C PROGRAM –

```
#include<stdio.h>
int main()
{
   int i=1,j,a[20],n=10,c=0,flag=0;
   printf("\nEnter first element : ");
   scanf("%d",&a[0]);
   while(c<n-1)
   {
```

```
    printf("\nEnter element : ");
    scanf("%d",&a[i]);
    for(j=i-1;j>=0;j--)
    {
     if(a[i]==a[j])
     {
       flag=1;
       printf("\nENTER DIFFERENT ELEMENT");
       break;
     }
     else
       flag=0;
    }
    if(flag!=1)
    {
     c++;
     i++;
    }
  }
  printf("\nUnique 10 elements array : \n");
  for(i=0;i<n;i++)
   printf("%d ",a[i]);
  return 0;
}
```

OUTPUT-



Q5. WAP for addition of two matrices.

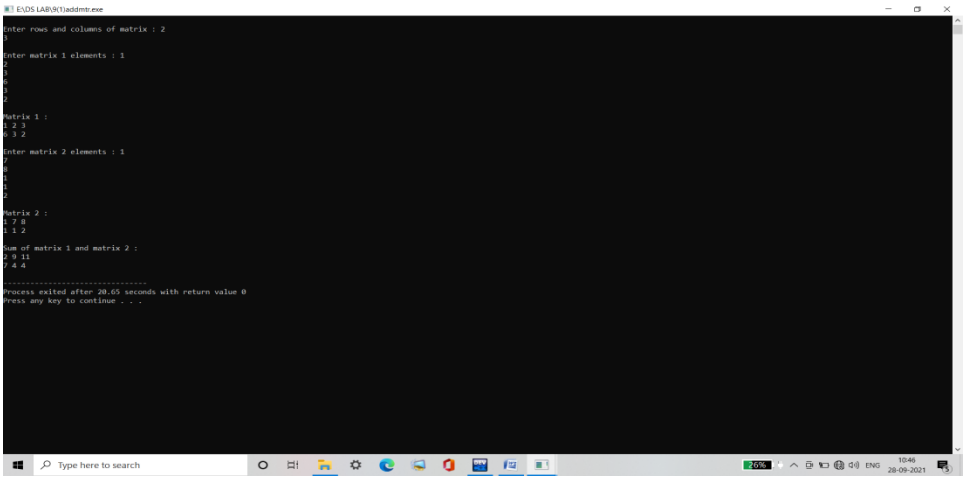
Ans5.

C PROGRAM –

```
#include<stdio.h>
int main()
{
  int m,n,i,j,a[10][10],b[10][10],c[10][10];
  printf("\nEnter rows and columns of matrix : ");
  scanf("%d%d",&m,&n);
  printf("\nEnter matrix 1 elements : ");
```

```
  for(i=0;i<m;i++)
   for(j=0;j<n;j++)
     scanf("%d",&a[i][j]);
  printf("\nMatrix 1 : \n");
  for(i=0;i<m;i++)
  {
   for(j=0;j<n;j++)
     printf("%d ",a[i][j]);
   printf("\n");
  }
  printf("\nEnter matrix 2 elements : ");
  for(i=0;i<m;i++)
   for(j=0;j<n;j++)
     scanf("%d",&b[i][j]);
  printf("\nMatrix 2 : \n");
  for(i=0;i<m;i++)
  {
   for(j=0;j<n;j++)
     printf("%d ",b[i][j]);
   printf("\n");
  }
  for(i=0;i<m;i++)
   for(j=0;j<n;j++)
     c[i][j]=a[i][j]+b[i][j];
  printf("\nSum of matrix 1 and matrix 2 : \n");
  for(i=0;i<m;i++)
  {
   for(j=0;j<n;j++)
     printf("%d ",c[i][j]);
   printf("\n");
  }
  return 0;
}
```

OUTPUT-



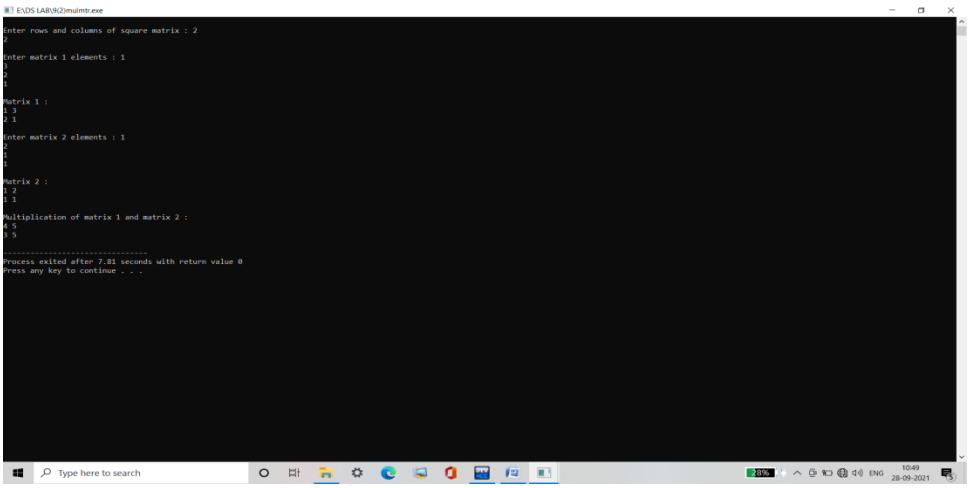
Q6. WAP for multiplication of two matrices.

Ans6.

C PROGRAM –

```
#include<stdio.h>
int main()
{
   int r,c,i,j,k,a[10][10],b[10][10],m[10][10];
   printf("\nEnter rows and columns of square matrix : ");
   scanf("%d%d",&r,&c);
   printf("\nEnter matrix 1 elements : ");
   for(i=0;i<r;i++)
    for(j=0;j<c;j++)
      scanf("%d",&a[i][j]);
   printf("\nMatrix 1 : \n");
   for(i=0;i<r;i++)
   {
    for(j=0;j<c;j++)
      printf("%d ",a[i][j]);
    printf("\n");
   }
   printf("\nEnter matrix 2 elements : ");
   for(i=0;i<r;i++)
    for(j=0;j<c;j++)
      scanf("%d",&b[i][j]);
   printf("\nMatrix 2 : \n");
   for(i=0;i<r;i++)
   {
    for(j=0;j<c;j++)
      printf("%d ",b[i][j]);
    printf("\n");
   }
   for(i=0;i<r;i++)
   {
    for(j=0;j<c;j++)
    {
      m[i][j]=0;
      for(k=0;k<c;k++)
        m[i][j]+=a[i][k]*b[k][j];
    }
   }
   printf("\nMultiplication of matrix 1 and matrix 2 : \n");
   for(i=0;i<r;i++)
   {
    for(j=0;j<c;j++)
      printf("%d ",m[i][j]);
    printf("\n");
   }
   return 0;
}
```

OUTPUT-



Q7. WAP for transpose of a matrix.

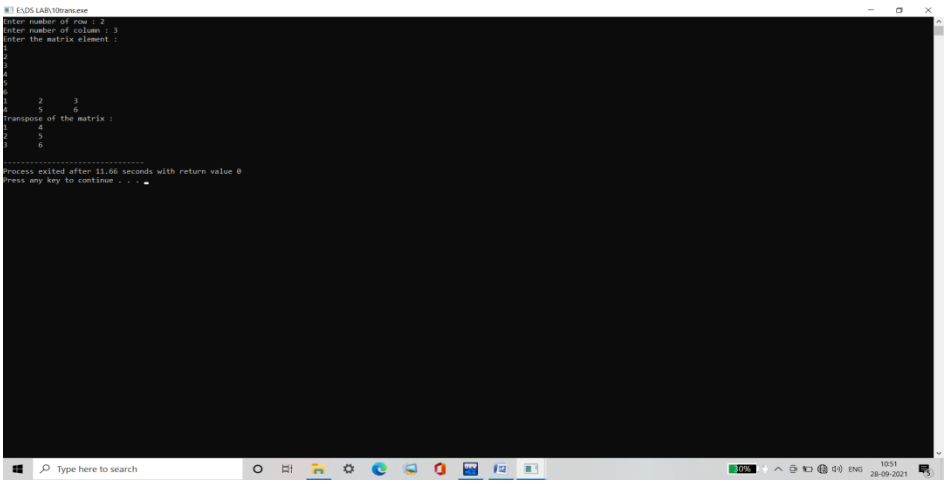
Ans7.

C PROGRAM –

```
#include<stdio.h>
int main()
{
  int a[5][5],trans[5][5],i,j,c,r,sor;
  printf("Enter number of row : ");
  scanf("%d",&r);
  printf("Enter number of column : ");
  scanf("%d",&c);
  printf("Enter the matrix element : \n");
  for(i=0;i<r;i++)
  {
     for(j=0;j<c;j++)
     {
        scanf("%d",&a[i][j]);
     }
  }
  for(i=0;i<r;i++)
  {
     for(j=0;j<c;j++)
     {
        printf("%d\t",a[i][j]);
     }
     printf("\n");
  }
  for(i=0;i<r;i++)
  {
     for(j=0;j<c;j++)
     {
       trans[j][i]=a[i][j];
     }
  }
  printf("Transpose of the matrix :\n");
```

```
  for(i=0;i<c;i++)
  {
     for(j=0;j<r;j++)
     {
       printf("%d\t",trans[i][j]);
     }
     printf("\n");
  }
  return 0;
}
```

OUTPUT-



PROGRAMS BASED ON STRUCTURE

Q8. WAP using array of structure (holding studid, studname). This application should be capable of performing following operations (using functions).
1. Read operation- Reads a single student's record.
2. Print operation – Prints records of all the students.
3. Sort operation - Sorts records on id/name as per user's choice.

Ans8.

C PROGRAM –

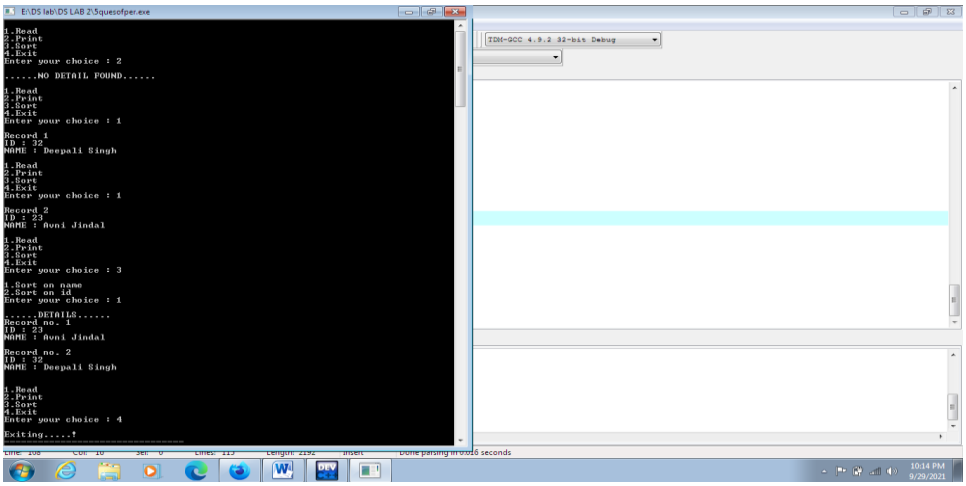
```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
struct studrecord
{
  int studid;
  char studname[20];
};
int Read(struct studrecord x[]);
void Print(struct studrecord y[],int n);
void Sort(struct studrecord y[],int n);
void main()
{
  struct studrecord s[100];
```

```
  int ch,n=0;
  static int i=0;
  do
  {
    printf("\n1.Read \n2.Print \n3.Sort \n4.Exit");
    printf("\nEnter your choice : ");
    scanf("%d",&ch);
    switch(ch)
    {
     case 1:
     n=Read(s);
     break;
     case 2:
           Print(s,n);
           break;
     case 3:
           Sort(s,n);
           break;
     case 4:
           printf("\nExiting.....!");
           break;
     default:
         printf("\nWrong choice entered!");
    }
  }while(ch!=4);
}
int Read(struct studrecord x[])
{
  static int i=0;
  printf("\nRecord %d\n",i+1);
  printf("ID : ");
  scanf("%d",&x[i].studid);
  fflush(stdin);
  printf("NAME : ");
  gets(x[i].studname);
  return (++i);
}
void Print(struct studrecord y[],int n)
{
        int j;
        if(n==0)
        {
                printf("\n......NO DETAIL FOUND..... \n");
        }
        else
        {
        printf("\n......DETAILS.....\n");
        for(j=0;j<n;j++)
        {
```

```
            printf("Record no. %d\n",j+1);
     printf("ID : %d\n",y[j].studid);
     printf("NAME : %s\n",y[j].studname);
     printf("\n");
    }
    }
}
void Sort(struct studrecord y[],int n)
{
    struct studrecord t;
    int j,k,ch;
    if(n==0)
          {
                printf("\n......NO DETAIL FOUND FOR SORTING..... \n");
          }
          else
          {
          do
    {
    printf("\n1.Sort on name \n2.Sort on id");
    printf("\nEnter your choice : ");
    scanf("%d",&ch);
    switch(ch)
    {
    case 1:
    for(j=0;j<n;j++)
    for(k=j+1;k<n;k++)
    if (strcmp(y[j].studname,y[k].studname)>0)
    {
      t=y[j];
      y[j]=y[k];
      y[k]=t;
    }
    Print(y,n);
    break;
    case 2:
    for(j=0;j<n;j++)
    for(k=j+1;k<n;k++)
    if (y[j].studid>y[k].studid)
    {
     t=y[j];
     y[j]=y[k];
     y[k]=t;
    }
    Print(y,n);
    break;
    default :
    printf("\nWrong choice entered!");
    }
```

```
   }while((ch!=1)&&(ch!=2));
   }
}
```

OUTPUT-



Q9. WAP structure Customer with following operations:
(Do with the help of functions only)
1. Hold record of 50 customers.
2. Print record of 50 customers.
3. Sort records on name / id / wallet as / des sort.
4. Search a particular customer in your records.
5. Update any customer's record.
6. Sum all customer's wallet amount.

Ans9.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#define max 100
struct customer
{
        int id, walletamt;
        char name[20];
};
int read (struct customer c[]);
void display(struct customer c[], int);
void sort(struct customer c[], int);
int search(struct customer c[], int, char s[]);
void update(struct customer c[], int);
int sumwalamt(struct customer c[], int);
void main()
{
        struct customer c[max];
        int n=0,res,ans,ch,sum;
        char s[50],r[50];
        do
```

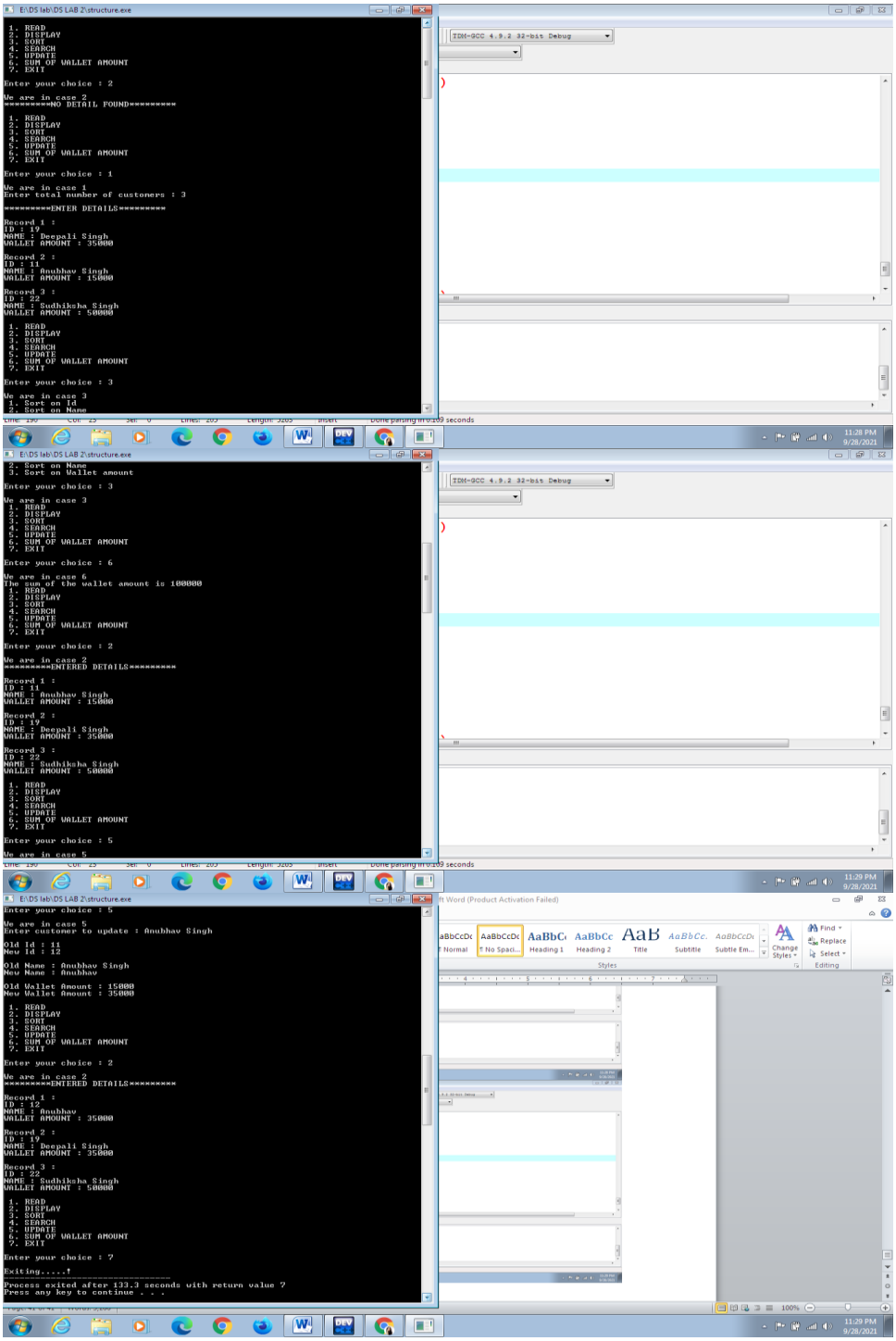
```
        {
    printf("\n 1. READ\n 2. DISPLAY\n 3. SORT\n 4. SEARCH\n 5. UPDATE\n 6. SUM OF WALLET AMOUNT\n 7. EXIT\n");
          printf("\nEnter your choice : ");
          scanf("%d",&ch);
          switch(ch)
          {
            case 1: printf("\nWe are in case 1");
                    n=read(c);
                    break;
             case 2: printf("\nWe are in case 2");
                    display(c,n);
                    break;
             case 3: printf("\nWe are in case 3");
                   sort(c,n);
                   break;
            case 4: printf("\nWe are in case 4");
                   if(n==0)
             printf("\n*********NO DETAIL FOR SEARCHING*********");
                   else
                   {
                   printf("\nEnter customer to search : ");
                   fflush(stdin);
                   gets(s);
                   res=search(c,n,s);
                   if(res==0)
                   printf("\nThe customer to search is not found");
             else
                   printf("\nThe customer is found at location %d",res);
                   }
                   break;
            case 5: printf("\nWe are in case 5");
                    if(n==0)
                   printf("\n*********NO DETAIL FOR UPDATION*********");
                   else
                   {
                   printf("\nEnter customer to update : ");
                   fflush(stdin);
                   gets(r);
                   ans=search(c,n,r);
                   if(ans==0)
                   printf("\nThe customer to update is not found");
                   else
                   update(c,ans-1);
                   }
                   break;
            case 6: printf("\nWe are in case 6");
                   if(n==0)
                   printf("\n*********NO DETAIL FOUND FOR SUM*********");
```

```
                else
                {
                sum=sumwalamt(c,n);
                if(sum==0)
                printf("\nThe sum of the wallet amount is 0");
                else
                printf("\nThe sum of the wallet amount is %d",sum);
                }
                break;
          case 7: printf("\nExiting.....!");
                break;
          default : printf("\nWrong choice entered!");
        }
    }while(ch!=7);
}
int read(struct customer c[])
{
    int i,n;
    printf("\nEnter total number of customers : ");
    scanf("%d",&n);
    printf("\n*********ENTER DETAILS*********\n");
    for(i=0;i<n;i++)
    {
        printf("\nRecord %d : \n",i+1);
        printf("ID : ");
        scanf("%d",&c[i].id);
        printf("NAME : ");
        fflush(stdin);
        gets(c[i].name);
        printf("WALLET AMOUNT : ");
        scanf("%d",&c[i].walletamt);
    }
    return n;
}
void display(struct customer c[], int n)
{
    int i;
    if(n==0)
    printf("\n*********NO DETAIL FOUND*********\n");
    else
    {
        printf("\n*********ENTERED DETAILS*********\n");
      for(i=0;i<n;i++)
      {
          printf("\nRecord %d : ",i+1);
          printf("\nID : ");
          printf("%d",c[i].id);
          printf("\nNAME : ");
          puts(c[i].name);
```

```
                printf("WALLET AMOUNT : ");
                printf("%d\n",c[i].walletamt);
        }
        }
}
void sort(struct customer c[], int n)
{
        struct customer key;
        int ch,i,j;
        if(n==0)
        printf("\n*********NO DETAIL FOR SORTING*********");
        else
        do
        {
        printf("\n 1. Sort on Id \n 2. Sort on Name \n 3. Sort on Wallet amount\n");
        printf("\nEnter your choice : ");
        scanf("%d",&ch);
        switch(ch)
        {
                case 1:
                   printf("\nWe are in case 1");
                   for(i=1;i<n;i++)
                   {
                        key=c[i];
                        for(j=i-1;(j>-1) && (c[j].id>key.id);j--)
                        c[j+1]=c[j];
                        c[j+1]=key;
                        }
                        break;
                case 2:
                   printf("\nWe are in case 2");
                   for(i=1;i<n;i++)
                   {
                        key=c[i];
                        for(j=i-1;(j>-1) && (strcmp(c[j].name,key.name)>0);j--)
                        c[j+1]=c[j];
                        c[j+1]=key;
                        }
                        break;
                case 3:
                   printf("\nWe are in case 3");
                   for(i=1;i<n;i++)
                   {
                        key=c[i];
                        for(j=i-1;(j>-1) && (c[j].walletamt>key.walletamt);j--)
                        c[j+1]=c[j];
                        c[j+1]=key;
                        }
                        break;
```

```
                default:
                        printf("\nWrong choice entered\n");
        }
   }while((ch!=1)&&(ch!=2)&&(ch!=3));
}
int search(struct customer c[], int n, char s[])
{
        int i;
        for(i=0;i<n;i++)
        {
                if(strcmp(c[i].name,s)==0)
                return (i+1);
        }
        return 0;
}
void update(struct customer c[], int ans)
{
        printf("\nOld Id : ");
        printf("%d",c[ans].id);
        printf("\nNew Id : ");
        scanf("%d",&c[ans].id);
        printf("\nOld Name : ");
        puts(c[ans].name);
        printf("New Name : ");
        fflush(stdin);
        gets(c[ans].name);
        printf("\nOld Wallet Amount : ");
        printf("%d",c[ans].walletamt);
        printf("\nNew Wallet Amount : ");
        scanf("%d",&c[ans].walletamt);
}
int sumwalamt(struct customer c[], int n)
{
        int count=0,i;
        for(i=0;i<n;i++)
        count=count+c[i].walletamt;
        return count;
}
```

OUTPUT-



PROGRAMS BASED ON POINTER

Q10. WAP to read name in function and print in main.

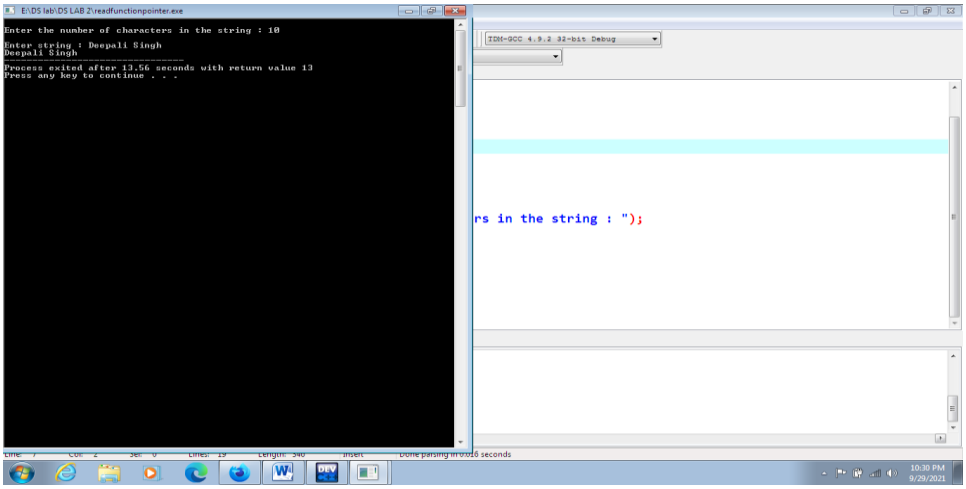
Ans10.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
char * Read();
```

```
void main()
{
  printf("%s",Read());
}
char * Read()
{
  char *p;
  int n;
  printf("\nEnter the number of characters in the string : ");
  scanf("%d",&n);
  fflush(stdin);
  p=(char *)malloc(sizeof(char)*n);
  printf("\nEnter string : ");
  gets(p);
  return p;
}
```

OUTPUT-



Q11. WAP of Fibonacci series using pointers.

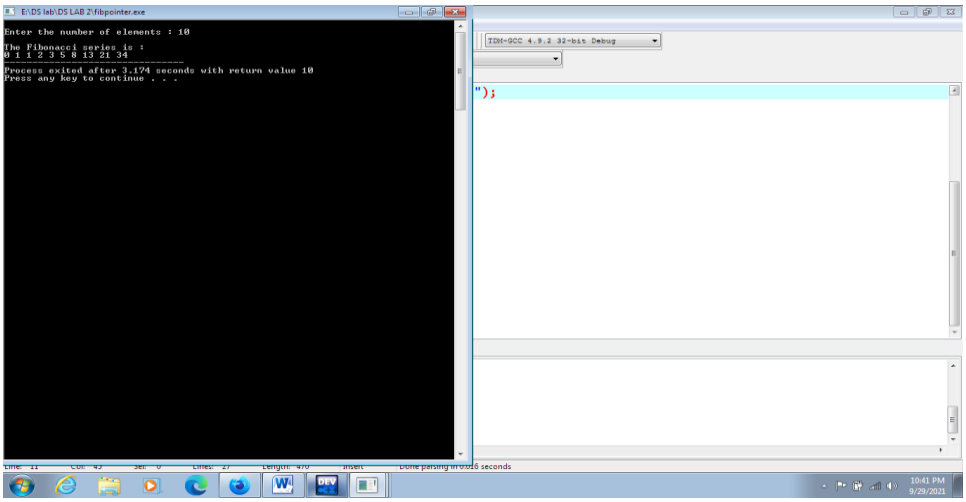
Ans11.

C PROGRAM –

```
#include<stdio.h>
#include<malloc.h>
#include<stdlib.h>
int * Fibo(int n);
void main()
{
  int n,i;
  int *q;
  printf("\nEnter the number of elements : ");
  scanf("%d",&n);
  q=Fibo(n);
  printf("\nThe Fibonacci series is : \n");
  for(i=0;i<n;i++)
  printf("%d ",*(q+i));
}
```

```
int * Fibo(int n)
{
  int *p,i,A,B,C;
  p=(int *)malloc(sizeof(int)*n);
  for(i=0,A=0,B=1;i<n;i++)
  {
    *(p+i)=A;
    C=A+B;
    A=B;
    B=C;
  }
  return p;
}
```

OUTPUT-



PROGRAMS BASED ON STACK

Q12. WAP to implement the basic operations of STACK.

Ans12.

C PROGRAM –

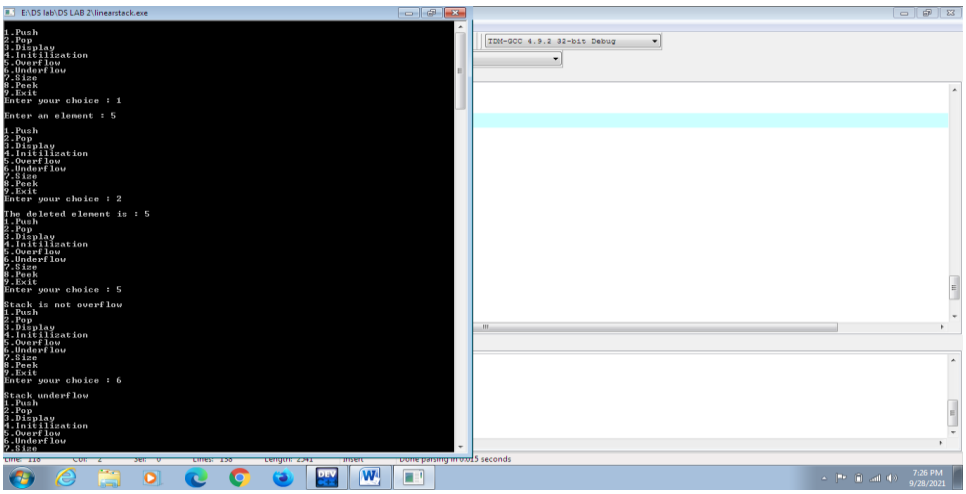
```
#include<stdio.h>
int top=-1;
#define max 20
int stk[max];
void init();
void push(int);
int pop();
void print();
int underflow();
int overflow();
int size();
int peek();
int main()
```

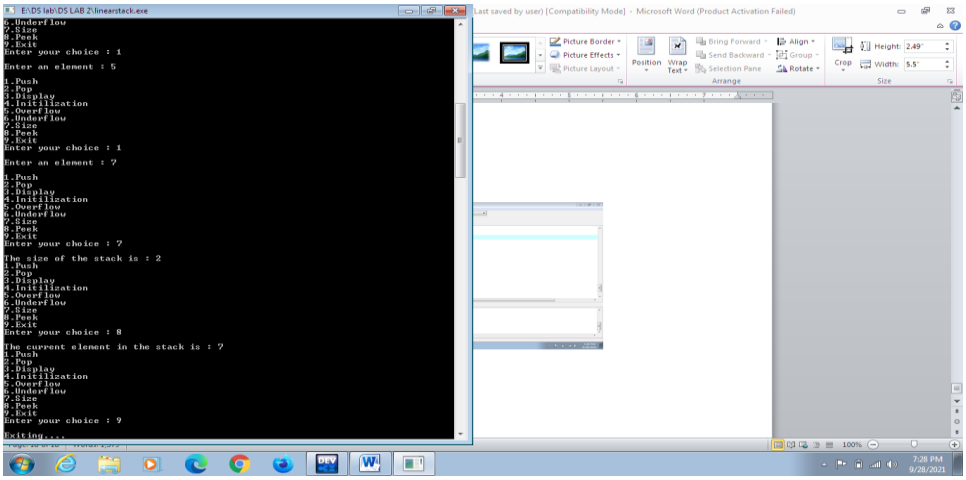
```
{
 int ch,n,y;
 do
 {
  printf("\n1.Push \n2.Pop \n3.Display \n4.Initilization \n5.Overflow \n6.Underflow \n7.Size \n8.Peek
    \n9.Exit");
  printf("\nEnter your choice : ");
  scanf("%d",&ch);
  switch(ch)
  {
   case 1:
        printf("\nEnter an element : ");
        scanf("%d",&n);
        push(n);
        break;
   case 2:
        y=(pop());
        if(y!=-999)
        printf("\nThe deleted element is : %d",y);
        break;
   case 3:
        print();
        break;
   case 4:
        init();
        break;
   case 5:
        if (overflow())
        printf("\nStack overflow");
        else
        printf("\nStack is not overflow");
        break;
   case 6:
        if (underflow())
        printf("\nStack underflow");
        else
        printf("\nStack is not underflow");
        break;
   case 7:
        printf("\nThe size of the stack is : %d",size());
        break;
   case 8:
        if(peek())
        printf("\nThe current element in the stack is : %d",peek());
        else
        printf("\nThere is no element to display");
        break;
   case 9:
        printf("\nExiting....");
```

```
            break;
        default:
            printf("\nWrong choice");
    }
  }while(ch!=9);
  return 0;
}
void init()
{
   top=-1;
}
void push(int x)
{
      if(overflow())
      printf("\nStack overflow");
      else
      {
      top++;
      stk[top]=x;
    }
}
int pop()
{
      int x;
      if(underflow())
      {
      printf("\nStack underflow");
      return -999;
    }
    else
    {
      x=stk[top];
      top--;
      return x;
    }
}
void print()
{
    int i;
    if(top==-1)
    printf("\nThere is no element to display");
    else
    {
      printf("\nThe elements of the stack are : \n");
      for(i=top;i>-1;i--)
      {
        printf("%d\t",stk[i]);
      }
    }
```

```
}
int overflow()
{
  if(top==max-1)
     return 1;
  else
     return 0;
}
int underflow()
{
  if(top==-1)
     return 1;
  else
     return 0;
}
int size()
{
  int y;
  y=top+1;
  return y;
}
int peek()
{
  if(top==-1)
  return 0;
  else
  return stk[top];
}
```

OUTPUT-





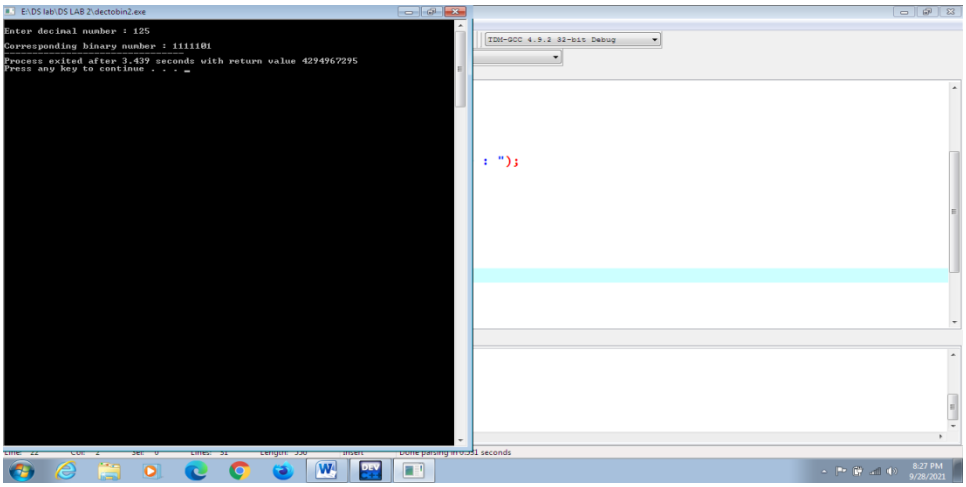
Q13. WAP to convert a decimal number into binary using STACK.

Ans13.

C PROGRAM –

```
#include<stdio.h>
#define max 50
void push(int [],int *,int *);
int pop(int [],int *);
void main()
{
   int n,r;
   int stack[max];
   int top=-1;
   printf("\nEnter decimal number : ");
   scanf("%d",&n);
   while(n>0)
     push(stack,&top,&n);
   printf("\nCorresponding binary number : ");
   while(top>-1)
   {
     r=pop(stack,&top);
     printf("%d",r);
     }
}
void push(int stack[],int *top,int *a)
{
     stack[++(*top)]=*a%2;
     *a=*a/2;
}
int pop(int stack[],int *top)
{
     int x;
     x=stack[(*top)--];
     return x;
}
```

OUTPUT-



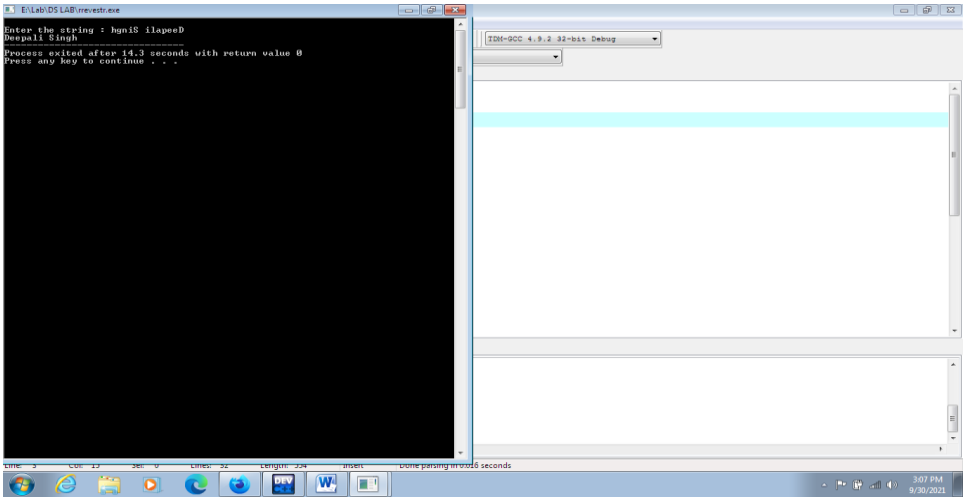
Q14. WAP to reverse a string using STACK.

Ans14.

C PROGRAM –

```
#include<stdio.h>
#include<string.h>
#define MAX 50
void push(char);
void pop();
int top;
char stack[MAX];
int main()
{
  char str[MAX];
  printf("\nEnter the string : ");
  gets(str);
  int len=strlen(str);
  int i;
  for(i=0;i<len;i++)
   push(str[i]);
  for(i=0;i<len;i++)
   pop();
  return 0;
}
void push(char x)
{
if(top==MAX-1)
        printf("\nStack overflow");
       else
        stack[++top]=x;
}
void pop()
{
    printf("%c",stack[top--]);
}
```

OUTPUT-



Q15. WAP to check whether the parentheses are balanced or not in a given expression using STACK.

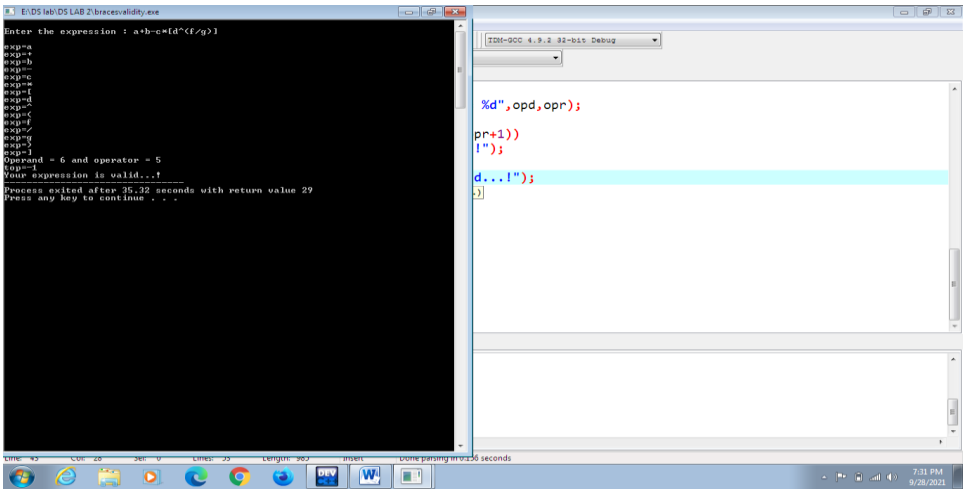
Ans15.

C PROGRAM –

```
#include<stdio.h>
#include<ctype.h>
#define max 50
int stk[max];
int top=-1;
void push(char);
void pop();
void main()
{
    char exp[max];
    int i,opr=0,opd=0;
    char ch;
    printf("\nEnter the expression : ");
    gets(exp);
    for(i=0;exp[i]!='\0';i++)
    {
       ch=exp[i];
       printf("\nexp=%c",ch);
       if(ch=='('||ch=='{'||ch=='['
       push(ch);
       else if(isalpha(ch))
       opd++;
       else if(ch==')'||ch=='}'||ch==']')
       {
         if(top==-1)
         break;
         else
         {
                  if(stk[top]=='('&&ch==')'||stk[top]=='['&&ch==']'||stk[top]=='{'&&ch=='}')
                  pop();
                  else
                  break;
```

```
                }
            }
        else
        opr++;
    }
    printf("\nOperand = %d and operator = %d",opd,opr);
    printf("\ntop=%d",top);
    if((top==-1)&&(exp[i]=='\0')&&(opd==opr+1))
    printf("\nYour expression is valid...!");
    else
    printf("\nYour expression is not valid...!");
}
void push(char ch)
{
    stk[++top]=ch;
}
void pop()
{
    int x;
    x=stk[top--];
}
```

OUTPUT-



Q16. WAP to covert an infix expression into postfix.

Ans16.

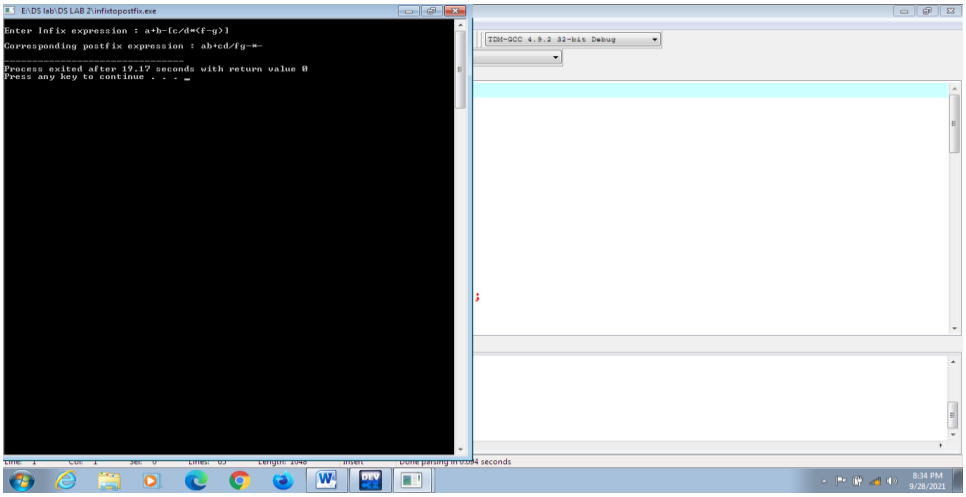
C PROGRAM –

```
#include<stdio.h>
#include<string.h>
#include<stdlib.h>
#define max 50
char stk[max];
int top=-1;
void push(char);
int pop();
int prec(char);
void main()
```

```
{
        char exp[max],post[max];
        int i,j=0,k;
        char ch;
        printf("\nEnter Infix expression : ");
        gets(exp);
        for(i=0;exp[i]!='\0';i++)
        {
                ch=exp[i];
                if(ch=='['||ch=='{')
                ch='(';
                else if(ch==']'||ch=='}')
                ch=')';
                if(isalpha(ch))
           post[j++]=ch;
           else if(ch=='(')
           push(ch);
           else if(ch==')')
           {
                while(stk[top]!='(')
                post[j++]=pop();
                top--;
                }
                else
                {
                        for(k=top;((k>-1) && (stk[k]!='(') && (prec(stk[top])>=prec(ch)));k--)
                        post[j++]=pop();
                        push(ch);
                }
        }
        while(top>-1)
        post[j++]=pop();
        post[j]='\0';
        printf("\nCorresponding postfix expression : ");
        puts(post);
}
void push(char ch)
{
        stk[++top]=ch;
}
int pop()
{
        int x;
        x=stk[top--];
        return x;
}
int prec(char x)
{
        if(x=='^')
```

```
        return 9;
        else if(x=='*'||x=='/')
        return 7;
        else if(x=='+'||x=='-')
        return 5;
}
```

OUTPUT-



Q17. WAP to covert an infix expression into prefix.

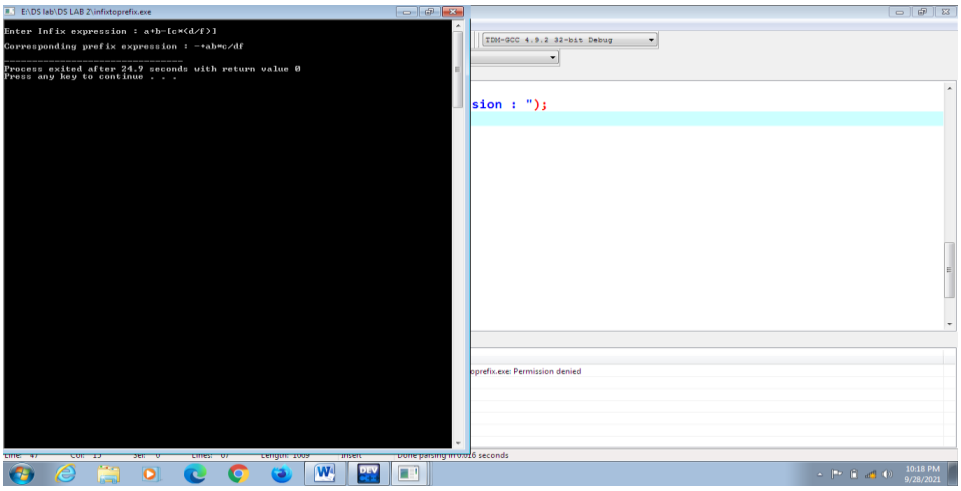
Ans17.

C PROGRAM –

```
#include<stdio.h>
#include<string.h>
#include<stdlib.h>
#define max 50
char stk[max];
int top=-1;
void push(char);
int pop();
int prec(char);
void main()
{
    char exp[max],pre[max];
    int i,j=0,k;
    char ch;
    printf("\nEnter Infix expression : ");
    gets(exp);
    strrev(exp);
    for(i=0;exp[i]!='\0';i++)
    {
        ch=exp[i];
        if(ch==']'||ch=='{')
        ch='(';
        else if(ch==']'||ch=='}')
        ch=')';
        if(isalpha(ch))
```

```
        pre[j++]=ch;
        else if(ch==')')
        push(ch);
        else if(ch=='(')
        {
          while(stk[top]!=')')
          pre[j++]=pop();
          top--;
          }
          else
          {
                    for(k=top;((k>-1) && (stk[k]!=')') && (prec(stk[top])>prec(ch)));k--)
                    pre[j++]=pop();
                    push(ch);
          }
    }
    while(top>-1)
    pre[j++]=pop();
    pre[j]='\0';
    strrev(pre);
    printf("\nCorresponding prefix expression : ");
    puts(pre);
}
void push(char ch)
{
    stk[++top]=ch;
}
int pop()
{
    int x;
    x=stk[top--];
    return x;
}
int prec(char x)
{
    if(x=='^')
    return 9;
    else if(x=='*'||x=='/')
    return 7;
    else if(x=='+'||x=='-')
    return 5;
}
```

OUTPUT-



Q18. WAP to evaluate a postfix expression.

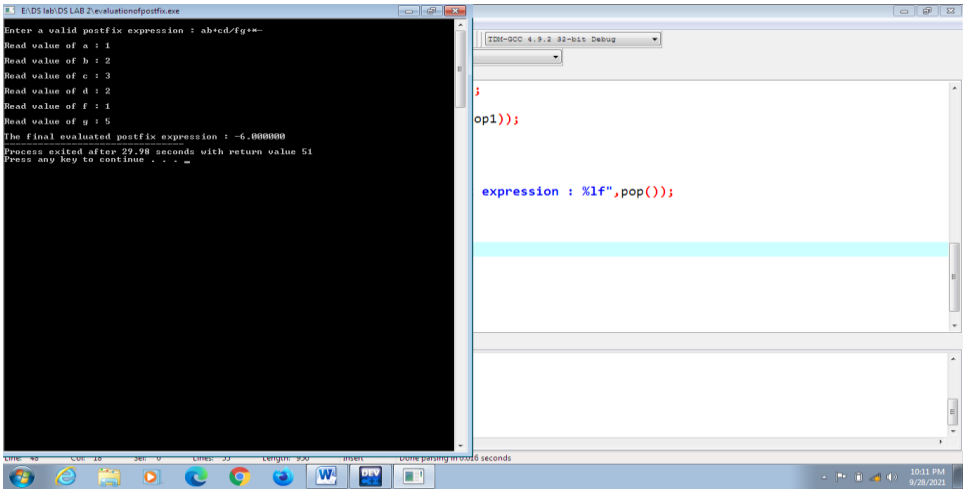
Ans18.

C PROGRAM –

```
#include<stdio.h>
#include<ctype.h>
#include<math.h>
#define max 30
void push(double);
double pop();
double stk[max];
int top=-1;
void main()
{
        char post[max],ch;
        int i;
        double op1,op2,n;
        printf("\nEnter a valid postfix expression : ");
        gets(post);
        for(i=0;post[i]!='\0';i++)
        {
                ch=post[i];
                if(isalpha(ch))
                {
                        printf("\nRead value of %c : ",ch);
                        scanf("%lf",&n);
                        push(n);
                }
                else
                {
                        op1=pop();
                        op2=pop();
                        switch(ch)
                        {
                                case '+' :  push(op2+op1);
                                        break;
```

```
                                case '-' :  push(op2-op1);
                                        break;
                                case '*' :  push(op2*op1);
                                        break;
                                case '/' :  push(op2/op1);
                                        break;
                                case '^' :  push(pow(op2,op1));
                                        break;
                        }
                }
        }
        printf("\nThe final evaluated postfix expression : %lf",pop());
}
void push(double n)
{
        stk[++top]=n;
        printf("\n%lf",stk[top]);
}
double pop()
{
        double x;
        x=stk[top--];
        return x;
}
```

OUTPUT-



PROGRAMS BASED ON QUEUE

Q19. WAP to implement the basic operations of QUEUE.

Ans19.

C PROGRAM –

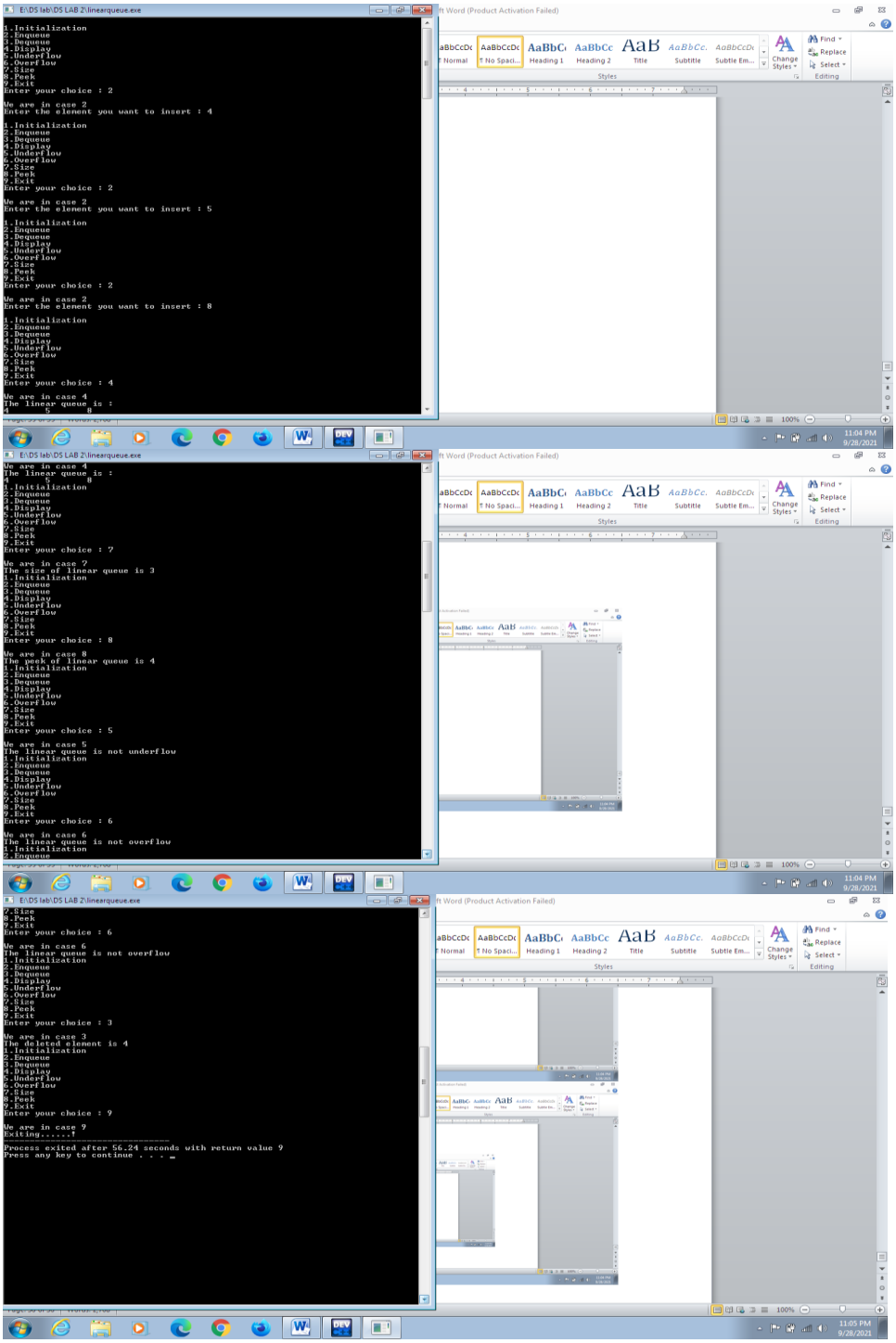
```
#include<stdio.h>
```

```
#define max 20
void init(int *, int *);
int underflow(int *, int *);
int underflow(int *, int *);
void display(int [],int *,int *);
int size(int *, int *);
int peek(int [],int *, int *);
void enqueue(int [],int *, int *, int);
int dequeue(int [],int *, int *);
void main()
{
        int ch,LQ[max],R=-1,F=-1,y,z,k;
        do
        {
         printf("\n1.Initialization \n2.Enqueue \n3.Dequeue \n4.Display");
         printf("\n5.Underflow \n6.Overflow \n7.Size \n8.Peek \n9.Exit");
         printf("\nEnter your choice : ");
         scanf("%d",&ch);
         switch(ch)
         {
                case 1: printf("\nWe are in case 1");
                        init(&R,&F);
                        break;
                case 2: printf("\nWe are in case 2");
                        printf("\nEnter the element you want to insert : ");
                        scanf("%d",&y);
                        enqueue(LQ,&R,&F,y);
                        break;
                case 3: printf("\nWe are in case 3");
                        k=dequeue(LQ,&R,&F);
                        if(k!=999)
                        printf("\nThe deleted element is %d",k);
                        else
                        printf("\nThere is no element for deletion");
                        break;
                case 4: printf("\nWe are in case 4");
                        display(LQ,&R,&F);
                        break;
                case 5: printf("\nWe are in case 5");
                        if(underflow(&R,&F))
                        printf("\nThe linear queue is underflow");
                        else
                        printf("\nThe linear queue is not underflow");
                        break;
                case 6: printf("\nWe are in case 6");
                        if(overflow(&R,&F))
                        printf("\nThe linear queue is overflow");
                        else
                        printf("\nThe linear queue is not overflow");
```

```
                    break;
                case 7: printf("\nWe are in case 7");
                    if(size(&R,&F))
                                printf("\nThe size of linear queue is %d",size(&R,&F));
                                else
                                printf("\nThe size of linear queue is 0");
                    break;
                case 8: printf("\nWe are in case 8");
                    if(peek(LQ,&R,&F)!=999)
                                printf("\nThe peek of linear queue is %d",(peek(LQ,&R,&F)));
                                else
                                printf("\nThe linear queue is empty");
                    break;
                case 9: printf("\nWe are in case 9");
                printf("\nExiting.....!");
                    break;
                default:
                    printf("\nWe are in default case");
            }
   }while(ch!=9);
}
void init(int *R, int *F)
{
        *R=*F=-1;
}
int underflow(int *R, int *F)
{
        if(*F==-1)
        return 1;
        else
        return 0;
}
int overflow(int *R,int *F)
{
        if(*R==max-1)
        return 1;
        else
        return 0;
}
int size(int *R, int *F)
{
        if(*F==-1)
        return 0;
        else
        return (*R-*F+1);
}
int peek(int Q[], int *R, int *F)
{
        if(*F==-1)
```

```
        return 999;
        else
        return Q[*F];
}
void display(int Q[], int *R, int *F)
{
        int i;
        if(*F==-1)
        printf("\nThe linear queue is empty");
        else
        {
                printf("\nThe linear queue is : \n");
                for(i=*F;i<=*R;i++)
                printf("%d\t",Q[i]);
        }
}
void enqueue (int Q[],int *R,int *F,int x)
{
        if(*R==max-1)
        printf("\nThe linear queue is overflow");
        else
        {
                if(*R==-1)
                *F=*R=0;
                else
                (*R)++;
                Q[*R]=x;
        }
}
int dequeue(int Q[],int *R,int *F)
{
        int x;
        if(*F==-1)
        return 999;
        else
        {
          x=Q[*F];
          if(*F==*R)
          *F=*R=-1;
          else
          (*F)++;
          return x;
        }
}
```

OUTPUT-



Q20. WAP to implement the basic operations of CIRCULAR QUEUE.

Ans20.

C PROGRAM –

```
#include <stdio.h>
#define SIZE 5
int cq[SIZE];
int f=-1, r=-1;
void init();
int size();
int peek();
int isFull();
```

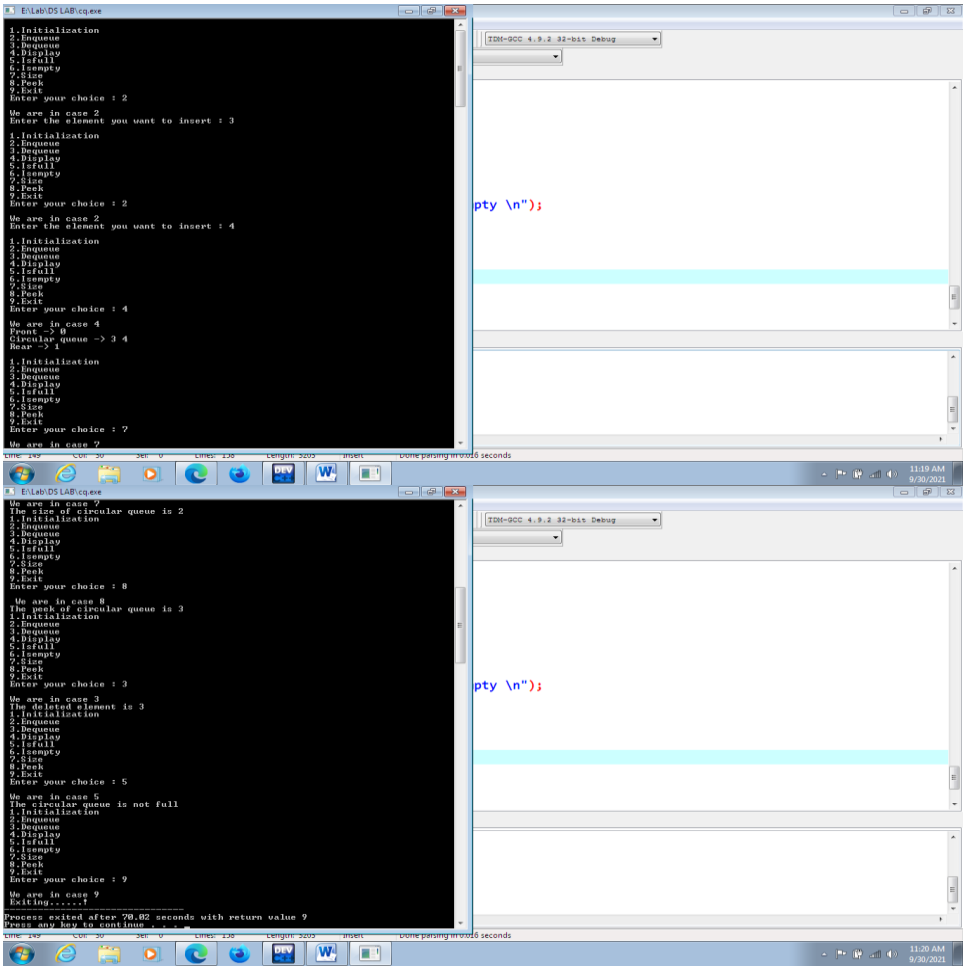
```
int isEmpty();
void enqueue(int) ;
int dequeue();
void display();
void main()
{
        int ch,y,z,k;
        do
        {
         printf("\n 1.Initialization \n 2.Enqueue \n 3.Dequeue \n 4.Display");
         printf("\n 5.Isfull \n 6.Isempty \n 7.Size \n 8.Peek \n 9.Exit");
         printf("\n Enter your choice : ");
         scanf("%d",&ch);
         switch(ch)
         {
                case 1: printf("\n We are in case 1");
                        init();
                        break;
                case 2: printf("\n We are in case 2");
                        printf("\n Enter the element you want to insert : ");
                        scanf("%d",&y);
                        enqueue(y);
                        break;
                case 3: printf("\n We are in case 3");
                        k=dequeue();
                        if(k!=999)
                        printf("\n The deleted element is %d",k);
                        else
                        printf("\n There is no element for deletion");
                        break;
                case 4: printf("\n We are in case 4");
                        display();
                        break;
                case 5: printf("\n We are in case 5");
                        if(isFull())
                        printf("\n The circular queue is full");
                        else
                        printf("\n The circular queue is not full");
                        break;
                case 6: printf("\n We are in case 6");
                        if(isEmpty())
                        printf("\n The circular queue is empty");
                        else
                        printf("\n The circular queue is not empty");
                        break;
                case 7: printf("\n We are in case 7");
                        if(size())
                                printf("\n The size of circular queue is %d",size());
                                else
```

```
                        printf("\n The size of circular queue is 0");
                    break;
                case 8: printf("\n  We are in case 8");
                    if(peek()!=999)
                        printf("\n The peek of circular queue is %d",(peek()));
                        else
                        printf("\n The circular queue is empty");
                    break;
                case 9: printf("\n We are in case 9");
                printf("\n Exiting.....!");
                    break;
                default:
                    printf("\n We are in default case");
            }
   }while(ch!=9);
}
void init()
{
        r=f=-1;
}
int size()
{
        if(f==-1)
        return 0;
        else if(r>=f)
        return (r-f+1);
        else
        return (SIZE-f+r+1);
}
int peek()
{
        if(f==-1)
        return 999;
        else
        return cq[f];
}
int isFull()
{
 if((f==r+1)||(f==0 && r==SIZE-1))
 return 1;
 else
 return 0;
}
int isEmpty()
{
 if (f==-1)
 return 1;
 else
 return 0;
```

```
}
void enqueue(int m)
{
  if (isFull())
    printf("\n Queue is full!! \n");
  else
  {
    if (f==-1)
          f=0;
    r=(r+1)%SIZE;
    cq[r]=m;
  }
}
int dequeue()
{
  int m;
  if (isEmpty())
    return 999;
  else
  {
    m=cq[f];
    if(f==r)
          {
      f=-1;
      r=-1;
    }
    else
          {
      f=(f+1)%SIZE;
    }
    return(m);
  }
}
void display()
{
  int i;
  if (isEmpty())
    printf(" \n The circular queue is empty \n");
  else
  {
    printf("\n Front -> %d ", f);
    printf("\n Circular queue -> ");
    for(i=f; i!=r; i=(i+1)%SIZE)
          {
      printf("%d ", cq[i]);
    }
    printf("%d ", cq[i]);
    printf("\n Rear -> %d \n", r);
  }
```

}

OUTPUT-



Q21. WAP to implement the basic operations of a PRIORITY QUEUE.

Ans21.

C PROGRAM –

```
#include<stdio.h>
#define N 5
int Q[N],P[N];
int r=-1,f=-1;
void init();
void display();
void enqueue(int,int);
void dequeue();
int isempty();
int isfull();
int size();
int peek();
int main()
{
        int ch,data,p,i,n;
        do
        {
                printf("\n 1. Initializtion \n 2. Enqueue \n 3. Display \n 4. Dequeue");
```

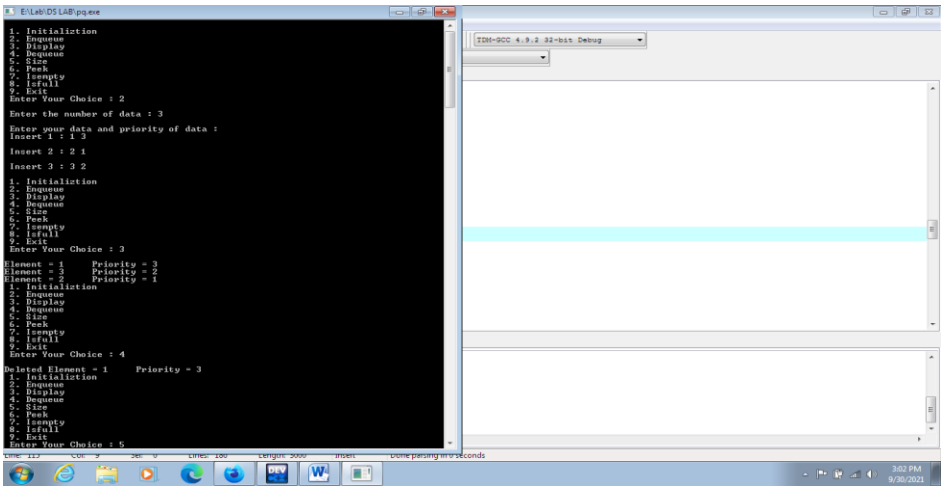
```
printf("\n 5. Size \n 6. Peek \n 7. Isempty \n 8. Isfull \n 9. Exit");
printf("\n Enter Your Choice : ");
scanf("%d",&ch);
switch(ch)
{
        case 1:
                init();
                break;
        case 2:
                printf("\n Enter the number of data : ");
                scanf("%d",&n);
                printf("\n Enter your data and priority of data : ");
                i=0;
                while(i<n)
                {
                        printf("\n Insert %d : ",i+1);
                        scanf("%d %d",&data,&p);
                        enqueue(data,p);
                        i++;
                }
                break;
        case 3:
                display();
                break;
        case 4:
                dequeue();
                break;
        case 5:
                if(size())
                printf("\nThe size of priority queue is %d",size());
                else
                printf("\nThe size of priority queue is 0");
                break;
        case 6:
                if(peek()!=999)
                printf("\nThe peek of priority queue is %d",peek());
                else
                printf("\nThe priority queue is empty");
    break;
        case 7:
                if(isempty())
    printf("\nThe priority queue is empty");
    else
    printf("\nThe priority queue is not empty");
    break;
        case 8:
                if(isfull())
    printf("\nThe priority queue is full");
    else
```

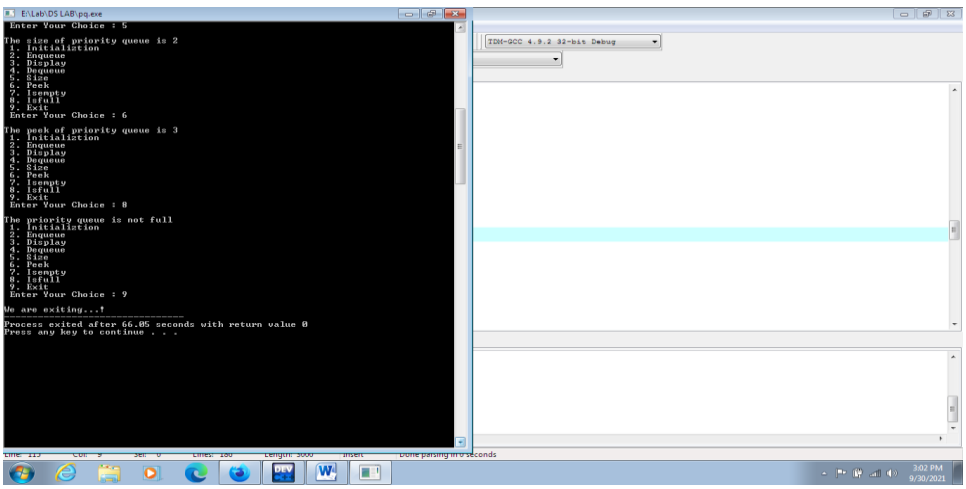
```
                        printf("\nThe priority queue is not full");
                        break;
                            case 9:
                                    printf("\nWe are exiting...!");
                                    break;
                            default:
                                    printf("\nIncorrect Choice");
                    }
        }while(ch!=9);
   return 0;
}
void init()
{
        r=f=-1;
}
int isempty()
{
        if(f==-1)
        return 1;
        else
        return 0;
}
int isfull()
{
        if(r==N-1)
        return 1;
        else
        return 0;
}
int size()
{
        if(f==-1)
        return 0;
        else
        return (r-f+1);
}
int peek()
{
        if(f==-1)
        return 999;
        else
        return Q[f];
}
void enqueue(int d,int p)
{
        int i;
        if((f==0)&&(r==N-1))
        printf("\nQueue is full");
        else
```

```
	{
		if(f==-1)
		{
			f=r=0;
			Q[r]=d;
			P[r]=p;
		}
		else if(r==N-1)
		{
			for(i=f;i<=r;i++)
			{
			  Q[i-f]=Q[i];
				P[i-f]=P[i];
				r=r-f;
				f=0;
				for(i=r;i>f;i--)
				{
					if(p>P[i])
					{
						Q[i+1]=Q[i];
						P[i+1]=P[i];
					}
					else
					break;
					Q[i+1]=d;
					P[i+1]=p;
					r++;
				}
			}
		}
		else
		{
			for(i=r;i>=f;i--)
			{
				if(p>P[i])
				{
					Q[i+1]=Q[i];
					P[i+1]=P[i];
				}
				else
				break;
			}
			Q[i+1]=d;
			P[i+1]=p;
			r++;
		}
	}
}
void display()
```

```
{
int i;
 if(f==-1)
        printf("\nQueue is Empty");
        else
        for(i=f;i<=r;i++)
        printf("\nElement = %d\tPriority = %d",Q[i],P[i]);
}
void dequeue()
{
        if(f==-1)
        printf("\nQueue is Empty");
        else
        {
                printf("\nDeleted Element = %d\tPriority = %d",Q[f],P[f]);
                if(f==r)
                f=r=-1;
                else
                f++;
        }
}
```

OUTPUT-





Q22. WAP for linear search.

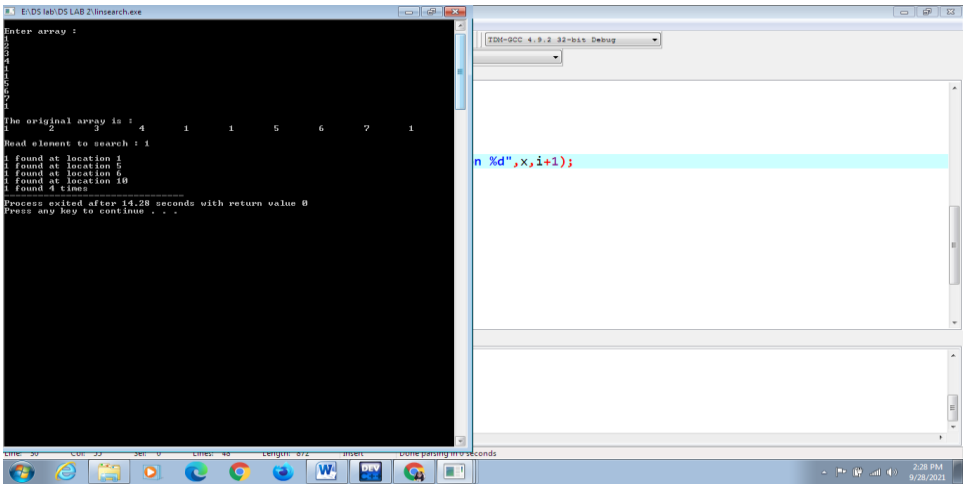
Ans22.

C PROGRAM –

```
#include<stdio.h>
int linsearch(int [],int,int);
void print(int [],int);
int main()
{
	int a[100],i,j,n,x,r;
	printf("\nEnter the number of elements in array : ");
	scanf("%d",&n);
	printf("\nEnter array : \n");
	for(i=0;i<n;i++)
	scanf("%d",&a[i]);
	printf("\nThe original array is : \n");
	print(a,n);
	printf("\nRead element to search : ");
	scanf("%d",&x);
	r=linsearch(a,n,x);
	if(r!=-999)
	printf("\n%d found %d times",x,r);
	else
	printf("\n%d not found",x);
	return 0;
}
int linsearch(int a[], int n, int x)
{
	int i,c=0;
	for(i=0;i<n;i++)
	{
		if(a[i]==x)
		{
			printf("\n%d found at location %d",x,i+1);
			c++;
		}
		else
		continue;
	}
	if(c==0)
	return -999;
	else
	return c;
}
void print(int a[],int n)
{
	int i;
```

```
        for(i=0;i<n;i++)
        printf("%d\t",a[i]);
}
```

OUTPUT-



Q23. WAP for binary search.

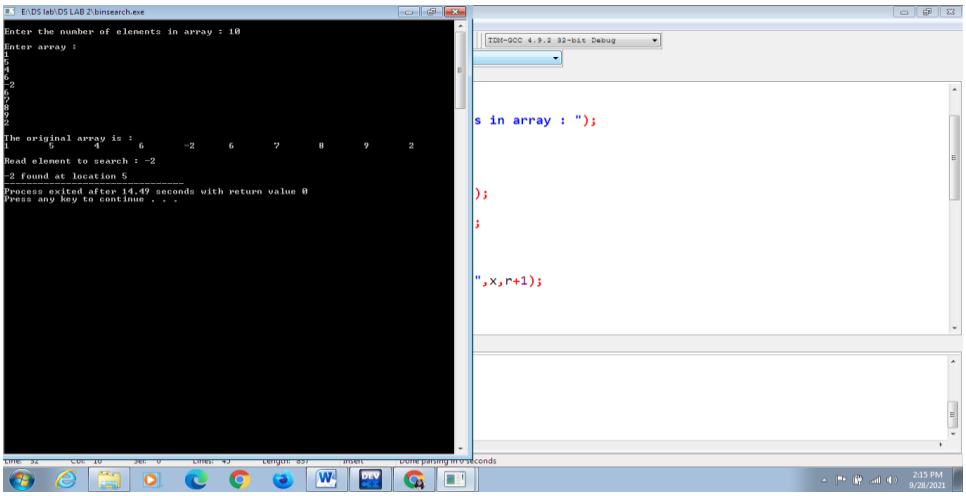
Ans23.

C PROGRAM –

```
#include<stdio.h>
int binsearch(int [],int,int);
void print(int [],int);
int main()
{
    int a[100],i,j,n,x,r;
    printf("\nEnter the number of elements in array : ");
    scanf("%d",&n);
    printf("\nEnter array : \n");
    for(i=0;i<n;i++)
        scanf("%d",&a[i]);
    printf("\nThe original array is : \n");
 print(a,n);
 printf("\nRead element to search : ");
scanf("%d",&x);
    r=binsearch(a,n,x);
    if(r!=-999)
       printf("\n%d found at location %d",x,r+1);
    else
    printf("\n%d not found",x);
return 0;
}
int binsearch(int a[], int n, int x)
{
    int l=0,h=n-1,m;
    do
    {
        m=(l+h)/2;
```

```
        if(x<a[m])
          h=m-1;
        else if(x>a[m])
          l=m+1;
        else
          return m;
    }while(l<=h);
    return -999;
}
void print(int a[],int n)
{
int i;
  for(i=0;i<n;i++)
  {
      printf("%d\t",a[i]);
  }
}
```

OUTPUT-



PROGRAMS BASED ON SORTING

Q24. WAP for Bubble sort.

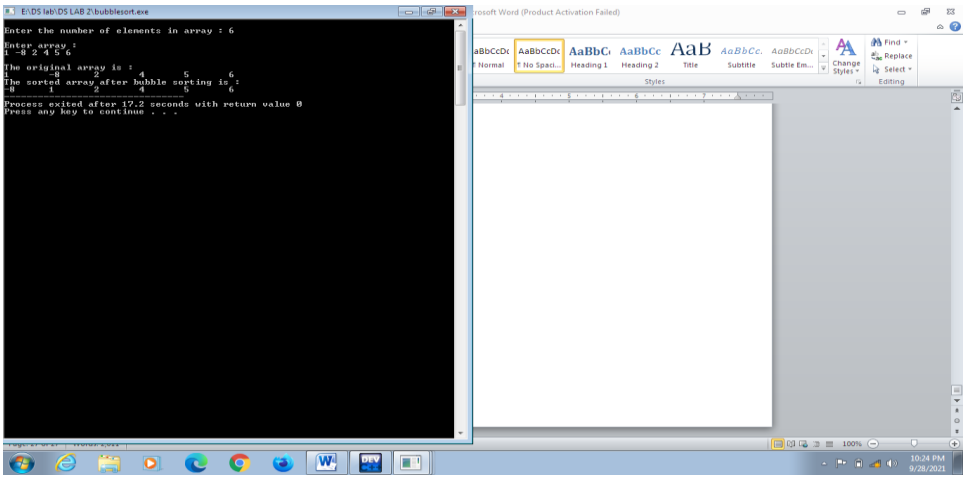
Ans24.

C PROGRAM –

```
#include<stdio.h>
void bsort(int [],int);
void print(int [],int);
int main()
{
        int a[100],i,j,n,x,r;
        printf("\nEnter the number of elements in array : ");
        scanf("%d",&n);
        printf("\nEnter array : \n");
```

```
        for(i=0;i<n;i++)
                scanf("%d",&a[i]);
        printf("\nThe original array is : \n");
   print(a,n);
   bsort(a,n);
   printf("\nThe sorted array after bubble sorting is : \n");
   print(a,n);
   return 0;
}
void bsort(int a[], int n)
{
   int i,j,t;
   for(i=1;i<n;i++)
    for(j=0;j<n-i;j++)
    {
        if(a[j]>a[j+1])
        {
                t=a[j];
                a[j]=a[j+1];
                a[j+1]=t;
                }
         }
}
void print(int a[],int n)
{
        int i;
   for(i=0;i<n;i++)
   {
          printf("%d\t",a[i]);
   }
}
```

OUTPUT-



Q25. WAP for Selection sort.

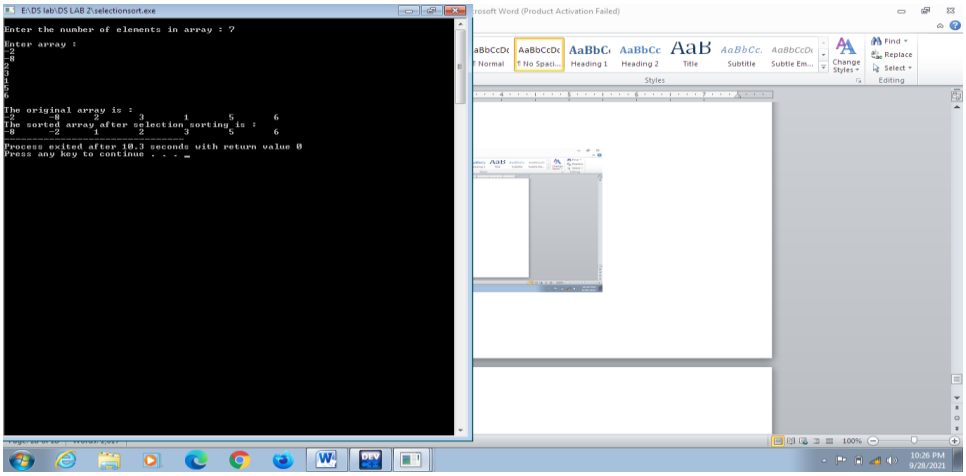
Ans25.

C PROGRAM –

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

```
void ssort(int [],int);
int main()
{
	int a[10],i,j,n;
	printf("\nEnter the number of elements in array : ");
	scanf("%d",&n);
	printf("\nEnter array : \n");
	for(i=0;i<n;i++)
	{
		scanf("%d",&a[i]);
	}
	printf("\nThe original array is : \n");
	for(i=0;i<n;i++)
	{
		printf("%d\t",a[i]);
	}
	ssort(a,n);
	printf("\nThe sorted array after selection sorting is : \n");
	for(i=0;i<n;i++)
	{
		printf("%d\t",a[i]);
	}
	return 0;
}
void ssort(int a[],int n)
{
	int i,j,min,t;
	for(i=0;i<n-1;i++)
	{
		min=i;
		for(j=i+1;j<n;j++)
		  if(a[min]>a[j])
		    min=j;
		t=a[i];
		a[i]=a[min];
		a[min]=t;
	}
}
```

OUTPUT-



Q26. WAP for Insertion sort.

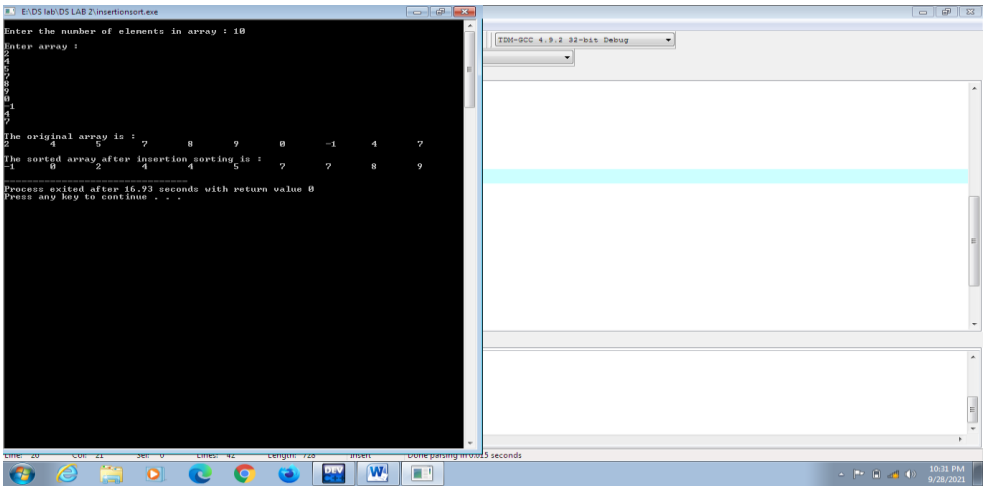
Ans26.

C PROGRAM –

```
#include<stdio.h>
void isort(int [],int);
void print(int [],int);
int main()
{
	int a[10],i,j,n;
	printf("\nEnter the number of elements in array : ");
	scanf("%d",&n);
	printf("\nEnter array : \n");
	for(i=0;i<n;i++)
	{
		scanf("%d",&a[i]);
	}
	printf("\nThe original array is : \n");
	for(i=0;i<n;i++)
	{
		printf("%d\t",a[i]);
	}
	isort(a,n);
	print(a,n);
	return 0;
}
void isort(int a[],int n)
{
	int i,j,key;
	for(i=1;i<n;i++)
	{
		key=a[i];
		for(j=i-1;(j>-1)&&(a[j]>key);j--)
		  a[j+1]=a[j];
		a[j+1]=key;
   }
}
```

```
void print(int a[],int n)
{
        int i;
   printf("\nThe sorted array after insertion sorting is : \n");
   for(i=0;i<n;i++)
   {
          printf("%d\t",a[i]);
   }
}
```

OUTPUT-



Q27. WAP for Quick sort.

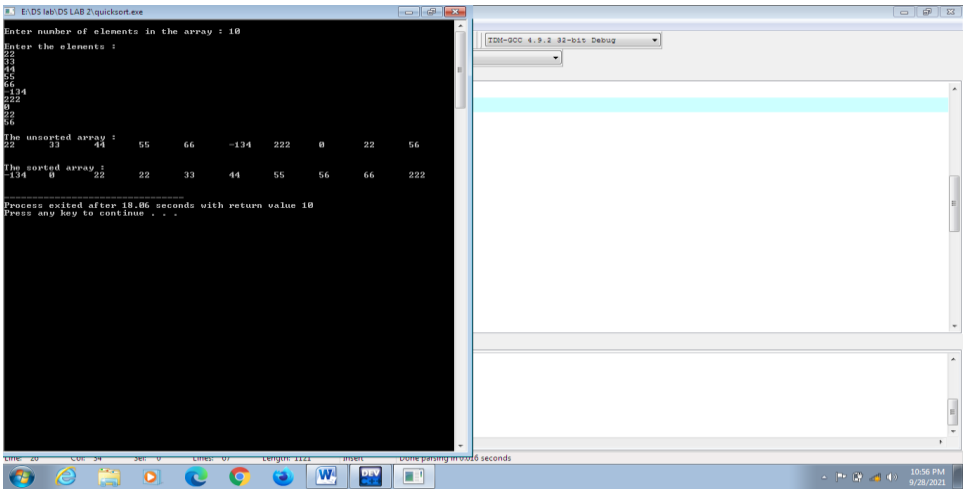
Ans27.

C PROGRAM –

```
#include<stdio.h>
void quicksort(int [], int, int);
int partition(int [], int, int);
void swap(int *, int *);
void read(int[],int);
void print(int[],int);
void main()
{
        int n;
        int a[50];
        printf("\nEnter number of elements in the array : ");
        scanf("%d",&n);
        printf("\nEnter the elements : \n");
        read(a,n);
        printf("\nThe unsorted array : \n");
        print(a,n);
        quicksort(a,0,n-1);
        printf("\nThe sorted array : \n");
        print(a,n);
}
void quicksort(int b[], int low, int high)
{
```

```
        int pi,n=7;
        if(low<high)
        {
                pi=partition(b,low,high);
                quicksort(b,low,pi-1);
                quicksort(b,pi+1,high);
        }
}
int partition(int c[], int low, int high)
{
        int pivot,i,j;
        pivot=c[high];
        i=low-1;
        for(j=low;j<high;j++)
        {
                if(c[j]<pivot)
                {
                        i++;
                        if(i!=j)
                        swap(&c[i],&c[j]);
                }
        }
        swap(&c[i+1],&c[high]);
        return (i+1);
}
void swap(int *a, int *b)
{
        int temp;
        temp=*a;
        *a=*b;
        *b=temp;
}
void read(int d[],int n)
{
        int i;
        for(i=0;i<n;i++)
        scanf("%d",&d[i]);
}
void print(int d[],int n)
{
        int i;
        for(i=0;i<n;i++)
        printf("%d\t",d[i]);
        printf("\n");
}
```

OUTPUT-



PROGRAMS BASED ON LINKED LIST

Q28. WAP for implementing Linked List with all basic operations - All insertions Deletions etc.

Ans28.

C PROGRAM –

```
#include<stdio.h>
#include<malloc.h>
struct node
{
        int data;
        struct node *next;
};
typedef struct node Node;
Node *start=NULL;
void init();
Node * createnode(int);
void insertf(int);
void insertl(int);
void insertr(int,int);
void insertm(int);
void display();
int deletef();
int deletel();
int deleter(int);
int deletem();
void delspdata(int);
int size();
void lsearch(int);
void main()
{
        int ch,a,loc,key,u;
        do
        {
```

```
        printf("\n 1. Initialization \n 2. Insert First \n 3. Insert Random \n 4. Insert Middle \n 5. Insert Last \n 6. Display");
        printf("\n 7. Delete First \n 8. Delete Random \n 9. Delete Middle \n 10. Delete Last \n 11. Delete specific data");
        printf("\n 12. Size \n 13. Exit");
        printf("\n Enter your choice : ");
        scanf("%d",&ch);
        switch(ch)
        {
             case 1:
               init();
               break;
            case 2:
              printf("\n Enter element to insert : ");
              scanf("%d",&a);
              insertf(a);
                 break;
            case 3:
              printf("\n Enter element to insert : ");
              scanf("%d",&a);
              printf("\n Enter position to insert : ");
              scanf("%d",&loc);
              insertr(a,loc);
                 break;
             case 4:
                printf("\n Enter element to insert : ");
              scanf("%d",&a);
              insertm(a);
              break;
             case 5:
                printf("\n Enter element to insert : ");
              scanf("%d",&a);
              insertl(a);
                 break;
            case 6:
              display();
                 break;
             case 7:
                u=deletef();
                if(u==-999)
                printf("\n Linked list is empty");
                else
                printf("\n Deleted element : %d",u);
                break;
             case 8:
                printf("\n Enter position to delete : ");
                scanf("%d",&loc);
                u=deleter(loc);
                if(u==-999)
```

```
                    printf("\n Linked list is empty");
                    else if(u==-9999)
                    printf("\n Deletion not possible");
                    else
                    printf("\n Deleted element : %d",u);
                    break;
                  case 9:
                    u=deletem();
                    if(u==-999)
                    printf("\n Linked list is empty");
                    else
                    printf("\n Deleted element : %d",u);
                    break;
                  case 10:
                    u=deletel();
                    if(u==-999)
                    printf("\n Linked list is empty");
                    else
                    printf("\n Deleted element : %d",u);
                    break;
                  case 11:
                    printf("\n Enter data to be deleted : ");
                    scanf("%d",&a);
                    delspdata(a);
                    break;
                  case 12:
                    if(size())
                    printf("\n Size of Linked list : %d",size());
                    else
                    printf("\n Size of Linked list : 0");
                    break;
                  case 13:
                    printf("\n We are exiting..Good Bye..!");
                    break;
                  default:
                    printf("\n Wrong choice entered..!");
              }
        }while(ch!=13);
}
void init()
{
        start=NULL;
}
Node * createnode(int x)
{
        Node *temp;
        temp=(Node *)malloc(sizeof(Node));
        temp->data=x;
        temp->next=NULL;
```

```
        return temp;
}
void insertf(int x)
{
        Node *temp;
        temp=createnode(x);
        if(start==NULL)
        start=temp;
        else
        {
                temp->next=start;
                start=temp;
        }
}
void insertl(int x)
{
        Node *temp,*p;
        temp=createnode(x);
        if(start==NULL)
        start=temp;
        else
        {
                for(p=start;p->next!=NULL;p=p->next);
                p->next=temp;
        }
}
void insertr(int x,int pos)
{
        Node *temp,*p;
        int i,l=size();
        if(start==NULL)
        printf("\n Linked list is empty");
        else if(pos<1 || pos>(l+1))
        {
                printf("\n Insertion not possible");
                return;
        }
        else if(pos==1)
        {
                insertf(x);
                return;
        }
        else if(pos==(l+1))
        {
                insertl(x);
                return;
        }
        else
        {
```

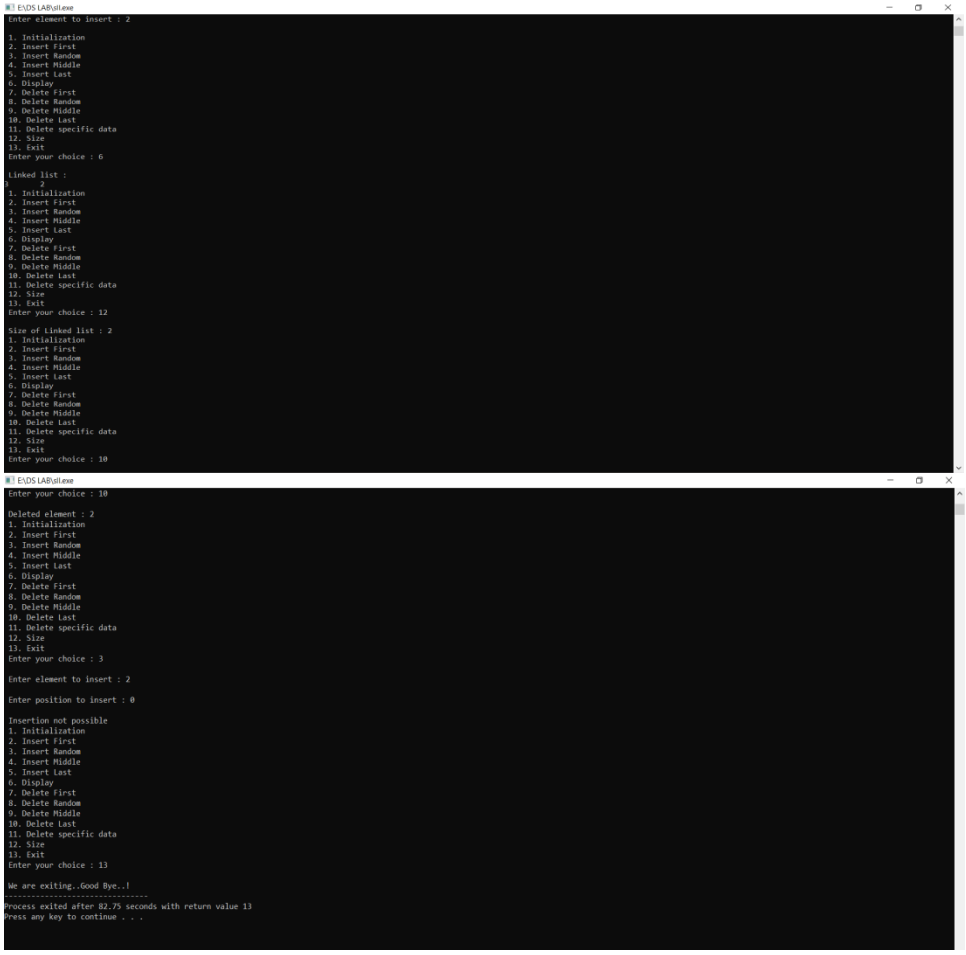
```
                temp=createnode(x);
                for(p=start,i=1;i<pos-1;i++,p=p->next);
                temp->next=p->next;
                p->next=temp;
                return;
        }
}
void insertm(int x)
{
        Node *temp,*p;
   int i;
   if(start==NULL)
   {
        temp=createnode(x);
        start=temp;
        }
   else
        {
                temp=createnode(x);
                for(p=start,i=1;i<(size()/2);i++,p=p->next);
                temp->next=p->next;
                p->next=temp;
        }
}
int size()
{
        Node *p;
        int c;
        if(start==NULL)
        return 0;
        else
        {
                for(p=start,c=0;p!=NULL;c++,p=p->next);
           return c;
        }
}
int deletef()
{
        Node *p;
        int x;
        if(start==NULL)
        return -999;
        else
        {
                p=start;
                start=p->next;
                x=p->data;
                free(p);
                return x;
```

```
        }
}
int deletel()
{
        Node *p,*t;
        int i,x;
        if(start==NULL)
        return -999;
        else if(size()==1)
        {
                deletef();
                return;
        }
        else
        for(p=start,i=1;i<(size()-1);i++,p=p->next);
        t=p->next;
        p->next=NULL;
        x=t->data;
        free(t);
        return x;
}
int deleter(int pos)
{
        Node *p,*t;
        int l=size(),x,i;
        if(start==NULL)
        return -999;
        else
        {
                if(pos<1 || pos>l)
                return -9999;
                else if(pos==1)
                {
                        deletef();
                        return;
                }
                else if(pos==l)
                {
                        deletel();
                        return;
                }
                else
                {
                        for(p=start,i=1;i<(pos-1);i++,p=p->next);
                        t=p->next;
                        p->next=t->next;
                        x=t->data;
                        free(t);
                        return x;
```

```
                }
        }
}
int deletem()
{
        Node *p,*t;
        int x,i;
        if(start==NULL)
        return -999;
        else if(size()==1)
        {
                t=start;
                start=NULL;
                x=t->data;
                free(t);
                return x;
        }
        else
        {
                for(p=start,i=1;i<(size()/2);i++,p=p->next);
                t=p->next;
                p->next=t->next;
                x=t->data;
                free(t);
                return x;
        }
}
void delspdata(int x)
{
        Node *p=start,*t;
        int flag=0;
        if(start==NULL)
        {
                printf("\n Linked list is empty");
                return;
        }
        else
        {
                while(p!=NULL)
        {
                  if(p==start)
                  {
                          if(start->data==x)
                          {
                                  flag++;
                                  start=start->next;
                                  p=start;
                          }
                          else
```

```
                {
                        t=p;
                        p=p->next;
                }
            }
            else if(p->data==x)
            {
                flag++;
                t->next=p->next;
                p=t->next;
            }
            else
            {
                t=p;
                p=p->next;
            }
        }
    }
    if(flag==0)
        printf("\n Element not found");
}
void display()
{
    Node *p,*t;
    if(start==NULL)
    {
        printf("\n Linked list is empty");
    }
    else
    {
        printf("\n Linked list : \n");
        for(p=start;p!=NULL;p=p->next)
    printf("%d\t",p->data);
    }
}
```

OUTPUT-



Q29. WAP for LL Create, Reversal and Display.

Ans29.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
        int info;
        struct node *next;
};
typedef struct node node;
node * createnode(int);
node * create(node *);
void display(node *);
node * reversll(node *);
void main()
{
        node *s=NULL;
        int ch;
        do
        {
          printf("\n 1. CREATE \n 2. DISPLAY \n 3. REVERSE \n 0. EXIT");
          printf("\n Enter your choice : ");
```

```
            scanf("%d",&ch);
            switch(ch)
            {
                        case 1:
                              s=create(s);
                              break;
                        case 2:
                           display(s);
                              break;
                        case 3:
                              s=reversll(s);
                              break;
                        case 0:
                              printf("\n Exiting");
                              break;
                        default:
                              printf("\n Wrong choice");
            }
          }while(ch!=0);
}
node * createnode(int x)
{
          node *temp;
          temp=(node *)malloc(sizeof(node));
          temp->info=x;
          temp->next=NULL;
          return temp;
}
node * create(node *s)
{
          node *temp,*p;
          int n,x,i;
          printf("\n Enter number of nodes in linked list : ");
          scanf("%d",&n);
          for(i=0;i<n;i++)
          {
                    printf("\n Enter data : ");
                    scanf("%d",&x);
                    temp=createnode(x);
                    if(s==NULL)
                    s=temp;
                    else
                    {
                              for(p=s;p->next!=NULL;p=p->next);
                       p->next=temp;
                    }
          }
          return s;
}
```

```
void display(node *s)
{
        node *p;
        if(s==NULL)
        printf("\n Linked list is empty");
        else
        {
                printf("\n LINKED LIST :\n");
          for(p=s;p!=NULL;p=p->next)
          printf(" %d ",p->info);
        }
}
node * reversll(node *s)
{
        node *pn=NULL,*cn=s,*nn=s;
        if(s==NULL || s->next==NULL)
                return s;
        else
        {
          while(nn!=NULL)
          {
                  nn=nn->next;
                  cn->next=pn;
                  pn=cn;
                  cn=nn;
          }
          s=pn;
          return s;
        }
}
```

OUTPUT-

Q30. WAP for LL Create, Search, Sort and Display.

Ans30

C PROGRAM –

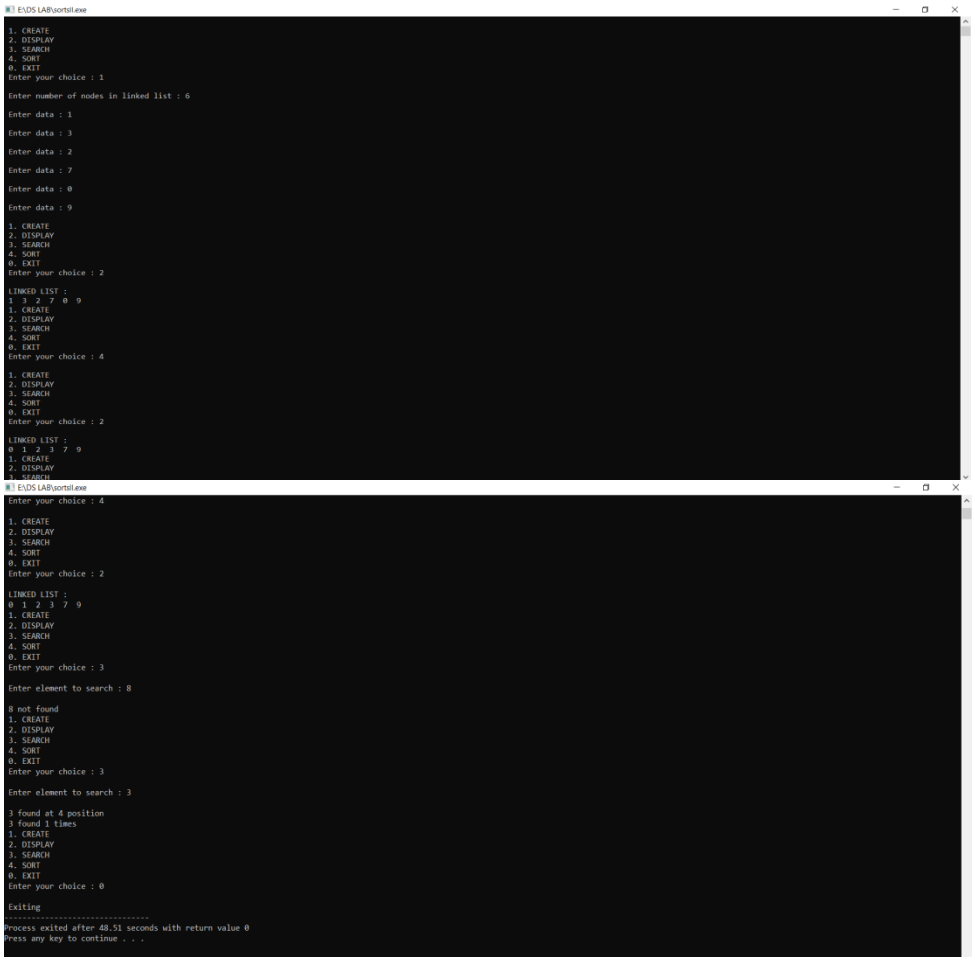
```
#include<stdio.h>
```

```
#include<stdlib.h>
struct node
{
    int info;
    struct node *next;
};
typedef struct node node;
node * createnode(int);
node * create(node *);
void display(node *);
node * sort(node *);
void lsearch(node *,int);
void main()
{
    node *s=NULL;
    int ch,key;
    do
    {
      printf("\n 1. CREATE \n 2. DISPLAY \n 3. SEARCH \n 4. SORT \n 0. EXIT");
      printf("\n Enter your choice : ");
      scanf("%d",&ch);
      switch(ch)
      {
            case 1:
                  s=create(s);
                  break;
            case 2:
               display(s);
                  break;
            case 3:
               printf("\n Enter element to search : ");
             scanf("%d",&key);
               lsearch(s,key);
                  break;
            case 4:
                  s=sort(s);
                  break;
            case 0:
                  printf("\n Exiting");
                  break;
            default:
                  printf("\n Wrong choice");
      }
    }while(ch!=0);
}
node * createnode(int x)
{
    node *temp;
    temp=(node *)malloc(sizeof(node));
```

```
    temp->info=x;
    temp->next=NULL;
    return temp;
}
node * create(node *s)
{
    node *temp,*p;
    int n,x,i;
    printf("\n Enter number of nodes in linked list : ");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        printf("\n Enter data : ");
        scanf("%d",&x);
        temp=createnode(x);
        if(s==NULL)
        s=temp;
        else
        {
                for(p=s;p->next!=NULL;p=p->next);
          p->next=temp;
        }
    }
    return s;
}
void display(node *s)
{
    node *p;
    if(s==NULL)
    printf("\n Linked list is empty");
    else
    {
        printf("\n LINKED LIST :\n");
      for(p=s;p!=NULL;p=p->next)
      printf(" %d ",p->info);
    }
}
node * sort(node *s)
{
    node *c=s,*n=NULL;
    int temp;
    if(s==NULL || s->next==NULL)
    return s;
    else
    {
        while(c!=NULL)
        {
                n=c->next;
                while(n!=NULL)
```

```
                {
                        if(c->info>n->info)
                        {
                                temp=c->info;
                                c->info=n->info;
                                n->info=temp;
                        }
                        n=n->next;
                }
                c=c->next;
        }
        return s;
    }
}
void lsearch(node *s,int y)
{
    node *p;
    int c=0,i;
    if(s==NULL)
    printf("\n Linked list is empty");
    else
    {
        for(p=s,i=1;p!=NULL;i++,p=p->next)
        {
                if(y==p->info)
                {
                   printf("\n %d found at %d position",y,i);
                   c++;
                }
        }
        if(c==0)
        printf("\n %d not found",y);
        else
        printf("\n %d found %d times",y,c);
    }
}
```

OUTPUT-



Q31. WAP for LL Create, Split (both) and Display.

Ans31.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
    int info;
    struct node *next;
};
typedef struct node node;
node * createnode(int);
node * create(node *);
void display(node *);
void split(node *,int);
int size(node *s);
void main()
{
    node *s=NULL;
    int ch,pos;
    do
    {
      printf("\n 1. CREATE \n 2. DISPLAY \n 3. SPLIT \n 0. EXIT");
```

```
        printf("\n Enter your choice : ");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1:
                s=create(s);
                break;
            case 2:
               display(s);
                break;
            case 3:
                printf("\n Enter position to split from : ");
                scanf("%d",&pos);
                split(s,pos);
                break;
            case 0:
                printf("\n Exiting");
                break;
            default:
                printf("\n Wrong choice");
        }
    }while(ch!=0);
}
node * createnode(int x)
{
    node *temp;
    temp=(node *)malloc(sizeof(node));
    temp->info=x;
    temp->next=NULL;
    return temp;
}
node * create(node *s)
{
    node *temp,*p;
    int n,x,i;
    printf("\n Enter number of nodes in linked list : ");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        printf("\n Enter data : ");
        scanf("%d",&x);
        temp=createnode(x);
        if(s==NULL)
        s=temp;
        else
        {
                for(p=s;p->next!=NULL;p=p->next);
          p->next=temp;
        }
```

```
    }
    return s;
}
void display(node *s)
{
    node *p;
    if(s==NULL)
    printf("\n Linked list is empty");
    else
    {
        printf("\n LINKED LIST :\n");
      for(p=s;p!=NULL;p=p->next)
      printf(" %d ",p->info);
    }
}
int size(node *s)
{
    node *p;
    int i=0;
    if(s==NULL)
    return i;
    else
    {
      for(p=s,i=1;p->next!=NULL;i++,p=p->next);
      return i;
    }
}
void split(node *s,int pos)
{
    node *p=s,*q=NULL;
    int l=size(s),i;
    if(l==0)
        return ;
    else if(pos<2 || pos>l)
  {
    printf("\n Invalid position for splitting");
    return ;
    }
    else
    {
        for(p=s,i=1;i<(pos-1);i++,p=p->next);
        q=p->next;
      p->next=NULL;
        p=s;
        display(p);
        display(q);
        return;
    }
}
```

OUTPUT-

Q32. WAP for LL Create, Merge (both) and Display.

Ans32.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
    int info;
    struct node *next;
};
typedef struct node node;
node * createnode(int);
node * create(node *);
void display(node *);
void sortedmerge(node *,node *);
node * sort(node *);
node * insertl(node *,int);
void main()
{
    node *s=NULL,*f=NULL,*p=NULL;
    int ch;
    do
    {
      printf("\n 1. CREATE \n 2. DISPLAY \n 3. SORTED MERGE \n 0. EXIT");
      printf("\n Enter your choice : ");
      scanf("%d",&ch);
      switch(ch)
      {
          case 1:
              printf("\n ***** LINKED LIST 1 *****\n");
              s=create(s);
              printf("\n ***** LINKED LIST 2 *****\n");
              f=create(f);
              break;
```

```
            case 2:
                  printf("\n ***** LINKED LIST 1 *****\n");
               display(s);
               printf("\n ***** LINKED LIST 2 *****\n");
               display(f);
                  break;
            case 3:
                  sortedmerge(s,f);
                  break;
            case 0:
                  printf("\n Exiting");
                  break;
            default:
                  printf("\n Wrong choice");
       }
    }while(ch!=0);
}
node * createnode(int x)
{
    node *temp;
    temp=(node *)malloc(sizeof(node));
    temp->info=x;
    temp->next=NULL;
    return temp;
}
node * create(node *s)
{
    node *temp,*p;
    int n,x,i;
    printf("\n Enter number of nodes in linked list : ");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        printf("\n Enter data : ");
        scanf("%d",&x);
        temp=createnode(x);
        if(s==NULL)
        s=temp;
        else
        {
                for(p=s;p->next!=NULL;p=p->next);
           p->next=temp;
        }
    }
    return s;
}
void display(node *s)
{
    node *p;
```

```
    if(s==NULL)
    printf("\n Linked list is empty");
    else
    {
        printf("\n LINKED LIST :\n");
      for(p=s;p!=NULL;p=p->next)
      printf(" %d ",p->info);
    }
}
void sortedmerge(node *s,node *f)
{
    node *p=NULL,*t,*u;
    if(s==NULL && f==NULL)
    {
        printf("\n Linked lists are empty");
        return;
    }
    else if(s!=NULL && f==NULL)
    {
        s=sort(s);
        display(s);
    }
    else if(s==NULL && f!=NULL)
    {
        f=sort(f);
        display(f);
    }
    else
    {
        s=sort(s);
        f=sort(f);
        t=s;
        u=f;
        while(t!=NULL && u!=NULL)
        {
                if(t->info<u->info)
                {
                        p=insertl(p,t->info);
                        t=t->next;
                }
                else if(u->info<t->info)
                {
                        p=insertl(p,u->info);
                        u=u->next;
                }
                else
                {
                        p=insertl(p,t->info);
                        t=t->next;
```

```
                        p=insertl(p,u->info);
                        u=u->next;
                }
        }
        while(t!=NULL)
        {
                p=insertl(p,t->info);
                t=t->next;
        }
        while(u!=NULL)
        {
                p=insertl(p,u->info);
                u=u->next;
        }
       display(p);
    }
}
node * sort(node *s)
{
    node *c=s,*n=NULL;
    int temp;
    if(s==NULL || s->next==NULL)
    return s;
    else
    {
        while(c!=NULL)
        {
                n=c->next;
                while(n!=NULL)
                {
                        if(c->info>n->info)
                        {
                                temp=c->info;
                                c->info=n->info;
                                n->info=temp;
                        }
                        n=n->next;
                }
                c=c->next;
        }
        return s;
    }
}
node * insertl(node *s,int x)
{
    node *temp,*p;
    temp=(node *)malloc(sizeof(node));
    temp->info=x;
    temp->next=NULL;
```

```
    if(s==NULL)
    s=temp;
    else
    {
        for(p=s;p->next!=NULL;p=p->next);
       p->next=temp;
    }
    return s;
}
```

OUTPUT-

Q33. WAP for LL Create, Other remaining operations like Duplicate Removal, movement of node etc. and Display.

Ans33.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
        int info;
        struct node *next;
};
typedef struct node node;
node * createnode(int);
node * create(node *);
void dupremoval(node *);
void display(node *);
node * move(node *,int,int);
int size(node *s);
int search(node *,int);
node * swap(node *,int,int);
node * insertsorted(node *,int);
node * sort(node *);
void split(node *);
node * insertl(node *,int);
void main()
```

```
{
        node *s=NULL;
        int ch,p,q,x,y,pos,i,j;
        do
        {
          printf("\n 1. CREATE \n 2. DISPLAY \n 3. DUPLICATE REMOVAL \n 4. MOVE NODE \n 5. SWAP NODE");
          printf("\n 6. INSERT SORTED \n 7. SPLIT IN ODD AND EVEN \n 0. EXIT");
          printf("\n Enter your choice : ");
          scanf("%d",&ch);
          switch(ch)
          {
                  case 1:
                        s=create(s);
                        break;
                  case 2:
                     display(s);
                        break;
                  case 3:
                        if(s!=NULL)
                        dupremoval(s);
                                else
                                printf("\n LINKED LIST IS EMPTY");
                        break;
                  case 4:
                        if(s!=NULL)
                        {
                                do
                                {
                                        printf("\n Enter position of node to move : ");
                           scanf("%d",&p);
                           printf("\n Enter position to move node to : ");
                           scanf("%d",&q);
                           }while((p>size(s) || p<1) || (q>size(s) || q<1));
                           s=move(s,p,q);
                                }
                                else
                                printf("\n LINKED LIST IS EMPTY");
                        break;
                  case 5:
                        if(s!=NULL)
                        {
                                printf("\n Enter element to search : ");
           scanf("%d",&x);
           i=search(s,x);
           printf("\n Enter element to search : ");
           scanf("%d",&y);
           j=search(s,y);
           s=swap(s,i,j);
                                }
```

```
                        else
                        printf("\n LINKED LIST IS EMPTY");
                    break;
                case 6:
                    printf("\n Enter element to insert : ");
                    scanf("%d",&x);
                    s=insertsorted(s,x);
                    break;
                case 7:
                    if(s!=NULL)
                    split(s);
                        else
                        printf("\n LINKED LIST IS EMPTY");
                    break;
                case 0:
                    printf("\n Exiting");
                    break;
                default:
                    printf("\n Wrong choice");
            }
        }while(ch!=0);
}
node * createnode(int x)
{
        node *temp;
        temp=(node *)malloc(sizeof(node));
        temp->info=x;
        temp->next=NULL;
        return temp;
}
node * create(node *s)
{
        node *temp,*p;
        int n,x,i;
        printf("\n Enter number of nodes in linked list : ");
        scanf("%d",&n);
        for(i=0;i<n;i++)
        {
                printf("\n Enter data : ");
                scanf("%d",&x);
                temp=createnode(x);
                if(s==NULL)
                s=temp;
                else
                {
                        for(p=s;p->next!=NULL;p=p->next);
                   p->next=temp;
                }
        }
```

```
        return s;
}
void display(node *s)
{
        node *p;
        if(s==NULL)
        printf("\n LINKED LIST IS EMPTY");
        else
        {
                printf("\n LINKED LIST :\n");
          for(p=s;p!=NULL;p=p->next)
          printf(" %d ",p->info);
        }
}
void dupremoval(node *s)
{
   node *p,*q,*r,*t;
   for(p=s;p!=NULL;p=p->next)
   {
     r=p;
        q=p->next;
        while(q!=NULL)
        {
                if(p->info==q->info)
                {
                        r->next=q->next;
                        t=q;
                        q=q->next;
                        free(t);
                        }
                        else
                        {
                                r=q;
                                q=q->next;
                        }
                }
        }
}
int search(node *s,int x)
{
        node *p;
        int flag=0,i;
        for(p=s,i=1;p!=NULL;i++,p=p->next)
        {
                if(p->info==x)
                {
                        flag=1;
                        return i;
                }
```

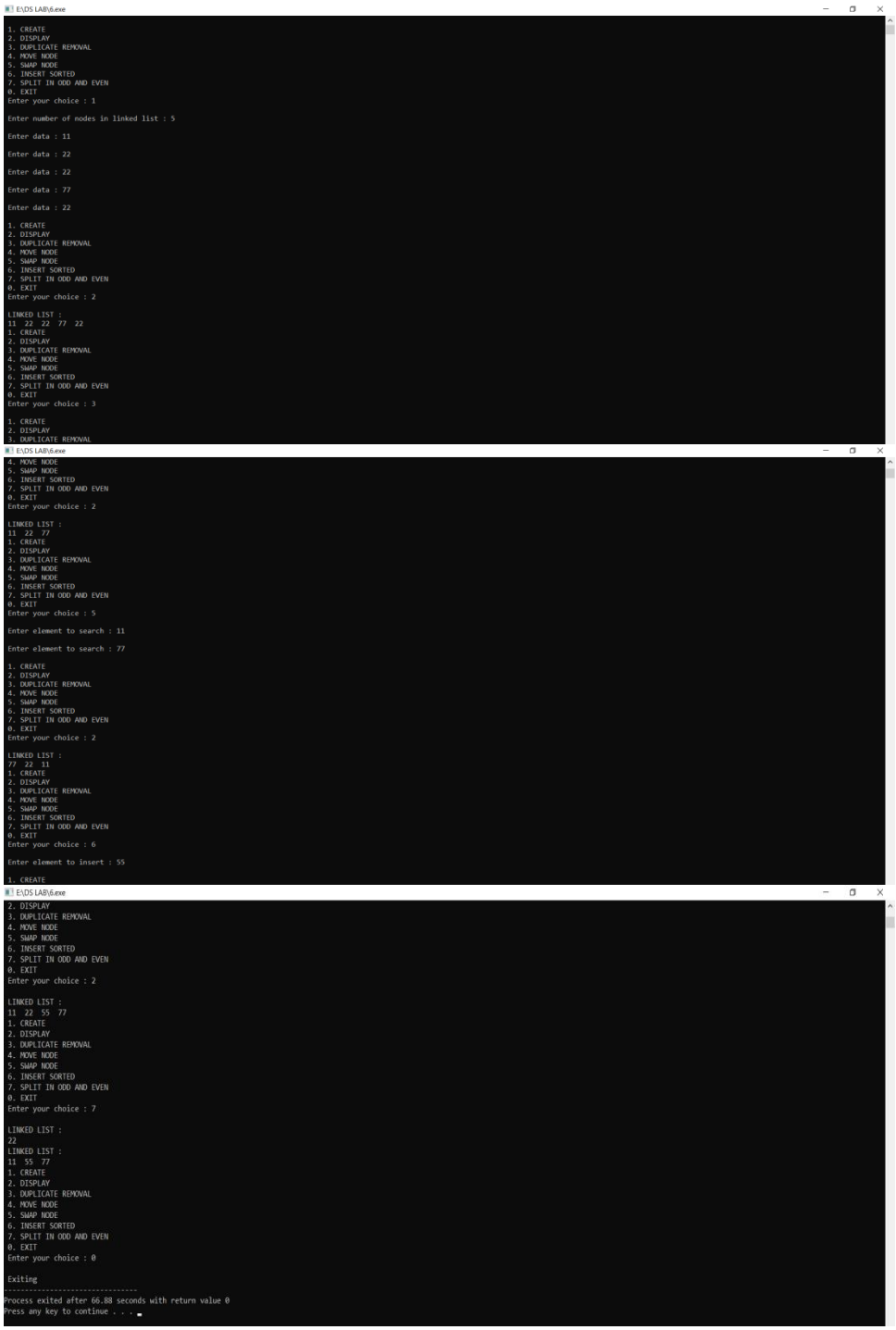
```
                else
                continue;
        }
        if(p==NULL && flag==0)
        return 0;
}
node * move(node *s,int x,int y)
{
        int pos;
        node *p,*t,*q;
        if(x==1)
        {
                t=s;
                s=s->next;
        }
        else
        {
                for(pos=1,p=s;pos<(x-1);pos++,p=p->next);
           t=p->next;
           p->next=t->next;
        }
        if(y==1)
        {
                t->next=s;
                s=t;
        }
        else
        {
                for(pos=1,p=s;pos<(y-1);pos++,p=p->next);
                q=p->next;
                t->next=q;
                p->next=t;
        }
        return s;
}
int size(node *s)
{
        int i;
        node *p;
        if(s==NULL)
        return 0;
        else
        {
           for(i=1,p=s;p->next!=NULL;i++,p=p->next);
           return i;
        }
}
node * swap(node *s,int i,int j)
{
```

```
        int pos;
        node *temp,*p,*t=NULL,*prevx,*px,*prevy,*py;
        for(p=s,pos=1;pos<i;pos++,t=p,p=p->next);
        prevx=t;
        px=p;
        for(p=s,pos=1;pos<j;pos++,t=p,p=p->next);
        prevy=t;
        py=p;
        //This is main swap function
        temp=py->next;
        py->next=px->next;
        px->next=temp;
        if(prevx==NULL)
        {
                s=py;
                prevy->next=px;
        }
        if(prevy==NULL)
        {
                s=px;
                prevx->next=py;
        }
        if(prevx!=NULL && prevy!=NULL)
        {
                prevx->next=py;
                prevy->next=px;
        }
        return s;
}
node * sort(node *s)
{
        node *c=s,*n=NULL;
        int temp;
        if(s==NULL || s->next==NULL)
        return s;
        else
        {
                while(c!=NULL)
                {
                        n=c->next;
                        while(n!=NULL)
                        {
                                if(c->info>n->info)
                                {
                                        temp=c->info;
                                        c->info=n->info;
                                        n->info=temp;
                                }
                                n=n->next;
```

```
                        }
                        c=c->next;
                }
                return s;
        }
}
node * insertsorted(node *s,int x)
{
        node *p,*temp,*r=NULL;
        temp=createnode(x);
        if(s==NULL)
        {
                s=temp;
                return s;
        }
        else
        {
                s=sort(s);
    for(p=s;p!=NULL;r=p,p=p->next)
    {
        if(p->info>temp->info || p->info==temp->info)
        {
                if(p==s)
                {
                        temp->next=s;
                        s=temp;
                        return s;
                                }
                                else
                                {
                                        temp->next=r->next;
                                        r->next=temp;
                                        return s;
                                }
                        }
                        else
                        continue;
                }
           for(p=s;p->next!=NULL;p=p->next);
                p->next=temp;
                return s;
        }
}
void split(node *s)
{
        node *p=NULL,*q=NULL,*t;
        for(t=s;t!=NULL;t=t->next)
        {
                if(t->info%2==0)
```

```
                p=insertl(p,t->info);
                else
                q=insertl(q,t->info);
        }
        display(p);
        display(q);
}
node * insertl(node *s,int x)
{
        node *temp,*p;
        temp=(node *)malloc(sizeof(node));
        temp->info=x;
        temp->next=NULL;
        if(s==NULL)
        s=temp;
        else
        {
                for(p=s;p->next!=NULL;p=p->next);
           p->next=temp;
        }
        return s;
}
```

OUTPUT-



Q34. WAP for implementing Doubly Linked List with all operations.

Ans34.

C PROGRAM –

```
#include<stdio.h>
#include<malloc.h>
struct dnode
{
        int data;
        struct dnode *next;
        struct dnode *prev;
};
```

```
typedef struct dnode dnode;
dnode * createnode(int);
dnode * init(dnode *);
dnode * insertf(dnode *,int);
dnode * insertl(dnode *,int);
dnode * insertp(dnode *,int,int);
dnode * deletef(dnode *);
dnode * deletel(dnode *);
dnode * deletep(dnode *,int);
void fdisplay(dnode *);
void bdisplay(dnode *);
int size(dnode *);
dnode * reversdll(dnode *);
void main()
{
        dnode *start=NULL;
        int ch,a,b,c,pos,p;
        do
        {
                printf("\n 1. Initialization \n 2. Insert first \n 3. Insert by position \n 4. Insert last \n 5. Forward
display");
                printf("\n 6. Backward display \n 7. Delete first \n 8. Delete by position \n 9. Delete last \n 10.
Size \n 11. Reverse\n 12. Exit");
                printf("\n Enter your choice : ");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:
                                start=init(start);
                                break;
                        case 2:
                                printf("\n Enter element to insert : ");
                                scanf("%d",&a);
                                start=insertf(start,a);
                                break;
                        case 3:
                                printf("\n Enter element to insert : ");
                                scanf("%d",&b);
                                printf("\n Enter position to insert : ");
                                scanf("%d",&p);
                                start=insertp(start,b,p);
                                break;
                        case 4:
                                printf("\n Enter element to insert : ");
                                scanf("%d",&c);
                                start=insertl(start,c);
                                break;
                        case 5:
                                fdisplay(start);
```

```
                        break;
                case 6:
                        bdisplay(start);
                        break;
                case 7:
                        start=deletef(start);
                        break;
                case 8:
                        printf("\n Enter position to delete : ");
                        scanf("%d",&pos);
                        start=deletep(start,pos);
                        break;
                case 9:
                        start=deletel(start);
                        break;
                case 10:
                        if(size(start)==0)
                        printf("\n Size of doubly linked list : 0");
                        else
                        printf("\n Size of doubly linked list : %d",size(start));
                        break;
                case 11:
                        start=reversdll(start);
                        break;
                case 12:
                        printf("\n Exiting...!");
                        break;
                default:
                        printf("\n Wrong choice entered");
                }
        }while(ch!=12);
}
dnode * createnode(int x)
{
        dnode *temp;
        temp=(dnode *)malloc(sizeof(dnode));
        temp->data=x;
        temp->prev=NULL;
        temp->next=NULL;
        return temp;
}
dnode * init(dnode *start)
{
        start=NULL;
        return start;
}
dnode * insertf(dnode *start,int x)
{
        dnode *temp;
```

```
        temp=createnode(x);
        if(start==NULL)
        {
                start=temp;
                return start;
        }
        else
        {
                temp->next=start;
                start->prev=temp;
                start=temp;
                return start;
        }
}
dnode * insertl(dnode *start,int x)
{
        dnode *temp,*p;
        temp=createnode(x);
        if(start==NULL)
        {
                start=insertf(start,x);
                return start;
        }
        else
        {
                for(p=start;p->next!=NULL;p=p->next);
                {
                        p->next=temp;
                        temp->prev=p;
                        return start;
                }
        }
}
dnode * insertp(dnode *start,int x, int pos)
{
        int s=size(start),i;
        dnode *temp,*p=start,*t;
        if(pos<1 || pos>(s+1))
        {
                printf("\n Insertion not possible due to invalid position");
                return start;
        }
        else if(pos==1)
        {
                start=insertf(start,x);
                return start;
        }
        else if(pos==(s+1))
        {
```

```
                start=insertl(start,x);
                return start;
        }
        else
        {
                temp=createnode(x);
                for(i=1,p=start;i<pos;i++,p=p->next);
                t=p->prev;
                t->next=temp;
                temp->prev=t;
                temp->next=p;
                p->prev=temp;
                return start;
        }
}
dnode * deletef(dnode *start)
{
        dnode *p;
        if(start==NULL)
        {
                printf("\n Deletion not possible as doubly linked list is empty");
                return start;
        }
        else if(start->next==NULL)
        {
                printf("\n %d deleted",start->data);
                free(start);
                start=NULL;
                return start;
        }
        else
        {
                p=start;
                start=start->next;
                start->prev=NULL;
                printf("\n %d deleted",p->data);
                free(p);
                return start;
        }
}
dnode * deletel(dnode *start)
{
        dnode *t,*p;
        if(start==NULL)
        {
                printf("\n Deletion not possible as doubly linked list is empty");
                return start;
        }
        else if(start->next==NULL)
```

```
        {
                printf("\n %d deleted",start->data);
                free(start);
                start=NULL;
                return start;
        }
        else
        {
                for(p=start;p->next!=NULL;p=p->next);
                {
                        t=p->prev;
                        t->next=NULL;
                        printf("\n %d deleted",p->data);
                   free(p);
                        return start;
                }
        }
}
dnode * deletep(dnode *start,int pos)
{
        int s=size(start),i;
        dnode *p=start,*t,*temp;
        if(start==NULL)
        {
                printf("\n Deletion not possible as doubly linked list is empty");
                return start;
        }
        else if(pos<1 || pos>s)
        {
                printf("\n Deletion not possible due to invalid position");
                return start;
        }
        else if(pos==1)
        {
                start=deletef(start);
                return start;
        }
        else if(pos==s)
        {
                start=deletel(start);
                return start;
        }
        else
        {
                for(i=1,p=start;i<pos;i++,p=p->next);
                t=p->prev;
                temp=p->next;
                t->next=temp;
                temp->prev=t;
```

```
                printf("\n %d deleted",p->data);
                free(p);
                return start;
        }
}
int size(dnode *start)
{
        int i;
        dnode *p;
        if(start==NULL)
        return 0;
        else
        {
                for(i=1,p=start;p->next!=NULL;i++,p=p->next);
          return i;
        }
}
void fdisplay(dnode *start)
{
        dnode *p;
        if(start==NULL)
  printf("\n Doubly linked list is empty");
  else
  {
        printf("\n Doubly linked list : \n");
     for(p=start;p!=NULL;p=p->next)
     printf("%d\t",p->data);
        }
}
void bdisplay(dnode *start)
{
        dnode *p;
        if(start==NULL)
  printf("\n Doubly linked list is empty");
  else
  {
        printf("\n Doubly linked list : \n");
        for(p=start;p->next!=NULL;p=p->next);
          for( ;p!=NULL;p=p->prev)
     printf("%d\t",p->data);
        }
}
dnode * reversdll(dnode *start)
{
        dnode *cn=start,*nn;
        if(start==NULL || start->next==NULL)
                return start;
  else
  {
```

```
    while(cn!=NULL)
    {
        start=cn;
        nn=cn->next;
        cn->next=cn->prev;
        cn->prev=nn;
        cn=nn;
                }
                return start;
        }
}
```

OUTPUT-

Q35. WAP for implementing Circular Linked List with all operations.

Ans35.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
    int data;
    struct node *next;
};
typedef struct node cnode;
cnode * init(cnode *);
cnode * createnode(int);
int size(cnode *);
cnode * insertf(cnode *,int);
cnode * insertl(cnode *,int);
cnode * insertr(cnode *,int,int);
cnode * deletef(cnode *);
cnode * deletel(cnode *);
cnode * deleter(cnode *,int);
void display(cnode *);
cnode * revercll(cnode *s);
void main()
{
    cnode *start=NULL;
    int ch,a,b,c,p,l,s;
    do
    {
        printf("\n1. Initialization \n2. Insert first \n3. Insert random \n4. Insert last \n5. Display");
        printf("\n6. Delete first \n7. Delete random \n8. Delete last \n9. Size \n10. Reverse \n11. Exit");
        printf("\n Enter your choice : ");
        scanf("%d",&ch);
        switch(ch)
        {
                case 1:
                    start=init(start);
                    break;
                case 2:
                 printf("\n Enter element to insert : ");
                    scanf("%d",&a);
                 start=insertf(start,a);
                    break;
                case 3:
                    printf("\n Enter element to insert : ");
                    scanf("%d",&b);
                    printf("\n Enter position to insert : ");
                    scanf("%d",&p);
                 start=insertr(start,b,p);
```

```
                    break;
                case 4:
                    printf("\n Enter element to insert : ");
                    scanf("%d",&c);
                 start=insertl(start,c);
                    break;
                case 5:
                    display(start);
                    break;
                case 6:
                    start=deletef(start);
                    break;
                case 7:
                    printf("\n Enter position to delete : ");
                    scanf("%d",&l);
                    start=deleter(start,l);
                    break;
                case 8:
                    start=deletel(start);
                    break;
                case 9:
                    s=size(start);
                    if(s!=0)
                    printf("\n Size of circular linked list : %d",s);
                    else
                    printf("\n Size of circular linked list : 0");
                    break;
                case 10:
                 start=revercll(start);
                    break;
                case 11:
                    printf("\n Exiting");
                    break;
                default:
                    printf("\n Wrong choice entered");
            }
    }while(ch!=11);
}
cnode * init(cnode *start)
{
    start=NULL;
    return start;
}
cnode * createnode(int x)
{
    cnode *temp;
    temp=(cnode *)malloc(sizeof(cnode));
    temp->data=x;
    return temp;
```

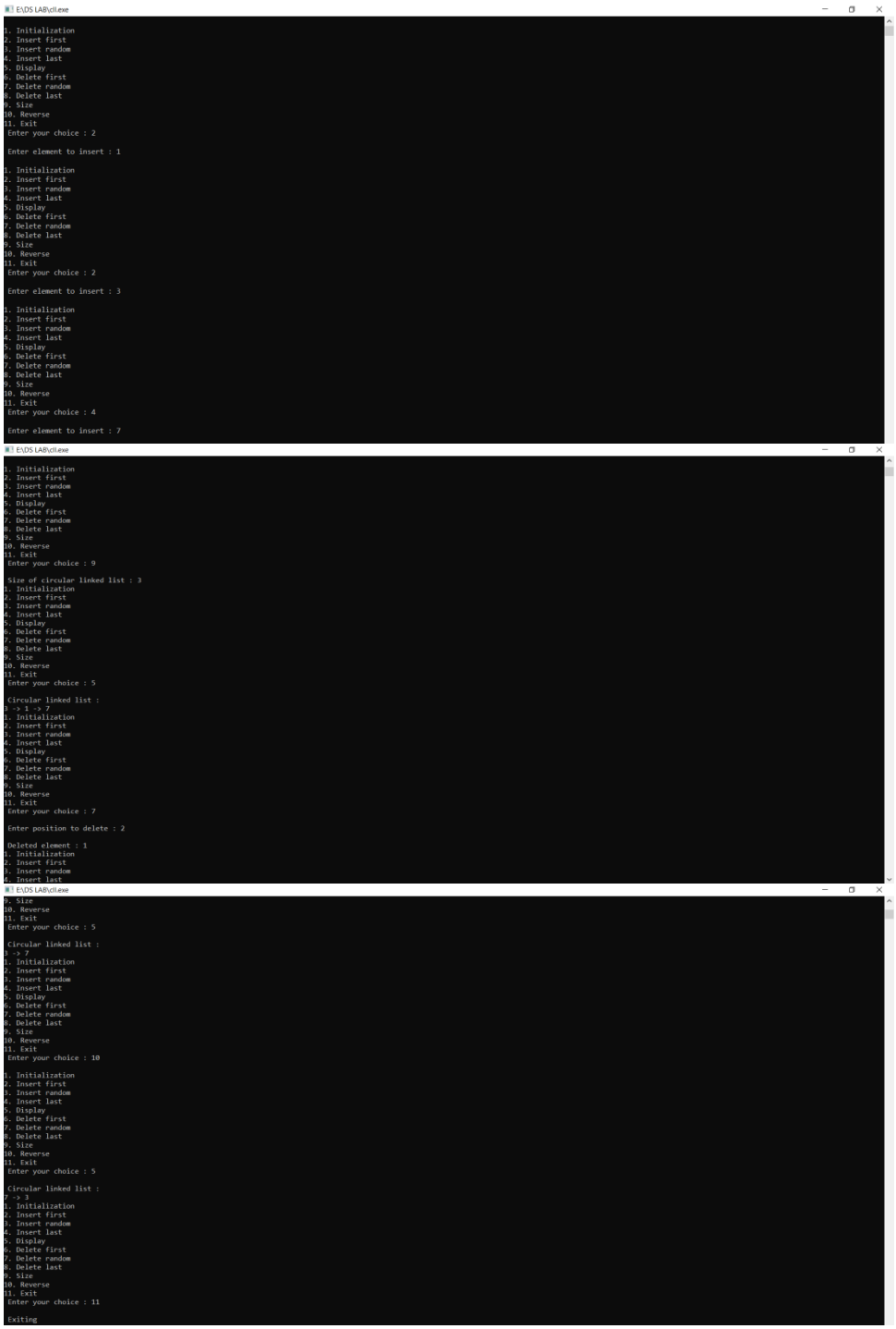
```
}
int size(cnode *start)
{
    cnode *p;
    int i;
    if(start==NULL)
    return 0;
    else
    {
        for(p=start,i=1;p->next!=start;i++,p=p->next);
    return i;
    }
}
cnode * insertf(cnode *start,int x)
{
    cnode *temp,*p;
    temp=createnode(x);
    if(start==NULL)
    {
        start=temp;
        temp->next=start;
        return start;
    }
    else
    {
        for(p=start;p->next!=start;p=p->next);
        p->next=temp;
        temp->next=start;
        start=temp;
        return start;
    }
}
cnode * insertl(cnode *start,int x)
{
    cnode *temp,*p;
    temp=createnode(x);
    if(start==NULL)
    {
        start=temp;
        temp->next=start;
        return start;
    }
    else
    {
        for(p=start;p->next!=start;p=p->next);
        p->next=temp;
        temp->next=start;
        return start;
    }
```

```
}
cnode * insertr(cnode *start,int x,int pos)
{
    cnode *temp,*p;
    int s=size(start),i;
    if(pos<1 || pos>s+1)
    {
        printf("\n Position not justified");
        return start;
    }
    else if(pos==1)
    {
        start=insertf(start,x);
        return start;
    }
    else if(pos==s+1)
    {
        start=insertl(start,x);
        return start;
    }
    else if(pos>1 && pos<=s)
    {
        temp=createnode(x);
      for(p=start,i=1;i<(pos-1);i++,p=p->next);
        temp->next=p->next;
        p->next=temp;
        return start;
    }
}
void display(cnode *start)
{
    cnode *p;
    if(start==NULL)
    printf("\n Circular linked list is empty");
    else
    {
        printf("\n Circular linked list : \n");
        for(p=start;p->next!=start;p=p->next)
        printf("%d -> ",p->data);
        printf("%d",p->data);
    }
}
cnode * deletef(cnode *start)
{
    cnode *p,*temp;
    if(start==NULL)
    printf("\n Circular linked list is empty");
    else
    {
```

```
        temp=start;
      if(start->next==start)
        start=NULL;
      else
        {
          for(p=start;p->next!=start;p=p->next);
          start=temp->next;
                p->next=start;
       }
      printf("\n Deleted element : %d",temp->data);
      free(temp);
   }
   return start;
}
cnode * deletel(cnode *start)
{
     cnode *p,*t;
     if(start==NULL)
     printf("\n Circular linked list is empty");
     else
     {
        p=start;
      if(start->next==start)
        start=NULL;
      else
        {
          for(p=start;p->next!=start;t=p,p=p->next);
          t->next=start;
       }
      printf("\n Deleted element : %d",p->data);
      free(p);
   }
   return start;
}
cnode * deleter(cnode *start,int pos)
{
     cnode *temp,*p,*t;
     int s=size(start),i;
     if(start==NULL)
     printf("\n Circular linked list is empty");
     else if(pos<1 || pos>s)
     printf("\n Position not justified");
     else if(pos==1)
     start=deletef(start);
     else if(pos==s)
     start=deletel(start);
     else if(pos>1 && pos<s)
     {
       for(p=start,i=1;i<(pos-1);i++,p=p->next);
```

```
        t=p->next;
          p->next=t->next;
          printf("\n Deleted element : %d",t->data);
       free(t);
      }
      return start;
}
cnode * revercll(cnode *s)
{
      cnode *c=s,*p=NULL,*n=NULL,*temp;
      if(s==NULL || s->next==s)
      return s;
      else
      {
            for(c=s;c->next!=s;c=c->next);
            temp=c;
            n=s->next;
            c=s;
            while(n!=s)
            {
                  if(c==s)
                  {
                        c->next=temp;
                        p=c;
               c=n;
                  }
             else
             {
                  n=n->next;
                  c->next=p;
               p=c;
               c=n;
                  }
            }
            s=p;
            return s;
      }
}
```

OUTPUT-



Q36. WAP for Header L.L. with Insertion, Delete and Display.

Ans36.

C PROGRAM –

```
#include<stdio.h>
#include<malloc.h>
#include<stdlib.h>
struct node
{
        int data;
        struct node * next;
};
```

```
struct head
{
	int hdata;
	struct node *next;
};
typedef struct node node;
typedef struct head head;
head * init(head *);
node * createnode(int);
int size(head *);
head * insertf(head *,int);
head * insertl(head *,int);
head * insertr(head *,int,int);
head * deletef(head *);
head * deletel(head *);
head * deleter(head *,int);
void display(head *);
void main()
{
	head *h;
	int ch,a,b,c,p,l;
	h=(head *)malloc(sizeof(head));
	h->hdata=0;
	h->next=NULL;
	do
	{
		printf("\n 1. Initialization \n 2. Insert first \n 3. Insert random \n 4. Insert last \n 5. Display");
		printf("\n 6. Delete first \n 7. Delete random \n 8. Delete last \n 9. Size \n 10. Exit");
		printf("\n Enter choice : ");
		scanf("%d",&ch);
		switch(ch)
		{
			case 1:
				h=init(h);
				break;
			case 2:
				printf("\n Enter element to insert : ");
				scanf("%d",&a);
				h=insertf(h,a);
				break;
			case 3:
			  printf("\n Enter element to insert : ");
				scanf("%d",&b);
				printf("\n Enter position to insert at : ");
				scanf("%d",&p);
				h=insertr(h,b,p);
			  break;
			case 4:
			  printf("\n Enter element to insert : ");
```

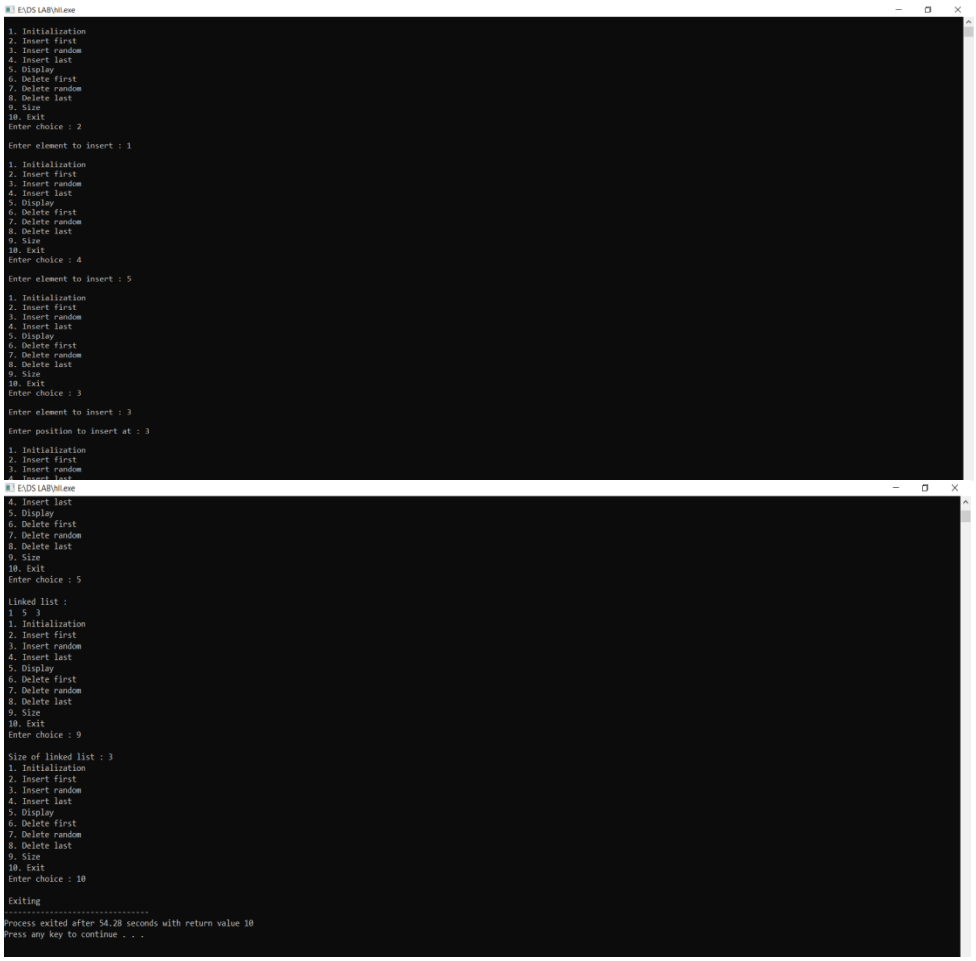
```
                        scanf("%d",&c);
                        h=insertl(h,c);
                    break;
                case 5:
                    display(h);
                    break;
                case 6:
                    h=deletef(h);
                    break;
                case 7:
                    printf("\n Enter position to delete from : ");
                        scanf("%d",&l);
                        h=deleter(h,l);
                    break;
                case 8:
                    h=deletel(h);
                    break;
            case 9:
                printf("\n Size of linked list : %d",h->hdata);
                        break;
                    case 10:
                        printf("\n Exiting");
                        break;
                    default:
                        printf("\n Wrong choice");

                }
        }while(ch!=10);
}
head * init(head * h)
{
        h->next=NULL;
        h->hdata=0;
        return h;
}
node * createnode(int x)
{
        node *temp;
        temp=(node *)malloc(sizeof(node));
        temp->data=x;
        temp->next=NULL;
        return temp;
}
head * insertf(head *h,int x)
{
        node *temp;
        temp=createnode(x);
        h->hdata++;
        if(h->next==NULL)
```

```
        h->next=temp;
        else
        {
                temp->next=h->next;
           h->next=temp;
        }
        return h;
}
head * insertl(head *h,int x)
{
        node *temp,*p;
        temp=createnode(x);
        h->hdata++;
        if(h->next==NULL)
        h->next=temp;
        else
        {
                for(p=h->next;p->next!=NULL;p=p->next);
           p->next=temp;
        }
        return h;
}
head * insertr(head *h,int x,int pos)
{
        int s=h->hdata;
        node *temp,*p;
        int i;
        if(pos<1 || pos>(s+1))
        {
                printf("\n Invalid position");
                return h;
        }
        else if(pos==1)
        {
                h=insertf(h,x);
                return h;
        }
        else if(pos==(s+1))
        {
                h=insertl(h,x);
                return h;
        }
        else
        {
                h->hdata++;
                temp=createnode(x);
                for(i=1,p=h->next;i<(pos-1);i++,p=p->next);
                temp->next=p->next;
                p->next=temp;
```

```
                return h;
        }
}
head * deletef(head *h)
{
        node *p;
        if(h->next==NULL)
        {
                printf("\n Linked list is empty");
                return h;
        }
        else
        {
           h->hdata--;
           p=h->next;
           h->next=p->next;
           printf("\n Deleted element = %d",p->data);
           free(p);
                return h;
   }
}
head * deletel(head *h)
{
        int s=h->hdata;
        node *p,*t;
        if(h->next==NULL)
        {
                printf("\n Linked list is empty");
                return h;
        }
        else if(s==1)
        {
                h=deletef(h);
                return h;
        }
        else
        {
           h->hdata--;
           for(p=h->next;p->next!=NULL;t=p,p=p->next);
                t->next=NULL;
           printf("\n Deleted element = %d",p->data);
           free(p);
                return h;
   }
}
head * deleter(head *h,int pos)
{
        int s=h->hdata;
        node *t,*p;
```

```
        int i;
        if(h->next==NULL)
        {
                printf("\n Linked list is empty");
                return h;
        }
        else if(pos<1 || pos>s)
        {
                printf("\n Invalid position");
                return h;
        }
        else if(pos==1)
        {
                h=deletef(h);
                return h;
        }
        else if(pos==s)
        {
                h=deletel(h);
                return h;
        }
        else
        {
                h->hdata--;
                for(p=h->next,i=1;i<(pos-1);i++,p=p->next);
                t=p->next;
                p->next=t->next;
                printf("\n Deleted element = %d",t->data);
                free(t);
                return h;
        }
}
void display(head *h)
{
        node *p;
        if(h->next==NULL)
        printf("\n Linked list is empty");
        else
        {
                printf("\n Linked list : \n");
                for(p=h->next;p!=NULL;p=p->next)
                printf(" %d ",p->data);
        }
}
```

OUTPUT-



Q37. WAP for Generate L.L. with Insertion, Delete and Display.

Ans37.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
        void *data;
        struct node *next;
        int type;
};
typedef struct node node;
node *s=NULL;
void init();
void insertf();
void insertl();
void insertr(int);
void deletef();
void deletel();
void deleter(int);
void display();
int size();
void main()
```

```
{
        int ch,p,l;
        do
        {
                printf("\n 1. Initialization \n 2. Insert first \n 3. Insert last \n 4. Insert random \n 5. Delete first");
                printf("\n 6. Delete last \n 7. Delete random \n 8. Display \n 9. Size \n 10. Exit");
                printf("\n Enter choice : ");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:
                                init();
                                break;
                        case 2:
                                insertf();
                                break;
                        case 3:
                                insertl();
                                break;
                        case 4:
                                printf("\n Enter position to insert : ");
                                scanf("%d",&p);
                                insertr(p);
                                break;
                        case 5:
                                deletef();
                                break;
                        case 6:
                                deletel();
                                break;
                        case 7:
                           printf("\n Enter position to delete : ");
                                scanf("%d",&l);
                           deleter(l);
                           break;
                        case 8:
                                display();
                                break;
                        case 9:
                                if(size())
                                printf("\n Size of generic linked list : %d",size());
                                else
                                printf("\n Size of generic linked list : 0");
                                break;
                        case 10:
                                printf("\n Exiting");
                                break;
                        default:
                                printf("\n Wrong choice");
```

```
                }
        }while(ch!=10);
}
void init()
{
        s=NULL;
}
int size()
{
        node *p=s,*temp;
        int i=0;
        if(s==NULL)
        return i;
        else
        {
                while(p!=NULL)
          {
                i++;
                p=p->next;
          }
          return i;
        }
}
void insertf()
{
        int type,x;
        char y;
        float z;
        node *temp;
        printf("\n 1. Integer \n 2. Character \n 3. Float");
        printf("\n Choose type of data you want to insert : ");
        scanf("%d",&type);
        temp=(node *)malloc(sizeof(node));
        temp->type=type;
        temp->next=NULL;
        switch(type)
        {
                case 1:
                        scanf("%d",&x);
                        temp->data=malloc(sizeof(int));
                        *(int *)temp->data=x;
                        break;
                case 2:
                        fflush(stdin);
                        scanf("%c",&y);
                        temp->data=malloc(sizeof(char));
                        *(char *)temp->data=y;
                        break;
                case 3:
```

```
                scanf("%f",&z);
                temp->data=malloc(sizeof(float));
                *(float *)temp->data=z;
                break;
        default:
                printf("\n Wrong choice");
    }
    if(s==NULL)
    s=temp;
    else
    {
        temp->next=s;
        s=temp;
    }
}
void insertl()
{
    int type,x;
    char y;
    float z;
    node *temp,*p;
    printf("\n 1. Integer \n 2. Character \n 3. Float");
    printf("\n Choose type of data you want to insert : ");
    scanf("%d",&type);
    temp=(node *)malloc(sizeof(node));
    temp->type=type;
    temp->next=NULL;
    switch(type)
    {
        case 1:
                scanf("%d",&x);
                temp->data=malloc(sizeof(int));
                *(int *)temp->data=x;
                break;
        case 2:
                fflush(stdin);
                scanf("%c",&y);
                temp->data=malloc(sizeof(char));
                *(char *)temp->data=y;
                break;
        case 3:
                scanf("%f",&z);
                temp->data=malloc(sizeof(float));
                *(float *)temp->data=z;
                break;
        default:
                printf("\n Wrong choice");
    }
    if(s==NULL)
```

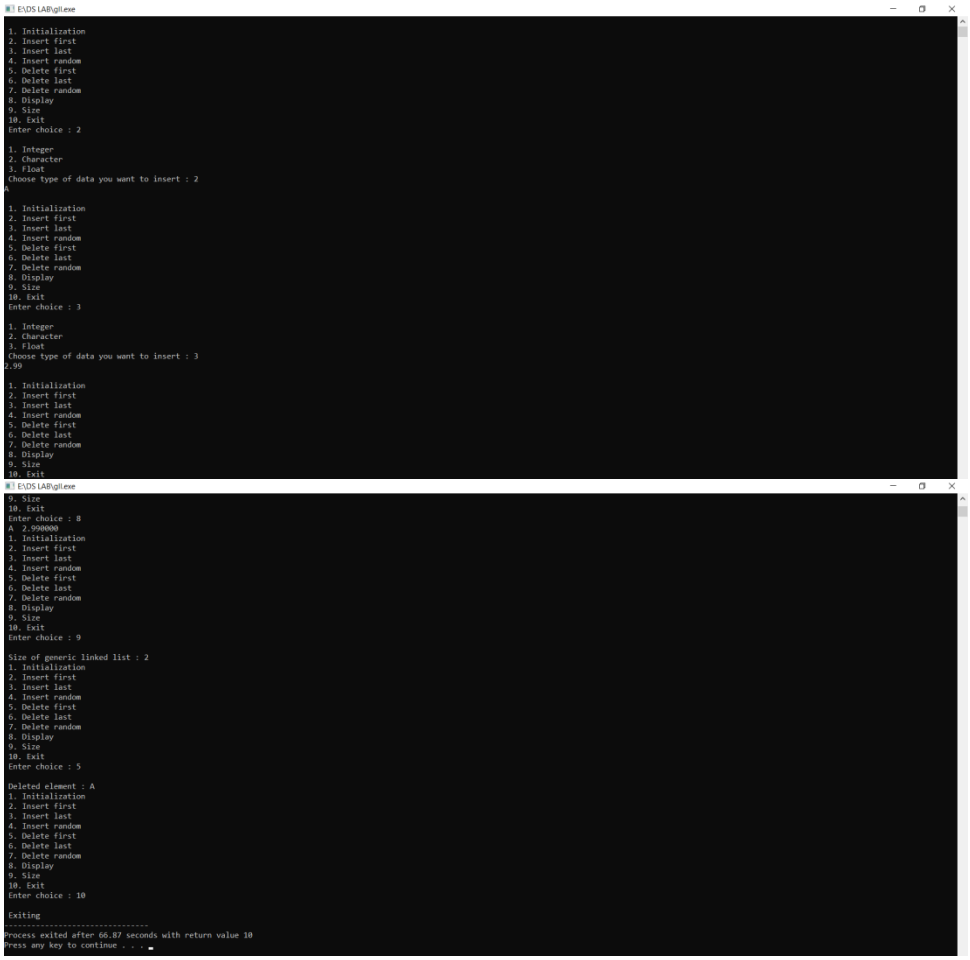
```
        s=temp;
        else
        {
                for(p=s;p->next!=NULL;p=p->next);
                p->next=temp;
        }
}
void insertr(int pos)
{
        int type,x,i,l=size();
        char y;
        float z;
        node *temp,*p;
        if(pos<1 || pos>(l+1))
        printf("\n Invalid position");
        if(s==NULL)
        s=temp;
   else if(pos==1)
        {
                insertf();
                return;
        }
        else if(pos==l+1)
        {
                insertl();
                return;
        }
        else
        {
                printf("\n 1. Integer \n 2. Character \n 3. Float");
        printf("\n Choose type of data you want to insert : ");
           scanf("%d",&type);
           temp=(node *)malloc(sizeof(node));
           temp->type=type;
        temp->next=NULL;
           switch(type)
           {
                   case 1:
                        scanf("%d",&x);
                        temp->data=malloc(sizeof(int));
                        *(int *)temp->data=x;
                        break;
                case 2:
                        fflush(stdin);
                        scanf("%c",&y);
                        temp->data=malloc(sizeof(char));
                        *(char *)temp->data=y;
                        break;
                case 3:
```

```
                        scanf("%f",&z);
                        temp->data=malloc(sizeof(float));
                        *(float *)temp->data=z;
                        break;
                default:
                        printf("\n Wrong choice");
            }
            for(p=s,i=1;i<(pos-1);i++,p=p->next);
            temp->next=p->next;
            p->next=temp;
        }
}
void display()
{
        node *p;
        if(s==NULL)
        printf("\n Generic linked list is empty");
        else
        {
                for(p=s;p!=NULL;p=p->next)
                {
                        if(p->type==1)
                        printf(" %d ",*(int *)p->data);
                        else if(p->type==2)
                        printf(" %c ",*(char *)p->data);
                    else
                        printf(" %f ",*(float *)p->data);
                }
        }
}
void deletef()
{
        node *p=s;
        if(s==NULL)
        printf("\n Generic linked list is empty");
        else
        {
                s=s->next;
                if(p->type==1)
                printf("\n Deleted element : %d",*(int *)p->data);
                else if(p->type==2)
                printf("\n Deleted element : %c",*(char *)p->data);
            else
                printf("\n Deleted element : %f",*(float *)p->data);
                free(p);
        }
}
void deletel()
{
```

```
        node *p=s,*t;
        if(s==NULL)
        printf("\n Generic linked list is empty");
        else if(size()==1)
        {
                deletef();
                return;
        }
        else
        {
                for(p=s;p->next!=NULL;t=p,p=p->next);
                t->next=NULL;
                if(p->type==1)
                printf("\n Deleted element : %d",*(int *)p->data);
                else if(p->type==2)
                printf("\n Deleted element : %c",*(char *)p->data);
           else
                printf("\n Deleted element : %f",*(float *)p->data);
                free(p);
        }
}
void deleter(int pos)
{
        node *p=s,*t;
        int l=size(),i;
        if(s==NULL)
        printf("\n Generic linked list is empty");
        else if(pos<1 || pos>l)
        printf("\n Invalid position");
        else if(pos==1)
        {
                deletef();
                return;
        }
        else if(pos==l)
        {
                deletel();
                return;
        }
        else
        {
                for(p=s,i=1;i<(pos-1);i++,p=p->next);
                t=p->next;
                p->next=t->next;
                if(t->type==1)
                printf("\n Deleted element : %d",*(int *)t->data);
                else if(t->type==2)
                printf("\n Deleted element : %c",*(char *)t->data);
           else
```

```
            printf("\n Deleted element : %f",*(float *)t->data);
            free(t);
        }
}
```

OUTPUT-



Q38. WAP for ,Polynomial representation, Polynomial Operations and Display.

Ans38.

C PROGRAM –

```
#include<stdio.h>
#include<stdlib.h>
struct poly
{
    int co;
    int ex;
    struct poly *next;
};
typedef struct poly poly;
poly * create(poly *);
poly * addnode(poly *,int,int);
poly * addpoly(poly *,poly *, poly *);
poly * subpoly(poly *,poly *, poly *);
poly * mulpoly(poly *,poly *, poly *);
void display(poly *);
```

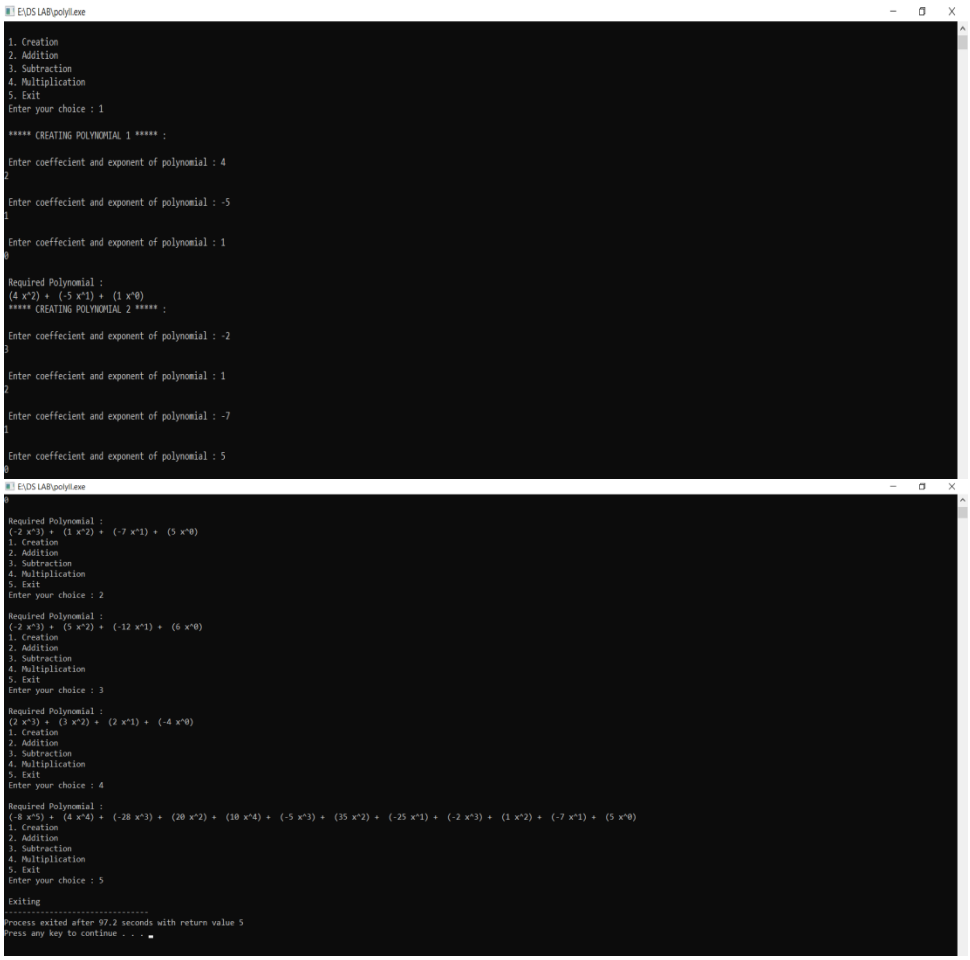
```
void main()
{
    int ch;
    poly *p1=NULL, *p2=NULL, *add=NULL, *sub=NULL, *mul=NULL;
    do
    {
        printf("\n 1. Creation \n 2. Addition \n 3. Subtraction \n 4. Multiplication \n 5. Exit");
        printf("\n Enter your choice : ");
        scanf("%d",&ch);
        switch(ch)
        {
                case 1:
                        printf("\n ***** CREATING POLYNOMIAL 1 ***** : \n");
                        p1=create(p1);
                        display(p1);
                        printf("\n ***** CREATING POLYNOMIAL 2 ***** : \n");
           p2=create(p2);
           display(p2);
                        break;
                case 2:
                        add=addpoly(add,p1,p2);
                        display(add);
                        break;
                case 3:
                        sub=subpoly(sub,p1,p2);
                        display(sub);
                        break;
                case 4:
                   mul=mulpoly(mul,p1,p2);
                   display(mul);
                   break;
                case 5:
                        printf("\n Exiting");
                        break;
                default:
                        printf("\n Wrong choice");
        }
    }while(ch!=5);
}
poly * addnode(poly *p, int co, int ex)
{
    poly *temp,*q;
    temp=(poly *)malloc(sizeof(poly));
    temp->co=co;
    temp->ex=ex;
    temp->next=NULL;
    if(p==NULL)
    p=temp;
    else
```

```
    {
       for(q=p;q->next!=NULL;q=q->next);
         q->next=temp;
    }
    return p;
}
poly * create(poly *p)
{
    int ex,co;
    do
    {
        printf("\n Enter coeffecient and exponent of polynomial : ");
        scanf("%d %d",&co,&ex);
        p=addnode(p,co,ex);
    }while(ex!=0);
    return p;
}
poly * addpoly(poly *add, poly *p1, poly *p2)
{
    poly *p,*q;
    p=p1;
    q=p2;
    while(p!=NULL && q!=NULL)
    {
        if(p->ex > q->ex)
        {
                add=addnode(add,p->co,p->ex);
                p=p->next;
        }
        else if(q->ex > p->ex)
        {
                add=addnode(add,q->co,q->ex);
                q=q->next;
        }
        else
        {
                add=addnode(add,(p->co + q->co),p->ex);
                p=p->next;
                q=q->next;
        }
    }
    while(p!=NULL)
    {
        add=addnode(add,p->co,p->ex);
        p=p->next;
    }
    while(q!=NULL)
    {
        add=addnode(add,q->co,q->ex);
```

```
        q=q->next;
    }
    return add;
}
poly * subpoly(poly *sub, poly *p1, poly *p2)
{
    poly *p,*q;
    p=p1;
    q=p2;
    while(p!=NULL && q!=NULL)
    {
        if(p->ex > q->ex)
        {
                sub=addnode(sub,p->co,p->ex);
                p=p->next;
        }
        else if(q->ex > p->ex)
        {
                sub=addnode(sub,-(q->co),q->ex);
                q=q->next;
        }
        else
        {
                sub=addnode(sub,(p->co - q->co),p->ex);
                p=p->next;
                q=q->next;
        }
    }
    while(p!=NULL)
    {
        sub=addnode(sub,p->co,p->ex);
        p=p->next;
    }
    while(q!=NULL)
    {
        sub=addnode(sub,q->co,q->ex);
        q=q->next;
    }
    return sub;
}
poly * mulpoly(poly *mul, poly *p1, poly *p2)
{
    poly *p,*q;
    for(p=p1;p!=NULL;p=p->next)
    for(q=p2;q!=NULL;q=q->next)
    mul=addnode(mul,(p->co * q->co),(p->ex + q->ex));
    return mul;
}
void display(poly *p)
```

```
{
  poly *t;
  if(p==NULL)
  printf("\n Polynomial is empty");
  else
  {
        printf("\n Required Polynomial : \n");
      for(t=p;t->next!=NULL;t=t->next)
      printf(" (%d x^%d) + ",t->co,t->ex);
      printf(" (%d x^%d) ",t->co,t->ex);
  }
}
```

OUTPUT-



Q39. WAP for Sparse Matrix representation and Display.

Ans39.

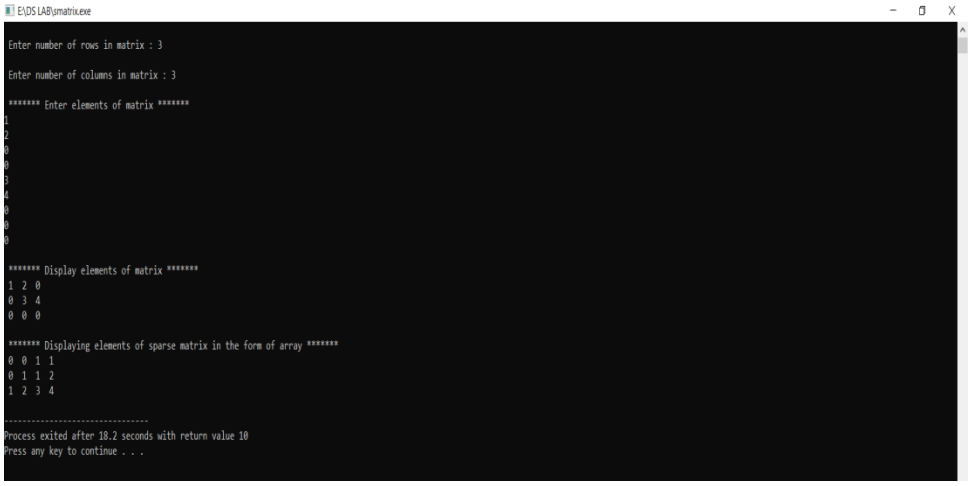
C PROGRAM –

ARRAY REPRESENTATION –

```
#include<stdio.h>
void main()
{
        int i,j,m[10][10],r,c,count=0,size=0;
        printf("\n Enter number of rows in matrix : ");
        scanf("%d",&r);
```

```
        printf("\n Enter number of columns in matrix : ");
        scanf("%d",&c);
        do
        {
                count=0;
                printf("\n ******* Enter elements of matrix ******* \n");
        for(i=0;i<r;i++)
           for(j=0;j<c;j++)
           scanf("%d",&m[i][j]);
           for(i=0;i<r;i++)
           for(j=0;j<c;j++)
           {
                   if(m[i][j]==0)
                   count++;
        }
        }while(count<=((r*c))/2);
        printf("\n ******* Display elements of matrix ******* \n");
        for(i=0;i<r;i++)
        {
                for(j=0;j<c;j++)
                printf(" %d ",m[i][j]);
                printf("\n");
        }
        for(i=0;i<r;i++)
        for(j=0;j<c;j++)
        {
                if(m[i][j]!=0)
                size++;
        }
        int k=0,sm[3][size];
        for(i=0;i<r;i++)
        for(j=0;j<c;j++)
        {
                if(m[i][j]!=0)
                {
                        sm[0][k]=i;
                        sm[1][k]=j;
                        sm[2][k]=m[i][j];
                        k++;
                }
        }
        printf("\n ******* Displaying elements of sparse matrix in the form of array ******* \n");
        for(i=0;i<3;i++)
        {
                for(j=0;j<size;j++)
                printf(" %d ",sm[i][j]);
                printf("\n");
        }
}
```

OUTPUT-



LINKED LIST REPRESENTATION –

```
#include<stdio.h>
#include<stdlib.h>
#include<malloc.h>
struct smatrix
{
    int r;
    int c;
    int v;
    struct smatrix *next;
};
typedef struct smatrix smatrix;
smatrix * addnode(smatrix *,int,int,int);
void display(smatrix *);
void main()
{
    smatrix *sm=NULL;
    int i,j,m[10][10],r,c,count=0;
    printf("\n Enter number of rows in matrix : ");
    scanf("%d",&r);
    printf("\n Enter number of columns in matrix : ");
    scanf("%d",&c);
    do
    {
        count=0;
        printf("\n ******* Enter elements of matrix ******* \n");
    for(i=0;i<r;i++)
       for(j=0;j<c;j++)
       scanf("%d",&m[i][j]);
       for(i=0;i<r;i++)
       for(j=0;j<c;j++)
       {
           if(m[i][j]==0)
           count++;
    }
```

```
    }while(count<=((r*c))/2);
    printf("\n ******* Display elements of matrix ******* \n");
    for(i=0;i<r;i++)
    {
        for(j=0;j<c;j++)
        printf(" %d ",m[i][j]);
        printf("\n");
    }
  for(i=0;i<r;i++)
    for(j=0;j<c;j++)
    {
        if(m[i][j]!=0)
        sm=addnode(sm,i,j,m[i][j]);
    }
    display(sm);
}
smatrix * addnode(smatrix *sm,int x,int y,int z)
{
    smatrix *temp;
    smatrix *p;
    temp=(smatrix *)malloc(sizeof(smatrix));
    temp->r=x;
    temp->c=y;
    temp->v=z;
    temp->next=NULL;
    if(sm==NULL)
    sm=temp;
    else
    {
        for(p=sm;p->next!=NULL;p=p->next);
        p->next=temp;
    }
    return sm;
}
void display(smatrix *sm)
{
    smatrix *p;
    if(sm==NULL)
    printf("\n ******* Sparse matrix is empty *******");
    else
    {
        printf("\n ******* Sparse matrix in linked list form *******\n In the format row no. col no. value -> is
    given below\n");
        for(p=sm;p->next!=NULL;p=p->next)
        printf(" %d %d %d ->",p->r,p->c,p->v);
        printf(" %d %d %d ",p->r,p->c,p->v);
    }
}
```

OUTPUT-

PROGRAMS BASED ON BINARY SEARCH TREE

Q40. WAP for implementing Binary Search with all basic operations and all no recursive Traversals.

Ans40.

C PROGRAM –

```
#include<stdio.h>
#include<malloc.h>
#define max 100
struct bst
{
        int data;
        struct bst *lc;
        struct bst *rc;
};
typedef struct bst BST;
BST * init(BST *);
BST * insert(BST *,int);
void search(BST *,int);
void nrinorder(BST *);
void nrpreorder(BST *);
void nrpostorder(BST *);
void nrlevelorder(BST *);
BST * nrdelete(BST *,int);
void main()
{
        BST *R=NULL;
        int n,i=0,x,ch,op;
        do
        {
                printf("\n ******** NON-RECURSIVE PROGRAM ********\n");
                printf("\n 1. INITIALIZATION \n 2. INSERT \n 3. DISPLAY \n 4. DELETE \n 5. SEARCH \n 0. EXIT");
                printf("\n Enter your choice : ");
                scanf("%d",&ch);
```

```
 switch(ch)
 {
          case 1:
                    R=init(R);
                    break;
          case 2:
                    printf("\n Enter total no. of elements in the binary tree : ");
scanf("%d",&n);
i=0;
while(i<n)
{
 i++;
          printf("\n Enter element to insert : ");
          scanf("%d",&x);
          R=insert(R,x);
}
                    break;
          case 3:
                    do
                    {
                              printf("\n 1. INORDER DISPLAY \n 2. PREORDER DISPLAY \n 3.
POSTORDER DISPLAY \n 4. LEVELORDER DISPLAY \n 0. EXIT");
                       printf("\n Enter your choice : ");
                       scanf("%d",&op);
                       switch(op)
                       {
                                 case 1:
                                      if(R==NULL)
                                      printf("\n Binary tree is empty");
                                      else
                                      nrinorder(R);
                                      break;
                                 case 2:
                                      if(R==NULL)
                                      printf("\n Binary tree is empty");
                                      else
                                      nrpreorder(R);
                                      break;
                                 case 3:
                                      if(R==NULL)
                                      printf("\n Binary tree is empty");
                                      else
                                      nrpostorder(R);
                                      break;
                                 case 4:
                                      if(R==NULL)
                                      printf("\n Binary tree is empty");
                                      else
                                      nrlevelorder(R);
```

```
                                        break;
                                case 0:
                                        break;
                                default:
                                        printf("\n Wrong choice");
                                }
                        }while(op!=0);
                        break;
                case 4:
                   if(R==NULL)
                        printf("\n Deletion not possible as binary tree is empty");
                        else
                        {
                                printf("\n Enter element to be deleted : ");
                           scanf("%d",&x);
                           R=nrdelete(R,x);
                        }
                        break;
                case 5:
                        if(R==NULL)
                        printf("\n Search not possible as binary tree is empty");
                        else
                        {
                                printf("\n Enter element to search : ");
                        scanf("%d",&x);
                           search(R,x);
                        }
                        break;
                case 0:
                        printf("\n Exiting");
                        break;
                default:
                        printf("\n Wrong choice");
                }
        }while(ch!=0);
}
BST * init(BST *R)
{
        R=NULL;
        return R;
}
BST * insert(BST *R,int x)
{
        BST *temp,*p,*t;
        temp=(BST *)malloc(sizeof(BST));
        temp->data=x;
        temp->lc=temp->rc=NULL;
        if(R==NULL)
        R=temp;
```

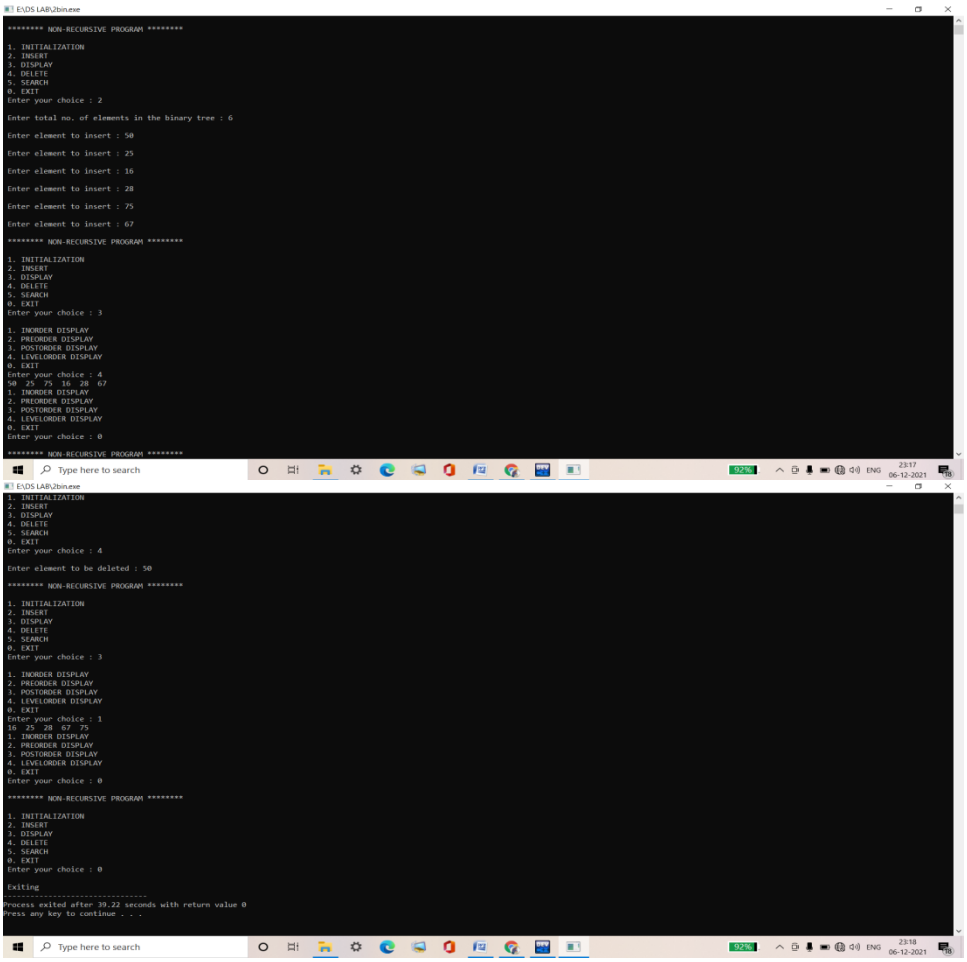
```
        else
        {
                t=R;
                while(t!=NULL)
                {
                        p=t;
                        if(x<t->data)
                        t=t->lc;
                        else if(x>t->data)
                        t=t->rc;
                        else
                        {
                                printf("\n Duplicate information");
                                return R;
                        }
                }
                if(p->data>x)
           p->lc=temp;
        else
           p->rc=temp;
        }
        return R;
}
void search(BST *R,int x)
{
   BST *t;
   t=R;
   while(t!=NULL)
   {
      if(x<t->data)
            t=t->lc;
      else if (x>t->data)
            t=t->rc;
      else
      {
            printf("\n Information found");
            return;
         }
   }
   printf("\n Information not found");
}
void nrpreorder(BST *R)
{
  BST *stk[10],*t;
  int top=-1;
  t=R;
  do
  {
     while(t!=NULL)
```

```
      {
         printf(" %d ",t->data);
         stk[++top]=t;
         t=t->lc;
      }
      t=stk[top--];
      t=t->rc;
  }while(t!=NULL || top>-1);
}
void nrinorder(BST *R)
{
  BST *stk[10],*t;
  int top=-1;
  t=R;
  do
   {
      while(t!=NULL)
      {
         stk[++top]=t;
         t=t->lc;
      }
      t=stk[top--];
      printf(" %d ",t->data);
      t=t->rc;
   }while(t!=NULL || top>-1);
}
void nrlevelorder(BST *R)
{
          BST *queue[max],*t;
          int f=0,r=-1;
          t=R;
          queue[++r]=t;
          while(f<=r)
          {
                    t=queue[f++];
                    if(t!=NULL)
                    {
                              printf(" %d ",t->data);
                              queue[++r]=t->lc;
                              queue[++r]=t->rc;
                    }
          }
}
void nrpostorder(BST *R)
{
          BST *stk1[max],*stk2[max],*t;
          int t1=-1,t2=-1;
          stk1[++t1]=R;
          while(t1!=-1)
```

```
        {
                R=stk1[t1--];
                stk2[++t2]=R;
                if(R->lc)
                stk1[++t1]=R->lc;
                if(R->rc)
                stk1[++t1]=R->rc;
        }
        while(t2!=-1)
        printf(" %d ",stk2[t2--]->data);
}
BST * nrdelete(BST *R, int x)
{
   BST *t,*p,*q,*t1,*t2,*t3;
   if(R==NULL)
   {
      printf("\n Deletion not possible as binary tree is empty");
      return R;
   }
   else
   {
      t=R;
      while((t!=NULL) && (x!=t->data))
      {
         p=t;
         if(x<t->data)
         t=t->lc;
         else if(x>t->data)
         t=t->rc;
      }
   }
   if(t==NULL)
   {
      printf("\n Element not found");
      return R;
   }
   else if(t==R)
   {
        p=t1=t->lc;
        t2=t->rc;
        while(t1->rc!=NULL)
        t1=t1->rc;
        t1->rc=t2;
        R=p;
        free(t);
        return R;
        }
   else
   {
```

```
    if((t->lc==NULL)&&(t->rc==NULL))
    {
       if(t->data<p->data)
       p->lc=NULL;
       else
       p->rc=NULL;
    }
    else if((t->lc!=NULL)&&(t->rc==NULL))
    {
       if(t->data<p->data)
       p->lc=t->lc;
       else
       p->rc=t->lc;
    }
    else if((t->lc==NULL)&&(t->rc!=NULL))
    {
       if(t->data<p->data)
       p->lc=t->rc;
       else
       p->rc=t->rc;
    }
    else
    {
       t1=t->lc;
       t2=t->rc;
       while(t1->rc!=NULL)
       t1=t1->rc;
       t1->rc=t2;
       if(t->data<p->data)
       p->lc=t->lc;
       else
       p->rc=t->lc;
    }
  }
  free(t);
  return R;
}
```

OUTPUT –



Q41. WAP for Binary Search Create and all recursive Traversals.

Ans41.

C PROGRAM –

```
#include<stdio.h>
#include<malloc.h>
struct bst
{
        int data;
        struct bst *lc;
        struct bst *rc;
};
typedef struct bst BST;
BST * init(BST *);
BST * insert(BST *,int);
BST * search(BST *,int);
void inorder(BST *);
void preorder(BST *);
void postorder(BST *);
void levelorder(BST *);
BST * rdelete(BST *,int);
BST * MinValueNode(BST *);
int height_of_tree(BST *);
void currentlevel(BST *,int);
```

```
void main()
{
	BST *R=NULL,*t;
	int n,i=0,x,ch,op;
	do
	{
		printf("\n ******** RECURSIVE PROGRAM ********\n");
		printf("\n 1. INITIALIZATION \n 2. INSERT \n 3. DISPLAY \n 4. DELETE \n 5. SEARCH \n 0. EXIT");
		printf("\n Enter your choice : ");
		scanf("%d",&ch);
		switch(ch)
		{
			case 1:
				R=init(R);
				break;
			case 2:
				printf("\n Enter total no. of elements in the binary tree : ");
		scanf("%d",&n);
		i=0;
		while(i<n)
		{
		 i++;
			printf("\n Enter element to insert : ");
			scanf("%d",&x);
			R=insert(R,x);
		}
				break;
			case 3:
				do
				{
					printf("\n 1. INORDER DISPLAY \n 2. PREORDER DISPLAY \n 3.
POSTORDER DISPLAY \n 4. LEVELORDER DISPLAY \n 0. EXIT");
				  printf("\n Enter your choice : ");
				  scanf("%d",&op);
				  switch(op)
				  {
					case 1:
					    if(R==NULL)
					    printf("\n Binary tree is empty");
					    else
					    inorder(R);
					    break;
					case 2:
					    if(R==NULL)
					    printf("\n Binary tree is empty");
					    else
					    preorder(R);
					    break;
					case 3:
```

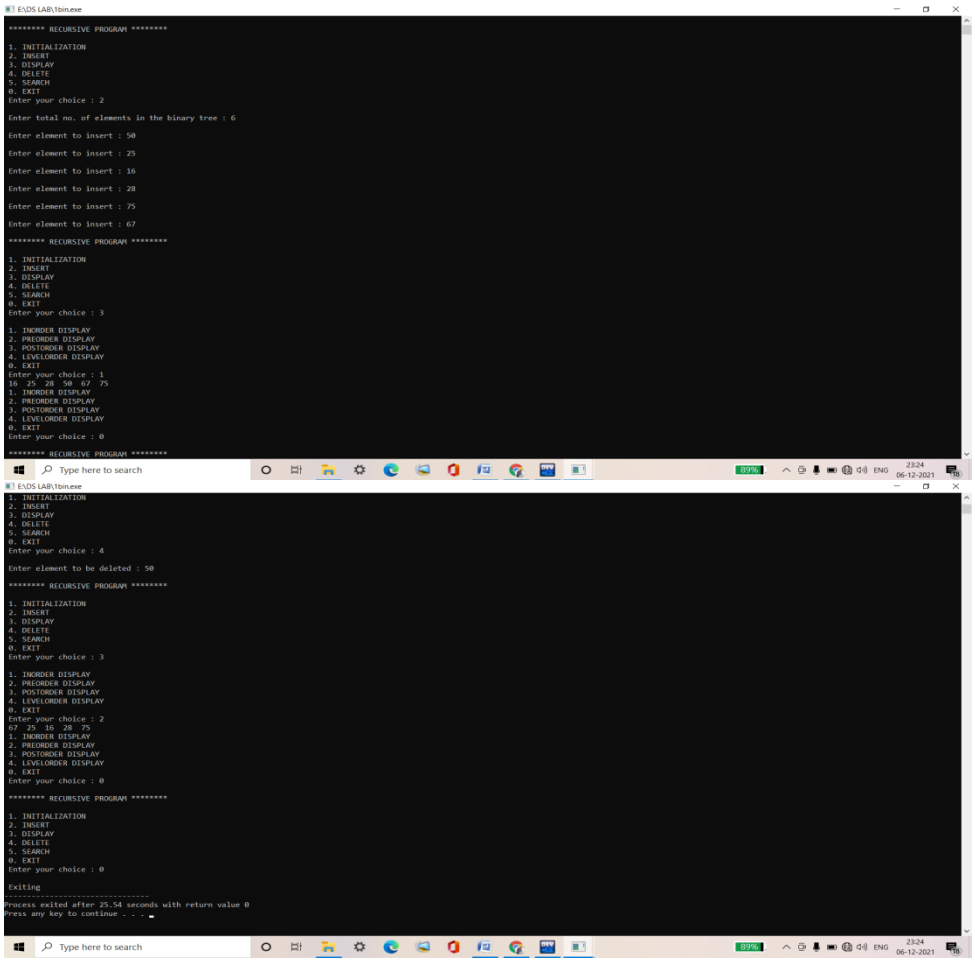
```
                                        if(R==NULL)
                                        printf("\n Binary tree is empty");
                                        else
                                        postorder(R);
                                        break;
                                    case 4:
                                        if(R==NULL)
                                        printf("\n Binary tree is empty");
                                        else
                                        levelorder(R);
                                        break;
                                     case 0:
                                        break;
                                     default:
                                        printf("\n Wrong choice");
                                   }
                                }while(op!=0);
                                break;
                        case 4:
                                if(R==NULL)
                                printf("\n Deletion not possible as binary tree is empty");
                                else
                                {
                                        printf("\n Enter element to be deleted : ");
                                   scanf("%d",&x);
                                   R=rdelete(R,x);
                                }
                                break;
                        case 5:
                                if(R==NULL)
                                printf("\n Search not possible as binary tree is empty");
                                else
                                {
                                        printf("\n Enter element to search : ");
                                scanf("%d",&x);
                                   t=search(R,x);
                                   if(t!=NULL)
                                   printf("\n Information found");
                                   else
                                   printf("\n Information not found");
                                }
                                break;
                        case 0:
                                printf("\n Exiting");
                                break;
                        default:
                                printf("\n Wrong choice");
                }
}while(ch!=0);
```

```
}
BST * init(BST *R)
{
        R=NULL;
        return R;
}
BST * insert(BST *R,int x)
{
        BST *temp;
        temp=(BST *)malloc(sizeof(BST));
        temp->data=x;
        temp->lc=temp->rc=NULL;
        if(R==NULL)
        R=temp;
        else
        {
                if(x<R->data)
                R->lc=insert(R->lc,x);
                else if(x>R->data)
                R->rc=insert(R->rc,x);
        }
        return R;
}
BST * search(BST *R,int x)
{
   BST *t;
   t=R;
   if(t!=NULL)
   {
      if(x<t->data)
            t=search(R->lc,x);
      else if (x>t->data)
            t=search(R->rc,x);
   }
   return t;
}
void preorder(BST *R)
{
   if(R!=NULL)
   {
     printf(" %d ",R->data);
     preorder(R->lc);
     preorder(R->rc);
   }
}
void inorder(BST *R)
{
   if(R!=NULL)
   {
```

```
    inorder(R->lc);
    printf(" %d ",R->data);
    inorder(R->rc);
  }
}
void postorder(BST *R)
{
        if(R!=NULL)
  {
    postorder(R->lc);
    postorder(R->rc);
    printf(" %d ",R->data);
  }
}
void levelorder(BST *R)
{
        int h=height_of_tree(R);
        int i;
        for(i=1;i<=h;i++)
        currentlevel(R,i);
}
void currentlevel(BST *R,int l)
{
        if(R==NULL)
        return;
        else if(l==1)
        printf(" %d ",R->data);
        else
        {
                currentlevel(R->lc,l-1);
                currentlevel(R->rc,l-1);
        }
}
int height_of_tree(BST *R)
{
        int lh,rh;
        if(R==NULL)
        return 0;
        else
        {
                lh=height_of_tree(R->lc);
                rh=height_of_tree(R->rc);
                if(lh>rh)
                return(lh+1);
                else
                return(rh+1);
        }
}
BST * MinValueNode(BST *R)
```

```
{
   BST *c=R;
   while(c && c->lc!=NULL)
      c=c->lc;
          return c;
}
BST * rdelete(BST *R,int x)
{
          BST *temp;
   if(R==NULL)
      return R;
   if(x<R->data)
      R->lc=rdelete(R->lc,x);
   else if(x>R->data)
      R->rc=rdelete(R->rc,x);
   else
         {
      if(R->lc==NULL && R->rc==NULL)
         return NULL;
      else if(R->lc==NULL)
                  {
         temp=R->rc;
         free(R);
         return temp;
      }
      else if(R->rc==NULL)
                  {
         temp=R->lc;
         free(R);
         return temp;
      }
      temp=MinValueNode(R->rc);
      R->data=temp->data;
      R->rc=rdelete(R->rc,temp->data);
   }
   return R;
}
```

OUTPUT –



Q42. WAP Binary Search Create and Traversals and other remaining operations.

Ans42.

C PROGRAM –

NON-RECURSIVE –

```
#include<stdio.h>
#include<malloc.h>
#define max 100
struct bst
{
        int data;
        struct bst *lc;
        struct bst *rc;
};
typedef struct bst BST;
BST * init(BST *);
BST * insert(BST *,int);
void search(BST *,int);
void nrinorder(BST *);
void nrpreorder(BST *);
void nrpostorder(BST *);
void nrlevelorder(BST *);
BST * nrdelete(BST *,int);
int height_of_tree(BST *);
```

```
int count_total(BST *);
int count_term(BST *);
int count_non_term(BST *);
int mindata(BST *);
int maxdata(BST *);
void mirror(BST *);
void cleartree(BST *);
void main()
{
        BST *R=NULL;
        int n,i=0,x,ch,op;
        do
        {
                printf("\n ******** NON-RECURSIVE PROGRAM ********\n");
                printf("\n 1. INITIALIZATION \n 2. INSERT \n 3. DISPLAY \n 4. DELETE \n 5. HEIGHT OR MAX
DEPTH \n 6. SEARCH");
                printf("\n 7. COUNT NODES \n 8. MINIMUM DATA \n 9. MAXIMUM DATA \n 10. MIRROR \n 11.
CLEAR TREE \n 0. EXIT");
                printf("\n Enter your choice : ");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:
                                R=init(R);
                                break;
                        case 2:
                                printf("\n Enter total no. of elements in the binary tree : ");
                scanf("%d",&n);
                i=0;
                while(i<n)
                {
                 i++;
                        printf("\n Enter element to insert : ");
                        scanf("%d",&x);
                        R=insert(R,x);
                }
                                break;
                         case 3:
                                do
                                {
                                        printf("\n 1. INORDER DISPLAY \n 2. PREORDER DISPLAY \n 3.
POSTORDER DISPLAY \n 4. LEVELORDER DISPLAY \n 0. EXIT");
                                   printf("\n Enter your choice : ");
                                   scanf("%d",&op);
                                   switch(op)
                                   {
                                           case 1:
                                        if(R==NULL)
                                        printf("\n Binary tree is empty");
```

```
                        else
                        nrinorder(R);
                        break;
                    case 2:
                        if(R==NULL)
                        printf("\n Binary tree is empty");
                        else
                        nrpreorder(R);
                        break;
                    case 3:
                        if(R==NULL)
                        printf("\n Binary tree is empty");
                        else
                        nrpostorder(R);
                        break;
                    case 4:
                        if(R==NULL)
                        printf("\n Binary tree is empty");
                        else
                        nrlevelorder(R);
                        break;
                    case 0:
                        break;
                    default:
                        printf("\n Wrong choice");
                }
            }while(op!=0);
            break;
case 4:
    if(R==NULL)
            printf("\n Deletion not possible as binary tree is empty");
            else
            {
                    printf("\n Enter element to be deleted : ");
                scanf("%d",&x);
                R=nrdelete(R,x);
            }
            break;
case 5:
            printf("\n Height or Max depth of tree : %d",height_of_tree(R));
            break;
case 6:
            if(R==NULL)
            printf("\n Search not possible as binary tree is empty");
            else
            {
                    printf("\n Enter element to search : ");
            scanf("%d",&x);
                search(R,x);
```

```
                }
                break;
        case 7:
                do
                {
                        printf("\n 1. TOTAL NODES \n 2. TERMINAL NODES \n 3. NON-TERMINAL
NODES \n 0. EXIT");
                  printf("\n Enter your choice : ");
                  scanf("%d",&op);
                  switch(op)
                  {
                        case 1:
                                i=count_total(R);
                                printf("\n Total no. of nodes : %d",i);
                                break;
                        case 2:
                                i=count_term(R);
                                printf("\n Total no. of terminal nodes : %d",i);
                                break;
                     case 3:
                          i=count_non_term(R);
                          printf("\n Total no. of non-terminal nodes : %d",i);
                          break;
                     case 0:
                          break;
                          default:
                             printf("\n Wrong choice");
                  }
                }while(op!=0);
                break;
        case 8:
                if(R==NULL)
                printf("\n Binary tree is empty");
                else
                {
                        i=mindata(R);
                  printf("\n Minimum data : %d",i);
                }
                break;
        case 9:
                if(R==NULL)
                printf("\n Binary tree is empty");
                else
                {
                        i=maxdata(R);
                  printf("\n Maximum data : %d",i);
                }
        break;
    case 10:
```

```
                        if(R==NULL)
                                printf("\n Binary tree is empty");
                                else
                                mirror(R);
                                break;
                        case 11:
                                if(R==NULL)
                                printf("\n Binary tree is empty");
                                else
                                cleartree(R);
                                R=NULL;
                                break;
                        case 0:
                                printf("\n Exiting");
                                break;
                        default:
                                printf("\n Wrong choice");
                }
        }while(ch!=0);
}
BST * init(BST *R)
{
        R=NULL;
        return R;
}
BST * insert(BST *R,int x)
{
        BST *temp,*p,*t;
        temp=(BST *)malloc(sizeof(BST));
        temp->data=x;
        temp->lc=temp->rc=NULL;
        if(R==NULL)
        R=temp;
        else
        {
                t=R;
                while(t!=NULL)
                {
                        p=t;
                        if(x<t->data)
                        t=t->lc;
                        else if(x>t->data)
                        t=t->rc;
                        else
                        {
                                printf("\n Duplicate information");
                                return R;
                        }
                }
```

```
                    if(p->data>x)
            p->lc=temp;
          else
            p->rc=temp;
          }
          return R;
}
void search(BST *R,int x)
{
   BST *t;
   t=R;
   while(t!=NULL)
   {
      if(x<t->data)
            t=t->lc;
      else if (x>t->data)
            t=t->rc;
      else
      {
               printf("\n Information found");
               return;
            }
   }
   printf("\n Information not found");
}
void nrpreorder(BST *R)
{
  BST *stk[10],*t;
  int top=-1;
  t=R;
  do
  {
      while(t!=NULL)
      {
         printf(" %d ",t->data);
         stk[++top]=t;
         t=t->lc;
      }
      t=stk[top--];
      t=t->rc;
  }while(t!=NULL || top>-1);
}
void nrinorder(BST *R)
{
  BST *stk[10],*t;
  int top=-1;
  t=R;
  do
   {
```

```
      while(t!=NULL)
      {
         stk[++top]=t;
         t=t->lc;
      }
      t=stk[top--];
      printf(" %d ",t->data);
      t=t->rc;
   }while(t!=NULL || top>-1);
}
void nrlevelorder(BST *R)
{
          BST *queue[max],*t;
          int f=0,r=-1;
          t=R;
          queue[++r]=t;
          while(f<=r)
          {
                    t=queue[f++];
                    if(t!=NULL)
                    {
                              printf(" %d ",t->data);
                              queue[++r]=t->lc;
                              queue[++r]=t->rc;
                    }
          }
}
void nrpostorder(BST *R)
{
          BST *stk1[max],*stk2[max],*t;
          int t1=-1,t2=-1;
          stk1[++t1]=R;
          while(t1!=-1)
          {
                    R=stk1[t1--];
                    stk2[++t2]=R;
                    if(R->lc)
                    stk1[++t1]=R->lc;
                    if(R->rc)
                    stk1[++t1]=R->rc;
          }
          while(t2!=-1)
          printf(" %d ",stk2[t2--]->data);
}
BST * nrdelete(BST *R, int x)
{
   BST *t,*p,*q,*t1,*t2,*t3;
   if(R==NULL)
   {
```

```
   printf("\n Deletion not possible as binary tree is empty");
   return R;
}
else
{
   t=R;
   while((t!=NULL) && (x!=t->data))
   {
      p=t;
      if(x<t->data)
      t=t->lc;
      else if(x>t->data)
      t=t->rc;
   }
}
if(t==NULL)
{
   printf("\n Element not found");
   return R;
}
else if(t==R)
{
       p=t1=t->lc;
       t2=t->rc;
       while(t1->rc!=NULL)
       t1=t1->rc;
       t1->rc=t2;
       R=p;
       free(t);
       return R;
       }
else
{
   if((t->lc==NULL)&&(t->rc==NULL))
   {
      if(t->data<p->data)
      p->lc=NULL;
      else
      p->rc=NULL;
   }
   else if((t->lc!=NULL)&&(t->rc==NULL))
   {
      if(t->data<p->data)
      p->lc=t->lc;
      else
      p->rc=t->lc;
   }
   else if((t->lc==NULL)&&(t->rc!=NULL))
   {
```

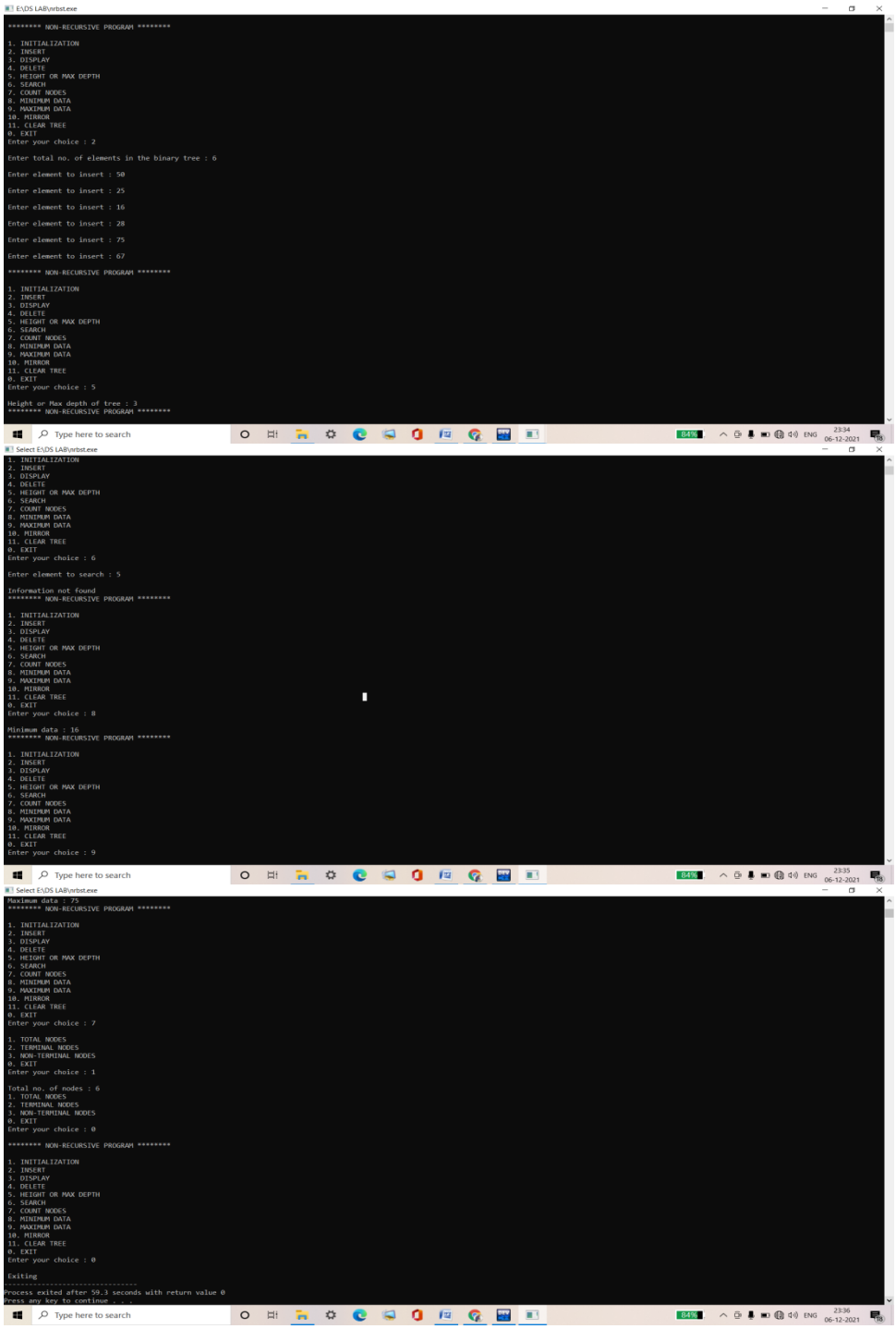
```
            if(t->data<p->data)
            p->lc=t->rc;
            else
            p->rc=t->rc;
        }
        else
        {
            t1=t->lc;
            t2=t->rc;
            while(t1->rc!=NULL)
            t1=t1->rc;
            t1->rc=t2;
            if(t->data<p->data)
            p->lc=t->lc;
            else
            p->rc=t->lc;
        }
    }
    free(t);
    return R;
}
int count_total(BST *R)
{
   int c=0;
   BST *stk[10],*t;
   int top=-1;
   t=R;
   if(R==NULL)
   return c;
   else
   {
              do
       {
          while(t!=NULL)
          {
             stk[++top]=t;
             t=t->lc;
          }
          t=stk[top--];
          c++;
          t=t->rc;
       }while(t!=NULL || top>-1);
                     return c;
   }
}
int count_term(BST *R)
{
   int tc=0;
   BST *stk[10],*t;
```

```
  int top=-1;
  t=R;
  if(R==NULL)
  return tc;
  else
  {
            do
     {
        while(t!=NULL)
        {
           stk[++top]=t;
           t=t->lc;
        }
        t=stk[top--];
        if(t->lc==NULL && t->rc==NULL)
        tc++;
        t=t->rc;
     }while(t!=NULL || top>-1);
                  return tc;
  }
}
int count_non_term(BST *R)
{
  int ntc=0;
  BST *stk[10],*t;
  int top=-1;
  t=R;
  if(R==NULL)
  return ntc;
  else
  {
            do
     {
        while(t!=NULL)
        {
           stk[++top]=t;
           t=t->lc;
        }
        t=stk[top--];
        if(t->lc==NULL && t->rc==NULL)
        ntc++;
        t=t->rc;
     }while(t!=NULL || top>-1);
                  return ntc;
  }
}
int mindata(BST *R)
{
          while(R->lc!=NULL)
```

```
        R=R->lc;
        return R->data;
}
int maxdata(BST *R)
{
        while(R->rc!=NULL)
        R=R->rc;
        return R->data;
}
void cleartree(BST *R)
{
  BST *stk[10],*t;
  int top=-1;
  t=R;
  do
   {
      while(t!=NULL)
      {
         stk[++top]=t;
         t=t->lc;
      }
      t=stk[top--];
      free(t);
      t=t->rc;
   }while(t!=NULL || top>-1);
}
void mirror(BST *R)
{
         BST *stk[10],*t,*temp;
   int top=-1;
   t=R;
   do
   {
      while(t!=NULL)
      {
         stk[++top]=t;
         t=t->lc;
      }
      t=stk[top--];
      temp=t->lc;
      t->lc=t->rc;
      t->rc=temp;
      t=t->rc;
   }while(t!=NULL || top>-1);
}
int height_of_tree(BST *R)
{
        BST *queue[max],*t;
        int f=0,r=-1,size=0,i=0;
```

```
        t=R;
        int c=-1;
        if(R==NULL)
        return c;
        else
        {
           queue[++r]=t;
           while(f<=r)
           {
                  size=r-f+1;
                  while(i<size)
                    {
                          t=queue[f++];
                     if(t!=NULL)
                     {
                              queue[++r]=t->lc;
                              queue[++r]=t->rc;
                     }
                     size--;
                     if(size==0)
                              c++;
                        }
        }
        return c;
        }
}
```

OUTPUT –



C PROGRAM – RECURSIVE –

```
#include<stdio.h>
#include<malloc.h>
struct bst
{
        int data;
        struct bst *lc;
        struct bst *rc;
};
typedef struct bst BST;
```

```
BST * init(BST *);
BST * insert(BST *,int);
BST * search(BST *,int);
void inorder(BST *);
void preorder(BST *);
void postorder(BST *);
void levelorder(BST *);
BST * rdelete(BST *,int);
BST * MinValueNode(BST *);
int height_of_tree(BST *);
void currentlevel(BST *,int);
int count_total(BST *);
int count_term(BST *);
int count_non_term(BST *);
int mindata(BST *);
int maxdata(BST *);
void mirror(BST *);
void cleartree(BST *);
void main()
{
        BST *R=NULL,*t;
        int n,i=0,x,ch,op;
        do
        {
                printf("\n ******** RECURSIVE PROGRAM ********\n");
                printf("\n 1. INITIALIZATION \n 2. INSERT \n 3. DISPLAY \n 4. DELETE \n 5. HEIGHT OR MAX
DEPTH \n 6. SEARCH");
                printf("\n 7. COUNT NODES \n 8. MINIMUM DATA \n 9. MAXIMUM DATA \n 10. MIRROR \n 11.
CLEAR TREE \n 0. EXIT");
                printf("\n Enter your choice : ");
                scanf("%d",&ch);
                switch(ch)
                {
                        case 1:
                                R=init(R);
                                break;
                        case 2:
                                printf("\n Enter total no. of elements in the binary tree : ");
                scanf("%d",&n);
                i=0;
                while(i<n)
                {
                 i++;
                        printf("\n Enter element to insert : ");
                        scanf("%d",&x);
                        R=insert(R,x);
                }
                                break;
                         case 3:
```

```
                do
                {
                        printf("\n 1. INORDER DISPLAY \n 2. PREORDER DISPLAY \n 3.
POSTORDER DISPLAY \n 4. LEVELORDER DISPLAY \n 0. EXIT");
                  printf("\n Enter your choice : ");
                  scanf("%d",&op);
                  switch(op)
                  {
                        case 1:
                            if(R==NULL)
                            printf("\n Binary tree is empty");
                            else
                            inorder(R);
                            break;
                        case 2:
                            if(R==NULL)
                            printf("\n Binary tree is empty");
                            else
                            preorder(R);
                            break;
                        case 3:
                            if(R==NULL)
                            printf("\n Binary tree is empty");
                            else
                            postorder(R);
                            break;
                       case 4:
                            if(R==NULL)
                            printf("\n Binary tree is empty");
                            else
                            levelorder(R);
                            break;
                        case 0:
                            break;
                        default:
                            printf("\n Wrong choice");
                  }
                }while(op!=0);
                break;
        case 4:
                if(R==NULL)
                printf("\n Deletion not possible as binary tree is empty");
                else
                {
                        printf("\n Enter element to be deleted : ");
                  scanf("%d",&x);
                  R=rdelete(R,x);
                }
                break;
```

```
                case 5:
                        printf("\n Height or Max depth of tree : %d",height_of_tree(R));
                        break;
                case 6:
                        if(R==NULL)
                        printf("\n Search not possible as binary tree is empty");
                        else
                        {
                                printf("\n Enter element to search : ");
                        scanf("%d",&x);
                           t=search(R,x);
                           if(t!=NULL)
                           printf("\n Information found");
                           else
                           printf("\n Information not found");
                        }
                        break;
                case 7:
                        do
                        {
                                printf("\n 1. TOTAL NODES \n 2. TERMINAL NODES \n 3. NON-TERMINAL
NODES \n 0. EXIT");
                           printf("\n Enter your choice : ");
                           scanf("%d",&op);
                           switch(op)
                           {
                                   case 1:
                                           i=count_total(R);
                                           printf("\n Total no. of nodes : %d",i);
                                           break;
                                   case 2:
                                           i=count_term(R);
                                           printf("\n Total no. of terminal nodes : %d",i);
                                           break;
                              case 3:
                                   i=count_non_term(R);
                                   printf("\n Total no. of non-terminal nodes : %d",i);
                                   break;
                              case 0:
                                   break;
                                   default:
                                      printf("\n Wrong choice");
                           }
                        }while(op!=0);
                        break;
        case 8:
                        if(R==NULL)
                        printf("\n Binary tree is empty");
                        else
```

```
                                {
                                        i=mindata(R);
                                   printf("\n Minimum data : %d",i);
                                }
                                break;
                        case 9:
                                if(R==NULL)
                                printf("\n Binary tree is empty");
                                else
                                {
                                        i=maxdata(R);
                                   printf("\n Maximum data : %d",i);
                                }
                                break;
                        case 10:
                                if(R==NULL)
                                printf("\n Binary tree is empty");
                                else
                                mirror(R);
                                break;
                        case 11:
                                if(R==NULL)
                                printf("\n Binary tree is empty");
                                else
                                cleartree(R);
                                R=NULL;
                                break;
                        case 0:
                                printf("\n Exiting");
                                break;
                        default:
                                printf("\n Wrong choice");
                   }
        }while(ch!=0);
}
BST * init(BST *R)
{
        R=NULL;
        return R;
}
BST * insert(BST *R,int x)
{
        BST *temp;
        temp=(BST *)malloc(sizeof(BST));
        temp->data=x;
        temp->lc=temp->rc=NULL;
        if(R==NULL)
        R=temp;
        else
```

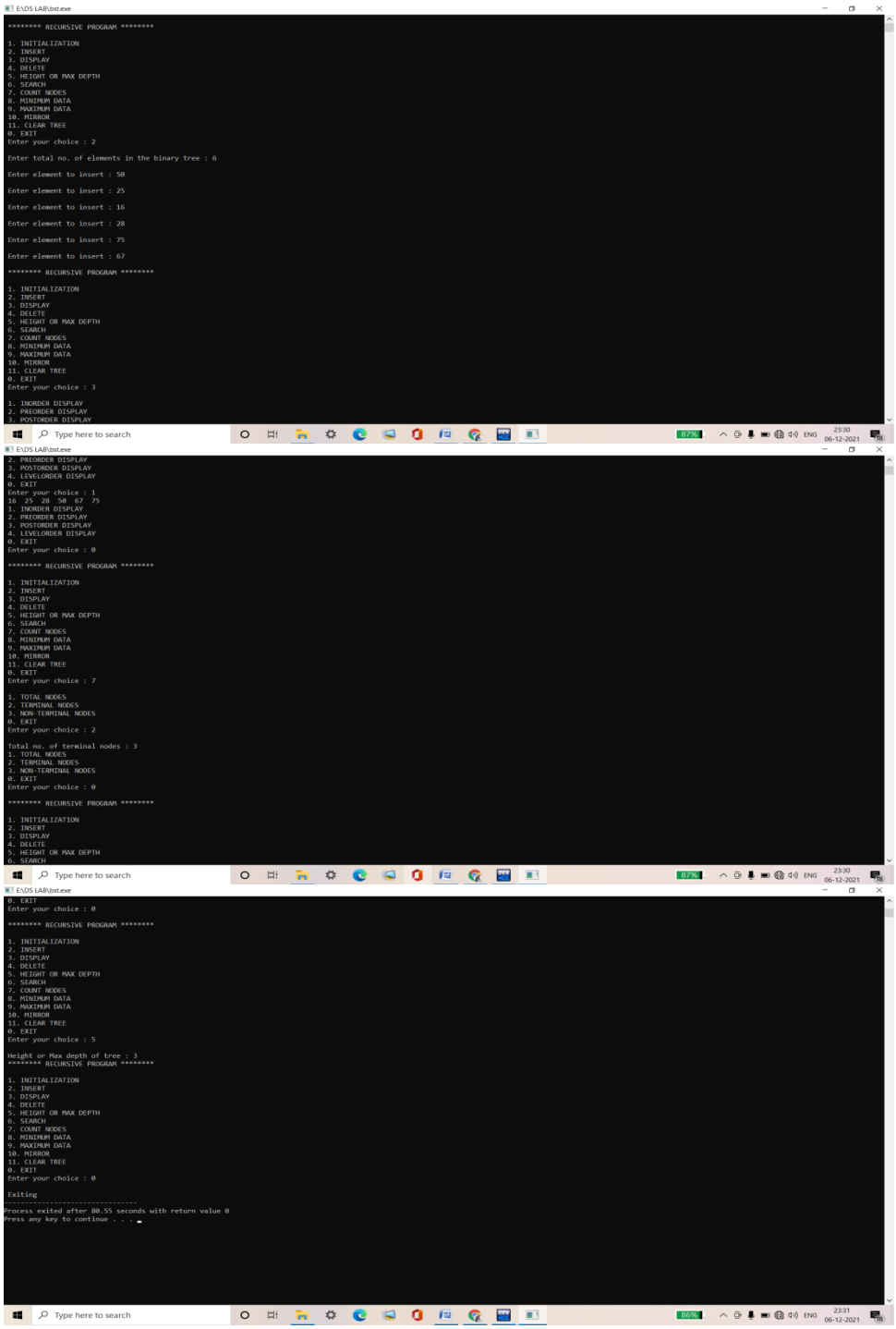
```
        {
                if(x<R->data)
                R->lc=insert(R->lc,x);
                else if(x>R->data)
                R->rc=insert(R->rc,x);
        }
        return R;
}
BST * search(BST *R,int x)
{
   BST *t;
   t=R;
   if(t!=NULL)
   {
      if(x<t->data)
            t=search(R->lc,x);
      else if (x>t->data)
            t=search(R->rc,x);
   }
   return t;
}
void preorder(BST *R)
{
   if(R!=NULL)
   {
     printf(" %d ",R->data);
     preorder(R->lc);
     preorder(R->rc);
   }
}
void inorder(BST *R)
{
   if(R!=NULL)
   {
     inorder(R->lc);
     printf(" %d ",R->data);
     inorder(R->rc);
   }
}
void postorder(BST *R)
{
        if(R!=NULL)
   {
     postorder(R->lc);
     postorder(R->rc);
     printf(" %d ",R->data);
   }
}
void levelorder(BST *R)
```

```
{
        int h=height_of_tree(R);
        int i;
        for(i=1;i<=h;i++)
        currentlevel(R,i);
}
void currentlevel(BST *R,int l)
{
        if(R==NULL)
        return;
        else if(l==1)
        printf(" %d ",R->data);
        else
        {
                currentlevel(R->lc,l-1);
                currentlevel(R->rc,l-1);
        }
}
int height_of_tree(BST *R)
{
        int lh,rh;
        if(R==NULL)
        return 0;
        else
        {
                lh=height_of_tree(R->lc);
                rh=height_of_tree(R->rc);
                if(lh>rh)
                return(lh+1);
                else
                return(rh+1);
        }
}
int count_total(BST *R)
{
        if(R==NULL)
        return 0;
        else
                return(1+ count_total(R->lc) + count_total(R->rc));
}
int count_term(BST *R)
{
        if(R==NULL)
        return 0;
        else if(R->rc==NULL && R->lc==NULL)
        return 1;
        else
        return(count_term(R->lc)+count_term(R->rc));
}
```

```
int count_non_term(BST *R)
{
	if(R==NULL || R->rc==NULL && R->lc==NULL)
	return 0;
	else
	{
		if(R->lc!=NULL || R->rc!=NULL)
			return(1+ count_non_term(R->lc) + count_non_term(R->rc));
	}
}
int mindata(BST *R)
{
	if(R->lc==NULL)
	return R->data;
	else
	return(mindata(R->lc));
}
int maxdata(BST *R)
{
	if(R->rc==NULL)
	return R->data;
	else
	return(maxdata(R->rc));
}
void mirror(BST *R)
{
	BST *temp;
	if(R==NULL)
	return;
	else
	{
		mirror(R->lc);
		mirror(R->rc);
		temp=R->lc;
		R->lc=R->rc;
		R->rc=temp;
	}
}
void cleartree(BST *R)
{
	if(R!=NULL)
	{
		cleartree(R->lc);
		cleartree(R->rc);
		free(R);
	}
}
BST * MinValueNode(BST *R)
{
```

```
   BST *c=R;
   while(c && c->lc!=NULL)
      c=c->lc;
          return c;
}
BST * rdelete(BST *R,int x)
{
          BST *temp;
   if(R==NULL)
      return R;
   if(x<R->data)
      R->lc= rdelete(R->lc,x);
   else if(x>R->data)
      R->rc= rdelete(R->rc,x);
   else
         {
      if(R->lc==NULL && R->rc==NULL)
         return NULL;
      else if(R->lc==NULL)
                  {
         temp=R->rc;
         free(R);
         return temp;
      }
      else if(R->rc==NULL)
                  {
         temp=R->lc;
         free(R);
         return temp;
      }
      temp=MinValueNode(R->rc);
      R->data=temp->data;
      R->rc=rdelete(R->rc,temp->data);
   }
   return R;
}
```

OUTPUT –



Q43. WAP for implementing Heap Sort.

Ans43.

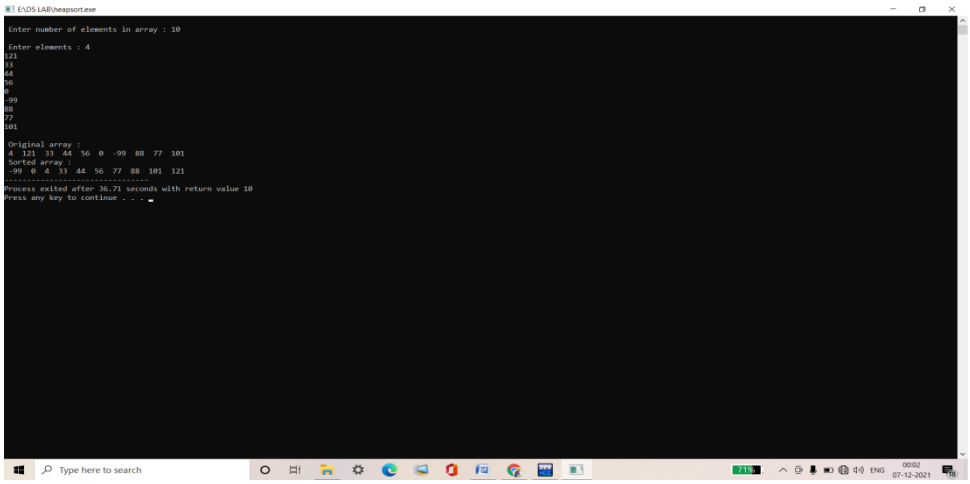
C PROGRAM –

```
#include<stdio.h>
#define max 20
void heapSort(int [], int);
void heapify(int [], int, int);
void printArray(int [], int);
void swap(int *, int *);
void main()
{
```

```
        int a[max];
        int n,i;
   printf("\n Enter number of elements in array : ");
   scanf("%d",&n);
   printf("\n Enter elements : ");
   for (i=0;i<n;i++)
     scanf("%d",&a[i]);
   printf("\n Original array : \n");
   for (i=0;i<n;i++)
     printf(" %d ",a[i]);
   heapSort(a,n);
   printf("\n Sorted array : \n");
   printArray(a,n);
}
void swap(int *a, int *b)
{
   int temp=*a;
   *a=*b;
   *b=temp;
}
void heapify(int arr[], int n, int i)
{
   int largest=i;
   int left=2*i+1;
   int right=2*i+2;
   if (left<n && arr[left]>arr[largest])
      largest=left;
   if (right<n && arr[right]>arr[largest])
      largest=right;
   if (largest!=i)
        {
      swap(&arr[i],&arr[largest]);
      heapify(arr,n,largest);
   }
}
void heapSort(int arr[], int n)
{
        int i;
   for(i=n/2-1;i>=0;i--)
   heapify(arr,n,i);
   for(i=n-1;i>=0;i--)
        {
      swap(&arr[0],&arr[i]);
      heapify(arr,i,0);
   }
}
void printArray(int arr[], int n)
{
        int i;
```

```
    for(i=0;i<n;++i)
    printf(" %d ",arr[i]);
}
```

OUTPUT –




Thank you