# DATA STRUCTURES

# LAB RECORD

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27/08/2020

## Experiment No:1

# BUBBLE SORT

**AIM:**

To perform bubble sort in an array and to arrange the elements of the array in ascending order.

**DATA STRUCTURE USED:**

Arrays.

**ALGORITHM:**

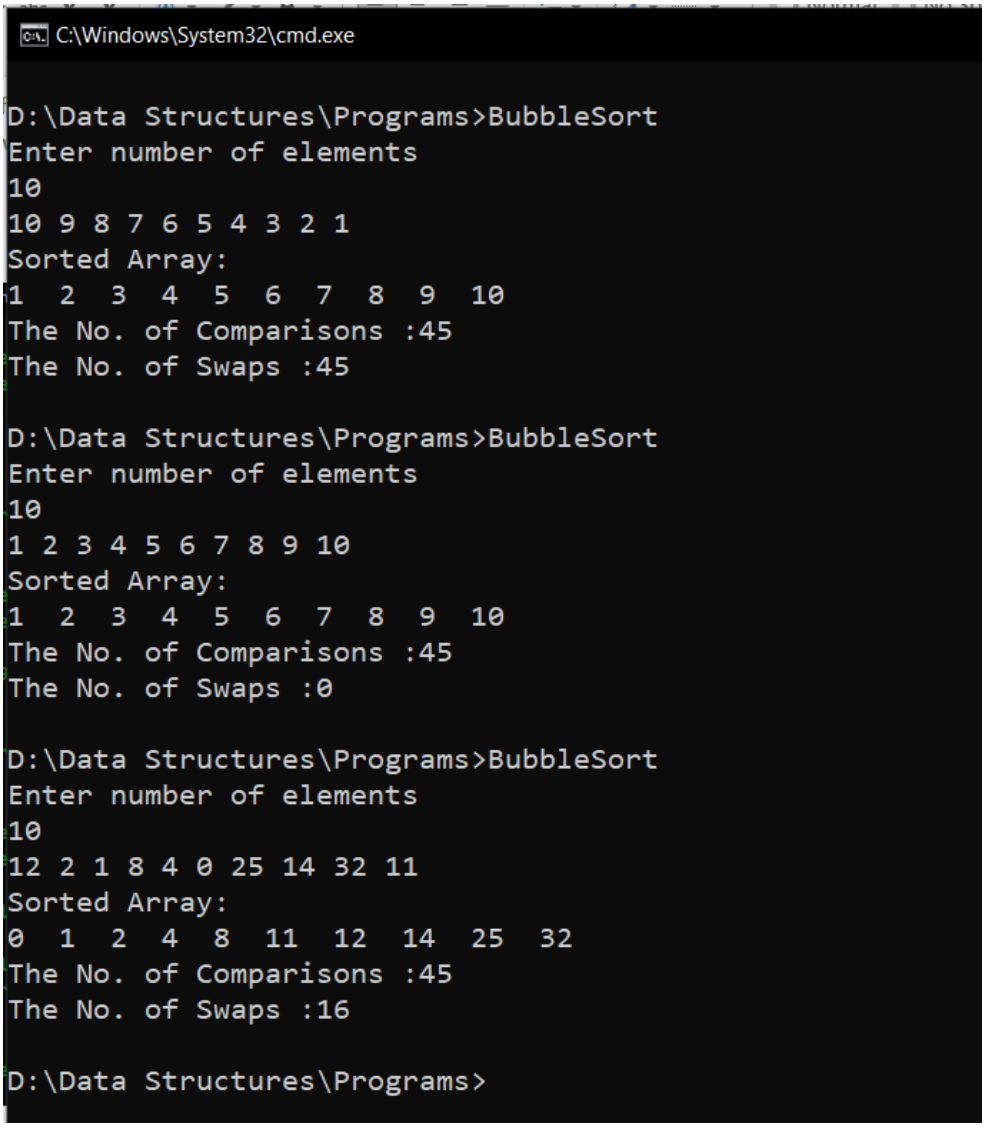
1. Declare the array arr[size] and read the values of array
2. for i=0 to size-1
3. for j=0 to size-i-1
4. if arr[j]>arr[j+1]
5. swap arr[j] and arr[j+1]
6. endif
7. endfor
8. endfor
9. print the sorted array

**PROGRAM:**

```
#include <stdio.h>
void main(){
 int arr[100], i,j, n,temp,s=0,c=0;

 printf("Enter number of elements\n");
 scanf("%d", &n);

 for (i=0; i<n; i++){
  scanf("%d", &arr[i]);
 }
 for (i=0 ; i<n-1;i++){
   for (j=0 ; j<n-i-1;j++){
      c++;
     if (arr[j]>arr[j+1]){
        temp=arr[j];
```

```
            arr[j]=arr[j+1];
            arr[j+1]=temp;
            s++;
          }
        }
      }

  printf("Sorted Array:\n");
  for (i=0;i< n;i++){
     printf("%d  ", arr[i]);
  }
  printf("\nThe No. of Comparisons :%d\n", c);
  printf("The No. of Swaps :%d\n", s);
}
```

**OUTPUT:**



## RESULT:

Bubble sort was performed in the array and the array elements were arranged in ascending order. Also, the number of comparisons and swaps performed were found out. Number of comparisons performed was found to be n(n-1)/2 where n is the number of array elements (Except for best case).

Time complexity:

Best case – O(n)
Average case – $O(n^2)$
Worst case – $O(n^2)$

27/08/2020

## Experiment No:2

# SELECTION SORT

### AIM:

To perform selection sort in an array and to arrange the elements of the array in ascending order.

### DATA STRUCTURE USED:

Arrays.

### ALGORITHM:

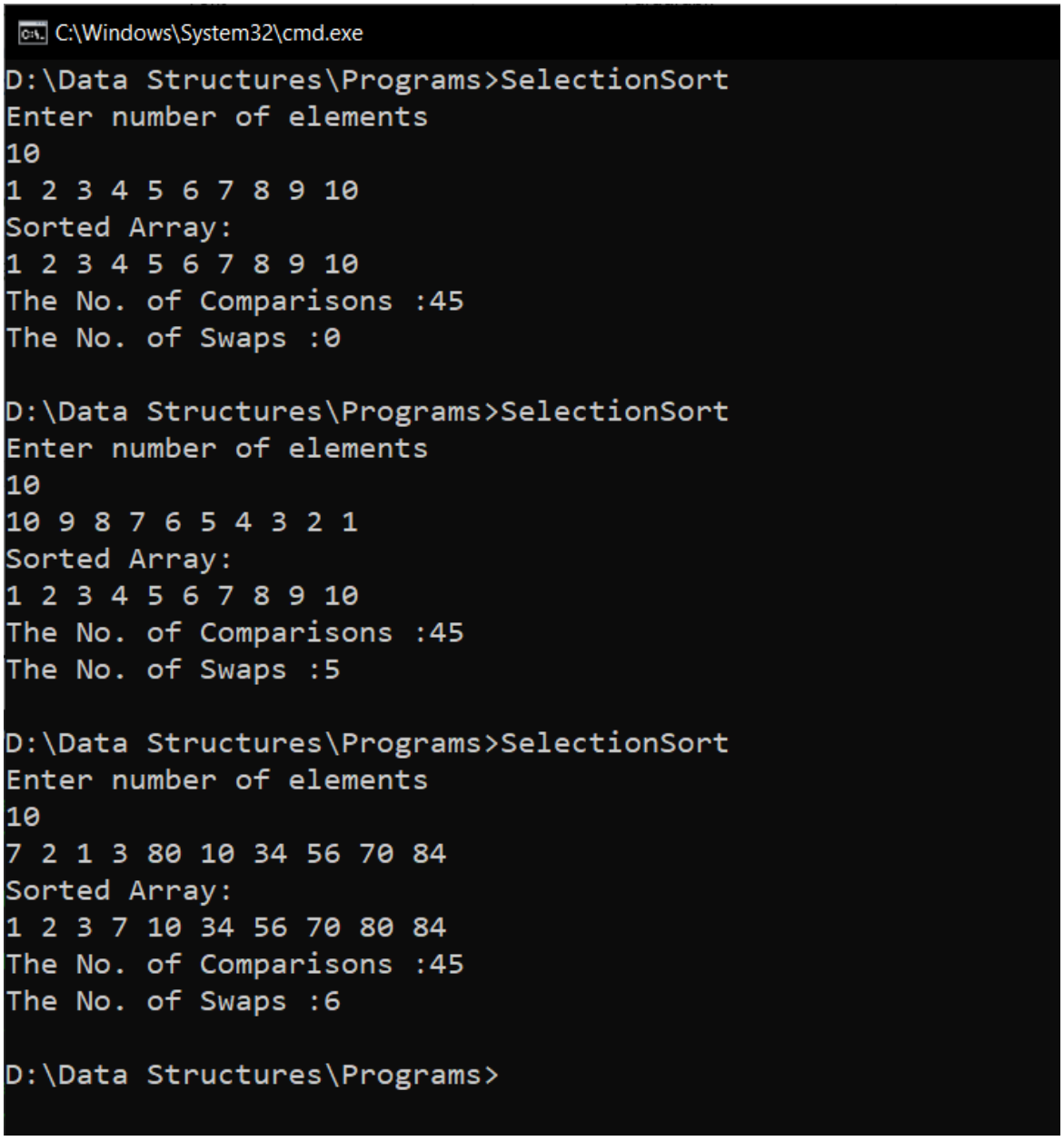
1. Read the elements of the array arr[size]
2. for i=0 to size
3. pos=i
4. for j= i+1 to size
5. if arr[pos]>arr[j]
6. pos=j
7. end if
8. endfor
9. if pos !=j
10. swap arr[j] and arr[pos]
11. endif
12. endfor

### PROGRAM:

```
#include <stdio.h>
void main(){
 int arr[100], n,i, j, pos,c=0,s=0,temp;

 printf("Enter number of elements\n");
 scanf("%d",&n);
 for (i=0;i< n;i++){
  scanf("%d", &arr[i]);
```

```
  }
 for (i=0;i<n-1;i++){
  pos = i;
  for (j=i+1;j<n;j++){ c++;
   if (arr[pos]> arr[j])
     pos=j;
   }
  if (pos!=i){
   temp = arr[i];
   arr[i] = arr[pos];
   arr[pos] = temp;
   s++;
  }
 }

 printf("Sorted Array:\n");

 for (i=0;i<n; i++){
  printf("%d ",arr[i]);
  }
 printf("\nThe No. of Comparisons :%d\n", c);
 printf("The No. of Swaps :%d\n", s);
 return 0;
}
```

**OUTPUT:**




**RESULT:**

Selection sort was performed in the array and the array elements were arranged in ascending order. Also, the number of comparisons and swaps performed were found out. Number of comparisons performed was found to be n(n-1)/2 where n is the number of array elements.

Time complexity:

Best case – $O(n^2)$

Average case – $O(n^2)$

Worst case – $O(n^2)$

06/09/2020

## Experiment No:3

# INSERTION SORT

### AIM:

To perform insertion sort in an array and to arrange the elements of the array in ascending order.

### DATA STRUCTURE USED:

Arrays.

### ALGORITHM:

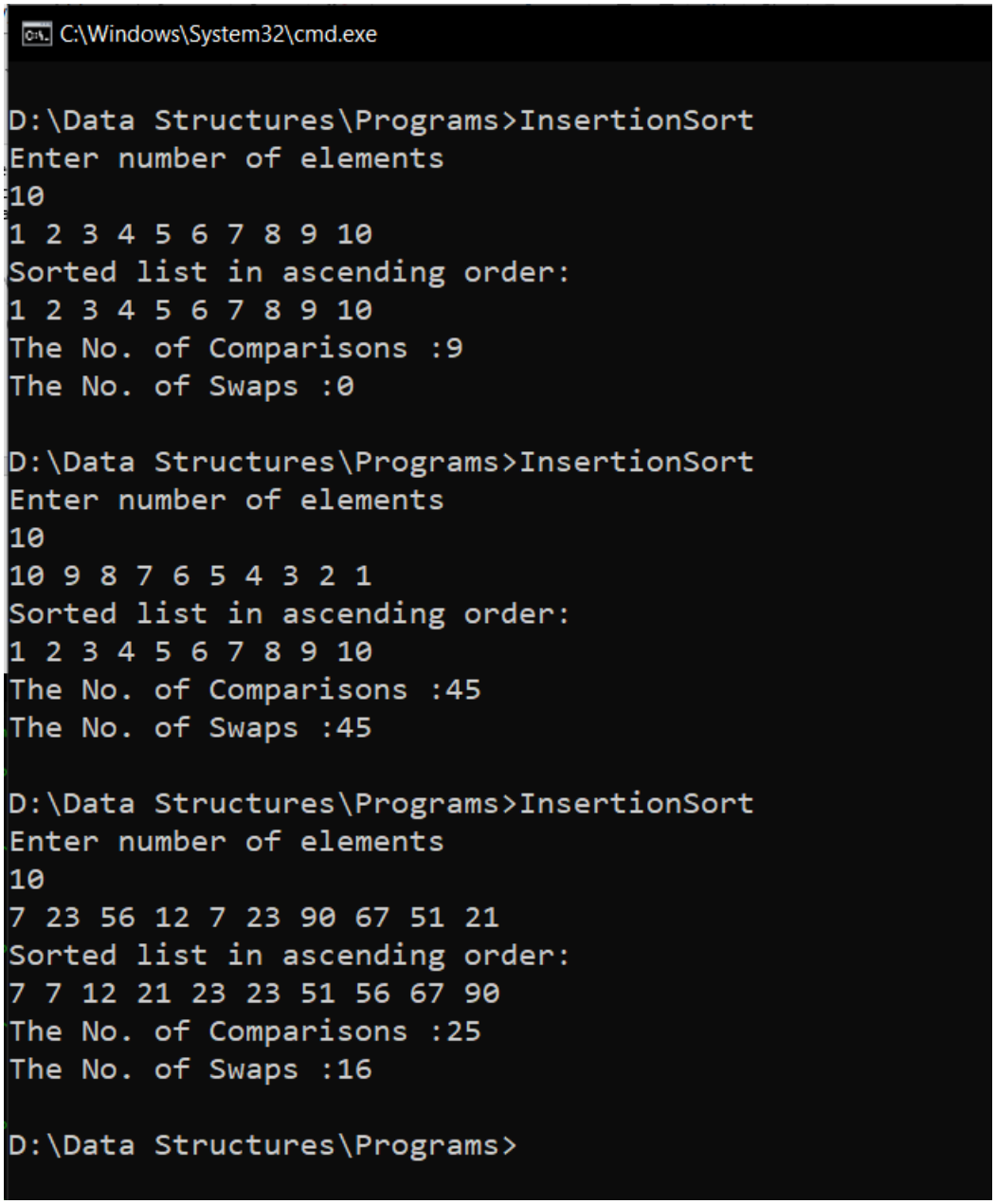
1. Read the elements of the array arr[size]
2. for i=1 to size
3. x = arr[i]
4. for j= i-1 to 0
5. if arr[j]>x
6. arr[j+1]=x
7. else
8. break
9. end if
10. endfor
11. arr[i+1]=x
12. endfor

### PROGRAM:

```
#include <stdio.h>
void main(){
 int n, arr[100], i, j, x,c=0,s=0, flag = 0;
 printf("Enter number of elements\n");
 scanf("%d", &n);

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

```
 for (i = 1 ; i < n ; i++){
    x = arr[i];
    for (j = i - 1 ; j >= 0; j--){
       c++;
       if (arr[j] > x) {
          s++;
          arr[j+1] = arr[j];
          flag = 1;
       }
       else
          break;

    }

  if (flag==1)
    arr[j+1] = x;
 }

 printf("Sorted list in ascending order:\n");

 for (i = 0; i < n ; i++) {
  printf("%d ", arr[i]);
 }
 printf("\nThe No. of Comparisons :%d\n", c);
 printf("The No. of Swaps :%d\n", s);
}
```

**OUTPUT:**




**RESULT:**

Insertion sort was performed in the array and the array elements were arranged in ascending order. Also, the number of comparisons and swaps performed were found out. Number of comparisons performed was found to be (n-1) for best case and n(n-1)/2 for worst case where n is the number of array elements.

Time complexity:

Best case – O(n)
Average case – $O(n^2)$
Worst case – $O(n^2)$

18/09/2020

## Experiment No:4

# POLYNOMIAL ADDITTION

### AIM:

Write a program to read two polynomials and store them in an array. Calculate the sum of the two polynomials and display the first polynomial, second polynomial and the resultant polynomial.

### DATA STRUCTURES USED:

Arrays

### ALGORITHM:

1. Initialise the exponent(row 0) and coefficient(row 1) and t1 (no of terms in a), t2 (no of terms in b)
2. Read the first polynomial and store it in the a coeff and exp arrays
3. Read the second polynomial to the p2 coeff and exp arrays
4. while i<=t1 || j<=t2

```
if i >= t1

        c.exp[k] = b.exp[j]

        c.coeff[k] = b.coeff[j]

        j++, k++

else if j >= t2

        c.exp[k] = a.exp[i]

        c.coeff[k] = a.coeff[i]

        i++, k++

else if a.exp[i] == b.exp[j]

        c.coeff[k] = a.coeff[i] + b.coeff[j]

        c.exp[k] = a.exp[i]

        i++, j++, k++
```

else if a.exp[i] > b.exp[j]

c.exp[k] = a.exp[i]

c.coeff[k] =a.coeff[i]

i++, k++

else

c.exp[k] = b.exp[j]

c.coeff[k] = b.coeff[j]

j++, k++

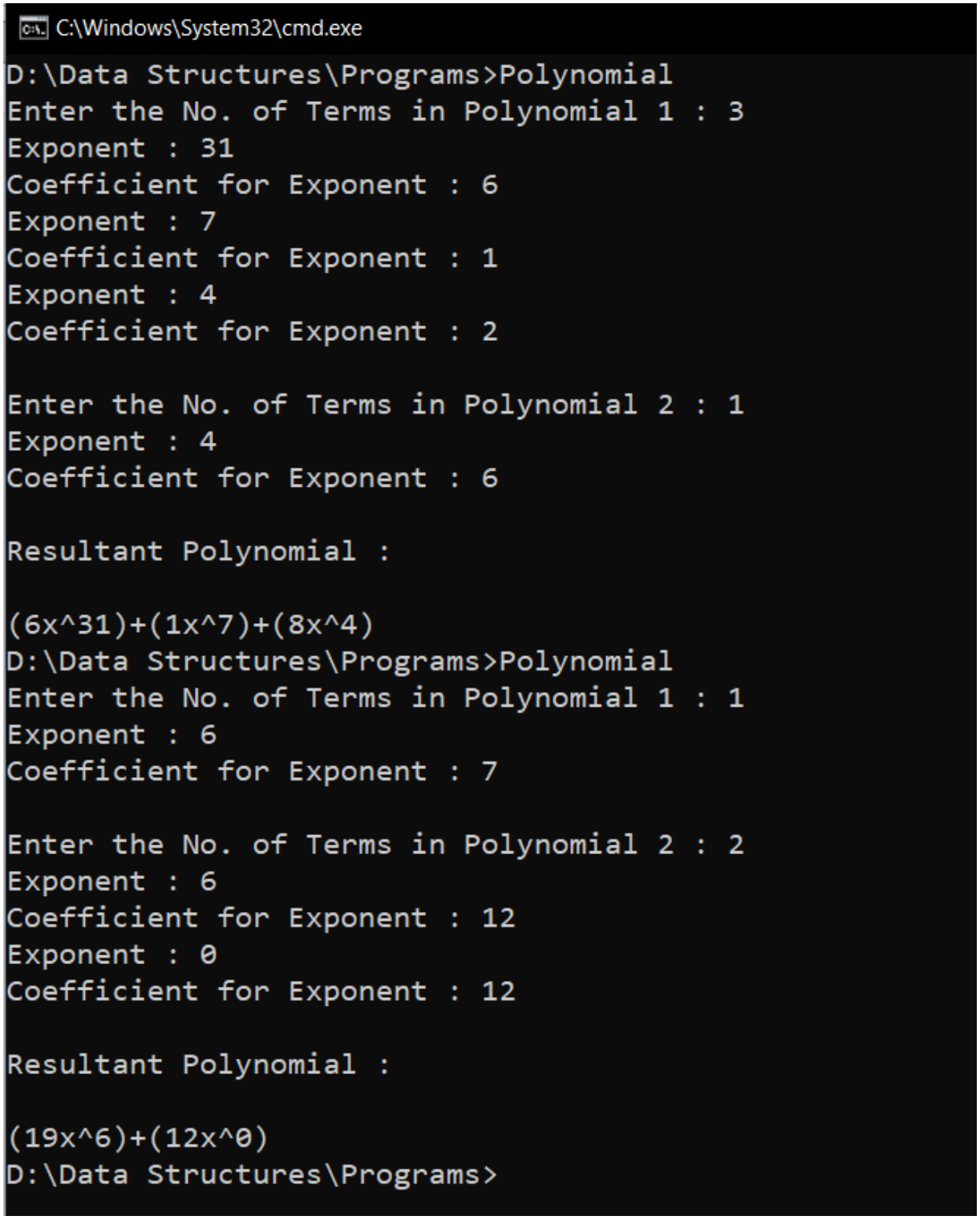
5. print p3

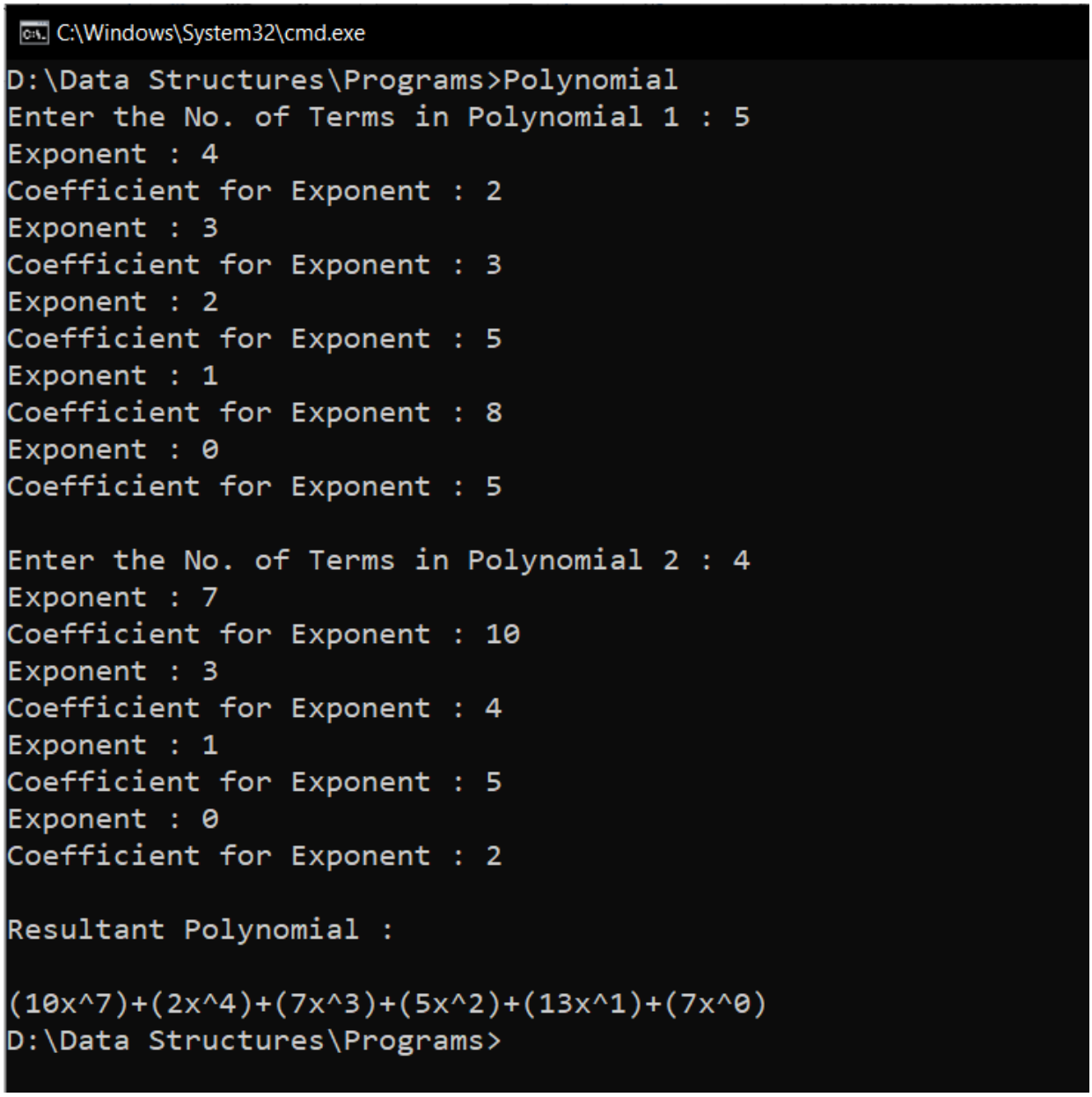
**PROGRAM:**

```
#include<stdio.h>
void main(){
   int a[2][10],b[2][10],c[2][10],i,j,k,t1,t2;
   printf("Enter the No. of Terms in Polynomial 1 : ");
   scanf("%d",&t1);
   for(i=0;i<t1;i++){
      printf("Exponent : ");
      scanf("%d",&a[0][i]);
      printf("Coefficient for Exponent : ");
      scanf("%d",&a[1][i]);
   }
   printf("\nEnter the No. of Terms in Polynomial 2 : ");
   scanf("%d",&t2);
   for(i=0;i<t2;i++){
      printf("Exponent : ");
      scanf("%d",&b[0][i]);
      printf("Coefficient for Exponent : ");
      scanf("%d",&b[1][i]);
   }
   i=0;j=0;k=0;
   while(i<t1 || j<t2){
      if (i>=t1){
         c[0][k] = b[0][j];
         c[1][k] = b[1][j];
         j++, k++;
      }
      else if (j>=t2){
```

```
            c[0][k] = a[0][j];
            c[1][k] = a[1][j];
            i++, k++;
        }
        else if (a[0][i]==b[0][j]){
            c[0][k]=a[0][i];
            c[1][k]=a[1][i]+b[1][j];
            i++, j++, k++;
        }
        else if(a[0][i]>b[0][j]){
            c[0][k]=a[0][i];
            c[1][k]=a[1][i];
            i++;
            k++;
        }
        else{
            c[0][k]=b[0][j];
            c[1][k]=b[1][j];
            k++;
            j++;
        }
    }
   printf("\nResultant Polynomial :\n\n");
    for(i=0;i<k;i++){
        printf("(%dx^%d)",c[1][i],c[0][i]);
        if(i!=k-1)
        printf("+");
    }
}
```

**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>Polynomial
Enter the No. of Terms in Polynomial 1 : 3
Exponent : 31
Coefficient for Exponent : 6
Exponent : 7
Coefficient for Exponent : 1
Exponent : 4
Coefficient for Exponent : 2
Enter the No. of Terms in Polynomial 2 : 1
Exponent : 4
Coefficient for Exponent : 6
Resultant Polynomial :
(6x^31)+(1x^7)+(8x^4)
D:\Data Structures\Programs>Polynomial
Enter the No. of Terms in Polynomial 1 : 1
Exponent : 6
Coefficient for Exponent : 7
Enter the No. of Terms in Polynomial 2 : 2
Exponent : 6
Coefficient for Exponent : 12
Exponent : 0
Coefficient for Exponent : 12
Resultant Polynomial :
(19x^6)+(12x^0)
D:\Data Structures\Programs>




**RESULT:**

Two polynomials are stored in an array and are added to obtain a resultant polynomial. All three polynomials are displayed.

20/09/2020

## Experiment No. 5

# SPARSE MATRIX

### AIM:

Write a program to enter two matrices in normal form. Write a function to convert two matrices to tuple form and display it. Also find the transpose of the two matrices represented in tuple form and display it. Find the sum of the two matrices in tuple form and display the sum in tuple form.

### DATA STRUCTURES USED:

Arrays

### ALGORITHM:

START
1. Accept the two matrix in normal form and R is the Resultant Matrix
2. Traverse throught the matrix such that k starts from 1
3. Find non zero values
4. Store its row in R[i][0] and column in R[i][1] and value in R[i][2]
5. Store R[0][0] = num of rows
6. Store R[0][1] = num of columns
7. Store R[0][0] = k-1 (Number of non-zero values)
8. Print the resultant Tuple Representation
9. Function Transpose(int sp[][3])
10. Check whether sp[0][2] is 0: then return "No elements"
11. Copy sp[0][0] into spt[0][0]
12. Copy sp[0][1] into spt[0][1]
13. Copy sp[0][2] into spt[0][2]
14. k = 1
15. for i=0 till number of columns
16. for j=1 till the number of non zero values
17. if i == a[j][1], insert the entire row into Resultant Array
18. k++
19. End if
20. End for
21. End for
22. Print Resultant Array
23. Function Addition(int sp1[][3],int sp2[][3])
24. If matrices doesn't match in size (i.e, rows and columns are not equal), print "Invalid operation"

25. Else
26. while i <= sp1[0][2] or j <= sp2[0][2] do
27. If sp1[i][0] < sp2[j][0]
28. Copy the data of ith row of sp1 to Resultant, i++, k++
29. Else if sp1[i][0] > sp2[j][0]
30. Copy the data of jth row of sp2 to Resultant, j++, k++
31. Else
32. If sp1[i][1] < sp2[j][1]
33. Copy the data of ith row of sp1 to Resultant, i++, k++
34. Else if sp1[i][1] > sp2[j][1]
35. Copy the data of jth row of sp2 to Resultant, j++, k++
36. Else
37. Add the values and insert to Resultant along with the row and column data, i++, j++, k++
38. End if
39. End if
40. End while
41. End if
42. Print the Resultant Tuple Representation
STOP

**PROGRAM:**

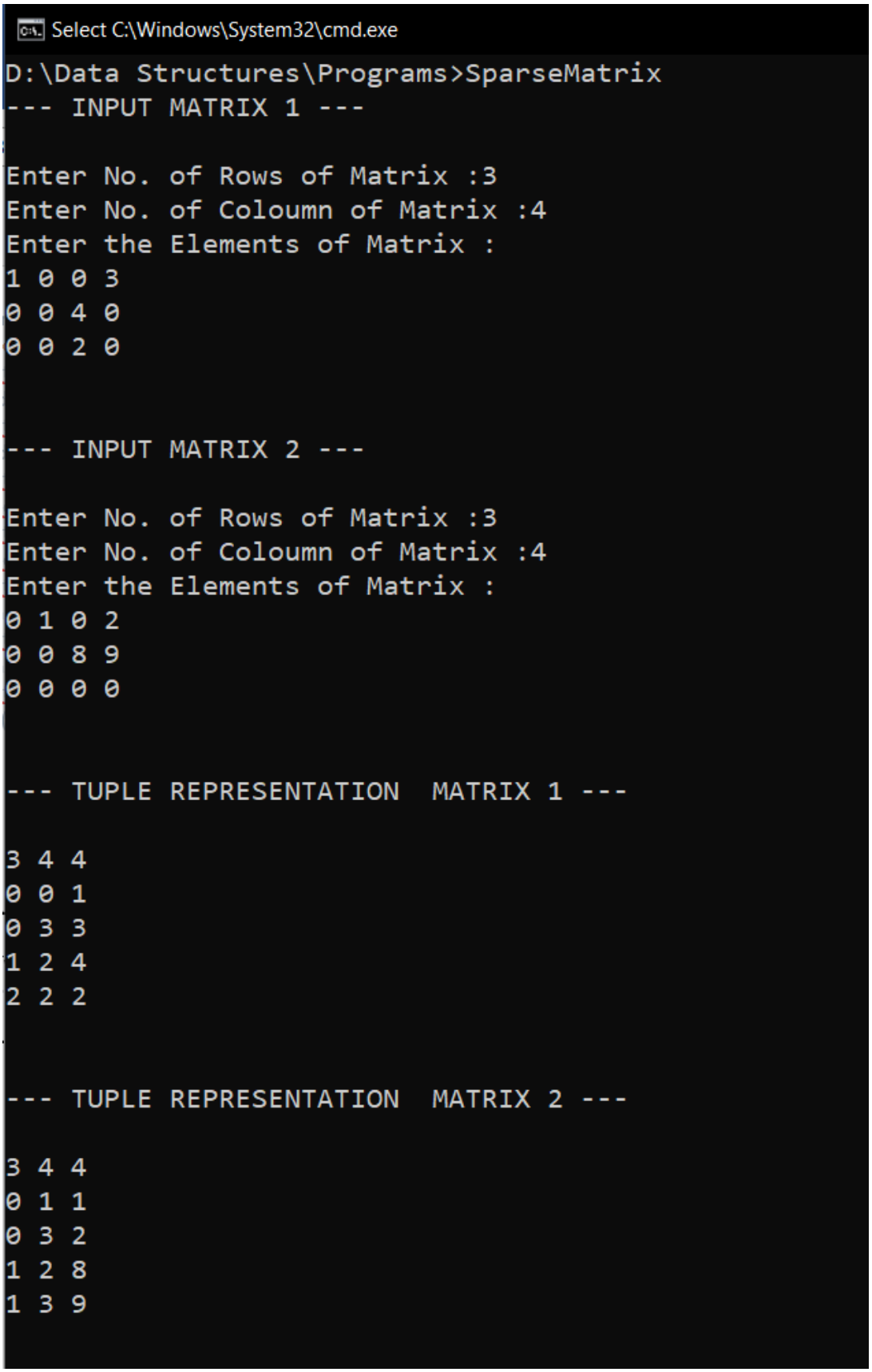
```
#include <stdio.h>
struct sparse{
   int row, col;
   int arr[10][10];
   int sarr[50][3];
   int tarr[50][3];
};


void read(struct sparse *sp){
 printf("Enter No. of Rows of Matrix :");
 scanf("%d", &sp->row);
 printf("Enter No. of Coloumn of Matrix :");
 scanf("%d",&sp->col);
 printf("Enter the Elements of Matrix :\n");
 for(int i=0;i<sp->row;i++){
    for(int j=0;j<sp->col;j++){
       scanf("%d", &sp->arr[i][j]);
    }
 }
}

void tupleRepresentation(struct sparse *sp){
 int k=0;
```

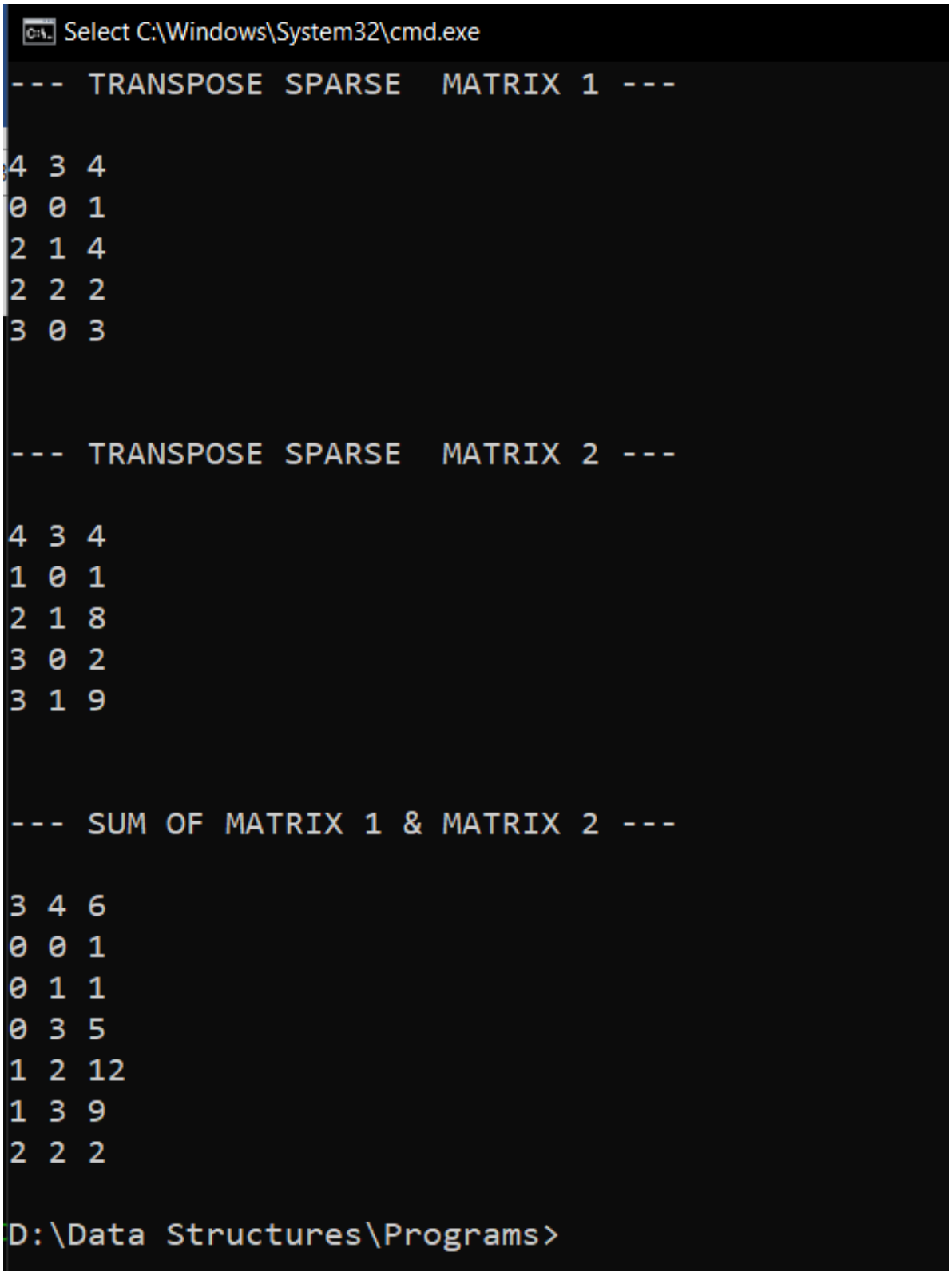
```
 sp->sarr[0][0] = sp->row;
 sp->sarr[0][1] = sp->col;
 for(int i=0;i<sp->row;i++){
    for(int j=0;j<sp->col;j++){
       if(sp->arr[i][j] != 0){
          k++;
          sp->sarr[k][0] = i;
          sp->sarr[k][1] = j;
          sp->sarr[k][2] = sp->arr[i][j];
       }
    }
 }
 sp->sarr[0][2] = k;
 for(int i=0;i<=sp->sarr[0][2];i++) {
    printf("%d ", sp->sarr[i][0]);
    printf("%d ", sp->sarr[i][1]);
    printf("%d \n", sp->sarr[i][2]);
 }
}



void transpose(struct sparse *sp){

 if(sp->sarr[0][2] == 0){
   printf("Matrix Cannot be Transposed\n");
 }
 else{
   sp->tarr[0][0] = sp->sarr[0][1];
   sp->tarr[0][1] = sp->sarr[0][0];
   sp->tarr[0][2] = sp->sarr[0][2];
   int k=1;
   for(int i=0;i<sp->sarr[0][1];i++){
      for(int j=1;j<=sp->sarr[0][2];j++){
         if(i == sp->sarr[j][1]){
            sp->tarr[k][0] = sp->sarr[j][1];
            sp->tarr[k][1] = sp->sarr[j][0];
            sp->tarr[k][2] = sp->sarr[j][2];
            k++;
         }
      }
   }
   for(int i=0;i<=sp->tarr[0][2];i++) {
    printf("%d ", sp->tarr[i][0]);
    printf("%d ", sp->tarr[i][1]);
    printf("%d \n", sp->tarr[i][2]);
 }
```

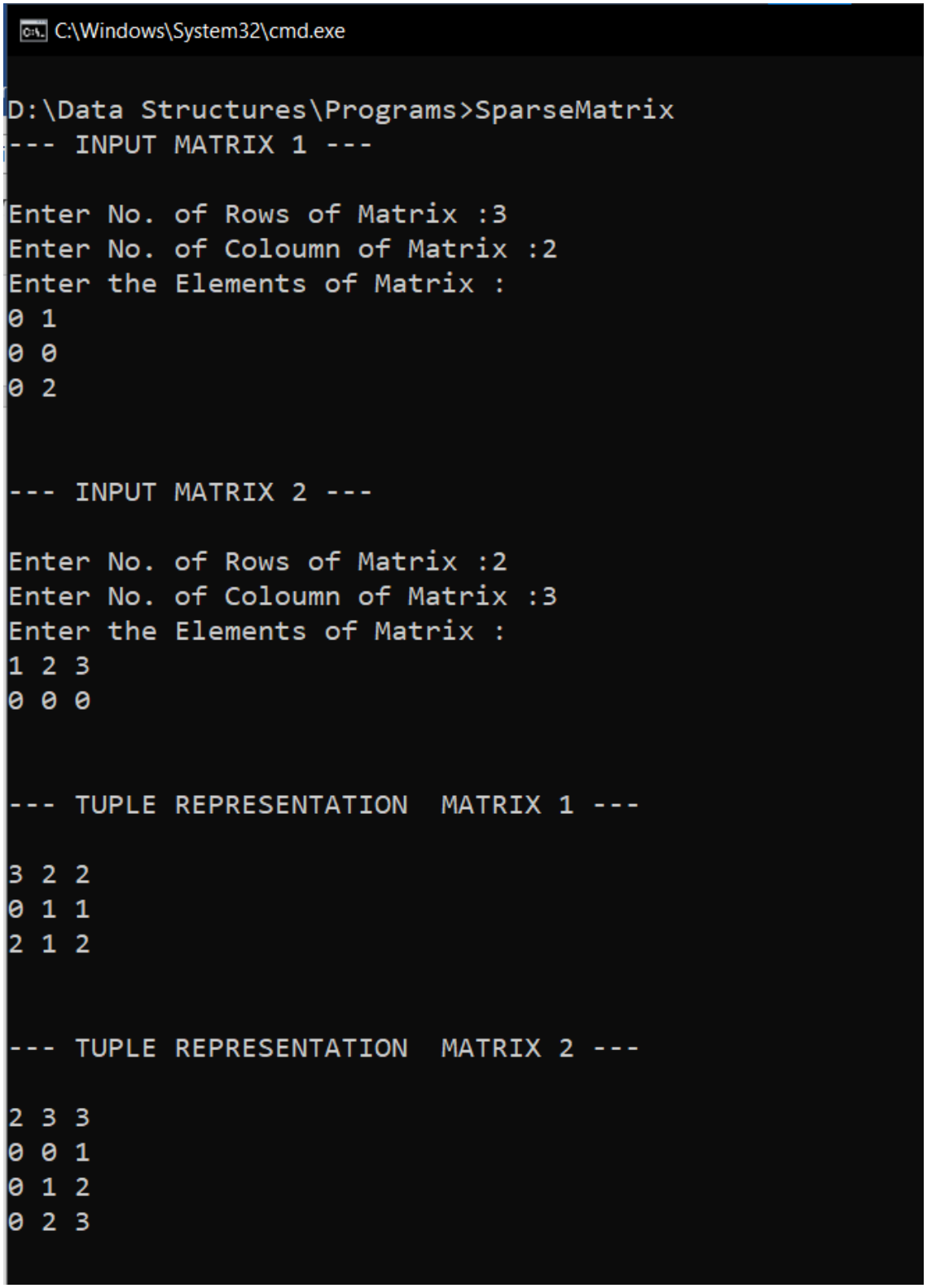
```
 }

}


void add(struct sparse *sp1, struct sparse *sp2, struct sparse *sp3){
 int i=1, j=1, k=1;
 if(sp1->sarr[0][0]!=sp2->sarr[0][0]||sp1->sarr[0][1]!= sp2->sarr[0][1]){
    printf("Matrix 1 and Matrix 2 can't be Added\n");
 }
else{
   while(i<=sp1->sarr[0][2]||j<=sp2->sarr[0][2]){
      if(sp1->sarr[i][0]==sp2->sarr[j][0]){
         if(sp1->sarr[i][1]==sp2->sarr[j][1]){
            sp3->sarr[k][2]=sp1->sarr[i][2]+sp2->sarr[j][2];
            sp3->sarr[k][1] = sp1->sarr[i][1];
            sp3->sarr[k][0] = sp1->sarr[i][0];
            k++, i++, j++;
         }
         else if(sp1->sarr[i][1] < sp2->sarr[j][1]){
            sp3->sarr[k][0] = sp1->sarr[i][0];
            sp3->sarr[k][1] = sp1->sarr[i][1];
            sp3->sarr[k][2] = sp1->sarr[i][2];
            k++, i++;
         }
         else{
            sp3->sarr[k][0] = sp2->sarr[j][0];
            sp3->sarr[k][1] = sp2->sarr[j][1];
            sp3->sarr[k][2] = sp2->sarr[j][2];
            k++, j++;
         }
      }
      else if(sp1->sarr[i][0] < sp2->sarr[j][0])
      {
            sp3->sarr[k][0] = sp1->sarr[i][0];
            sp3->sarr[k][1] = sp1->sarr[i][1];
            sp3->sarr[k][2] = sp1->sarr[i][2];
            k++, i++;
      }
      else{
            sp3->sarr[k][0] = sp2->sarr[j][0];
            sp3->sarr[k][1] = sp2->sarr[j][1];
            sp3->sarr[k][2] = sp2->sarr[j][2];
            k++, j++;
      }
   }
```

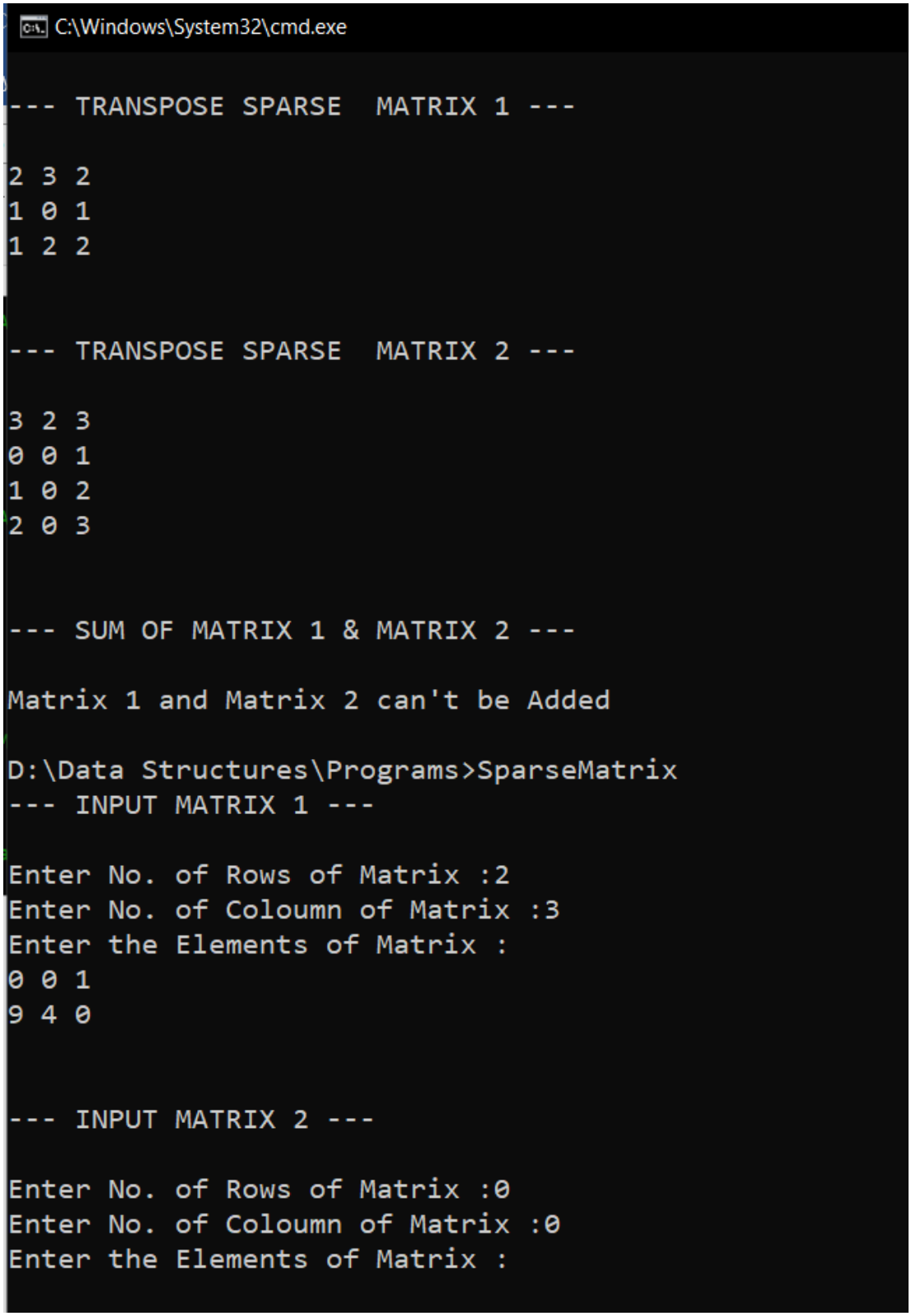
```
    sp3->sarr[0][0] = sp1->sarr[0][0];
    sp3->sarr[0][1] = sp1->sarr[0][1];
    sp3->sarr[0][2] = k-1;
    for(int i=0;i<=sp3->sarr[0][2];i++) {
     printf("%d ", sp3->sarr[i][0]);
     printf("%d ", sp3->sarr[i][1]);
     printf("%d \n", sp3->sarr[i][2]);
  }
  }
}


void main(){
  struct sparse sp1, sp2,sp3;
  printf("--- INPUT MATRIX 1 ---\n\n");
  read(&sp1);
  printf("\n\n--- INPUT MATRIX 2 ---\n\n");
  read(&sp2);
  printf("\n\n--- TUPLE REPRESENTATION  MATRIX 1 ---\n\n");
  tupleRepresentation(&sp1);
  printf("\n\n--- TUPLE REPRESENTATION  MATRIX 2 ---\n\n");
  tupleRepresentation(&sp2);
  printf("\n\n--- TRANSPOSE SPARSE  MATRIX 1 ---\n\n");
  transpose(&sp1);
  printf("\n\n--- TRANSPOSE SPARSE  MATRIX 2 ---\n\n");
  transpose(&sp2);
  printf("\n\n--- SUM OF MATRIX 1 & MATRIX 2 ---\n\n" );
  add(&sp1, &sp2, &sp3);
}
```

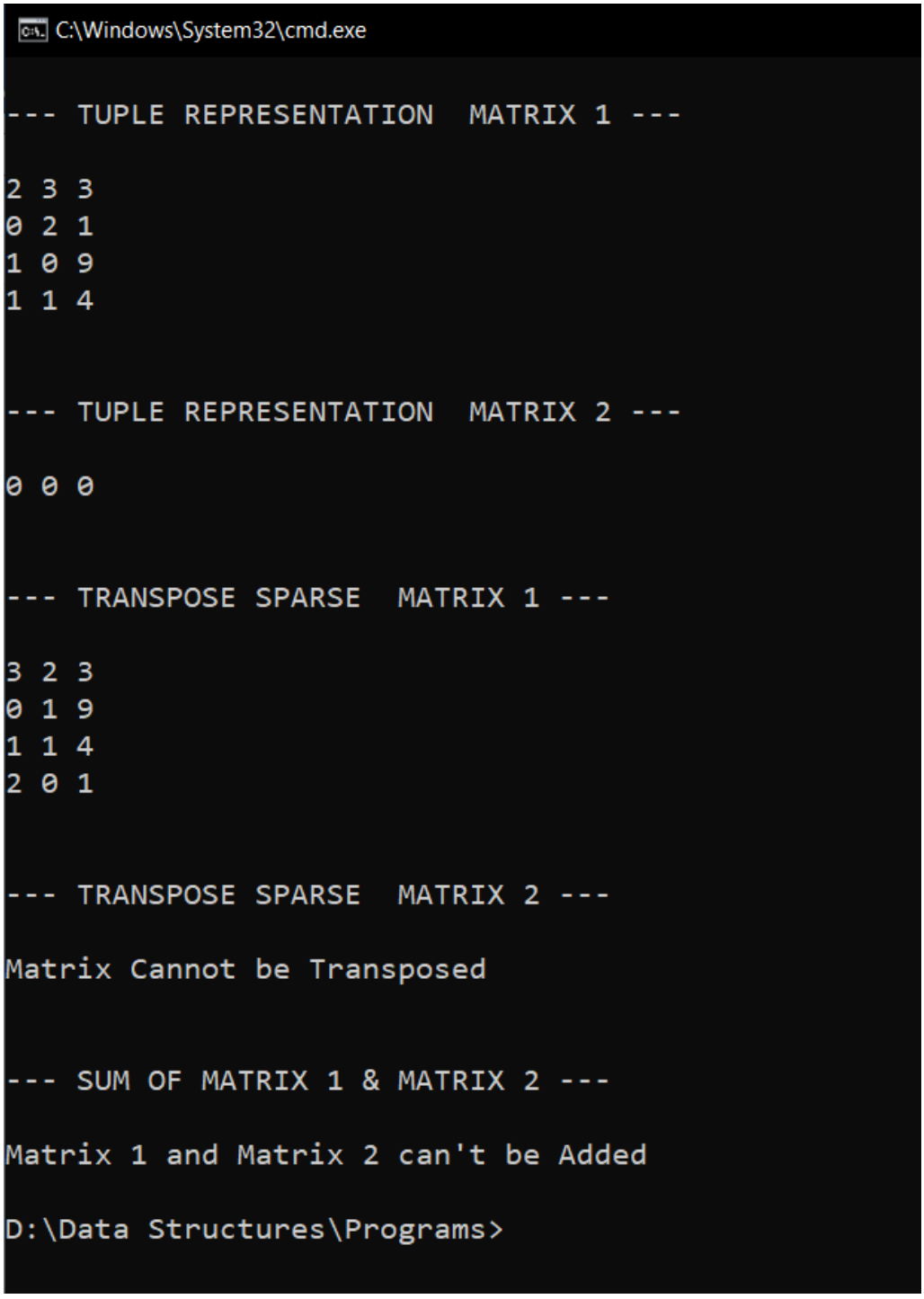
**OUTPUT:**


Select C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>SparseMatrix
--- INPUT MATRIX 1 ---
Enter No. of Rows of Matrix :3
Enter No. of Coloumn of Matrix :4
Enter the Elements of Matrix :
1 0 0 3
0 0 4 0
0 0 2 0
--- INPUT MATRIX 2 ---
Enter No. of Rows of Matrix :3
Enter No. of Coloumn of Matrix :4
Enter the Elements of Matrix :
0 1 0 2
0 0 8 9
0 0 0 0
--- TUPLE REPRESENTATION MATRIX 1 ---
3 4 4
0 0 1
0 3 3
1 2 4
2 2 2
--- TUPLE REPRESENTATION MATRIX 2 ---
3 4 4
0 1 1
0 3 2
1 2 8
1 3 9


Select C:\Windows\System32\cmd.exe
--- TRANSPOSE SPARSE MATRIX 1 ---
4 3 4
0 0 1
2 1 4
2 2 2
3 0 3
--- TRANSPOSE SPARSE MATRIX 2 ---
4 3 4
1 0 1
2 1 8
3 0 2
3 1 9
--- SUM OF MATRIX 1 & MATRIX 2 ---
3 4 6
0 0 1
0 1 1
0 3 5
1 2 12
1 3 9
2 2 2
D:\Data Structures\Programs>


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>SparseMatrix
--- INPUT MATRIX 1 ---
Enter No. of Rows of Matrix :3
Enter No. of Coloumn of Matrix :2
Enter the Elements of Matrix :
0 1
0 0
0 2
--- INPUT MATRIX 2 ---
Enter No. of Rows of Matrix :2
Enter No. of Coloumn of Matrix :3
Enter the Elements of Matrix :
1 2 3
0 0 0
--- TUPLE REPRESENTATION MATRIX 1 ---
3 2 2
0 1 1
2 1 2
--- TUPLE REPRESENTATION MATRIX 2 ---
2 3 3
0 0 1
0 1 2
0 2 3


C:\Windows\System32\cmd.exe
--- TRANSPOSE SPARSE MATRIX 1 ---
2 3 2
1 0 1
1 2 2
--- TRANSPOSE SPARSE MATRIX 2 ---
3 2 3
0 0 1
1 0 2
2 0 3
--- SUM OF MATRIX 1 & MATRIX 2 ---
Matrix 1 and Matrix 2 can't be Added
D:\Data Structures\Programs>SparseMatrix
--- INPUT MATRIX 1 ---
Enter No. of Rows of Matrix :2
Enter No. of Coloumn of Matrix :3
Enter the Elements of Matrix :
0 0 1
9 4 0
--- INPUT MATRIX 2 ---
Enter No. of Rows of Matrix :0
Enter No. of Coloumn of Matrix :0
Enter the Elements of Matrix :




**RESULT:**

Two sparse matrices entered in normal form are converted to their tuple forms. The tuple representations of their sum and each of their transposes are also found out.

20/09/2020

## Experiment No:6

# STACK USING ARRAYS

### AIM:

Implement a Stack using arrays with the operations:

1.Pushing elements to the Stack.

2.Popping elements from the Stack

3.Display the contents of the Stack after each operation.

### DATA STRUCTURES USED:

Stack

### ALGORITHM:

Algorithm Push(x)

1. if top=size-1
2. print “stack overflow”
3. else
4. arrr[++top]=x
5. endif

Algorithm Pop()

1. if top = -1
2. print “stack is empty”
3. else
4. item =arr[top]
5. top—
6. endif

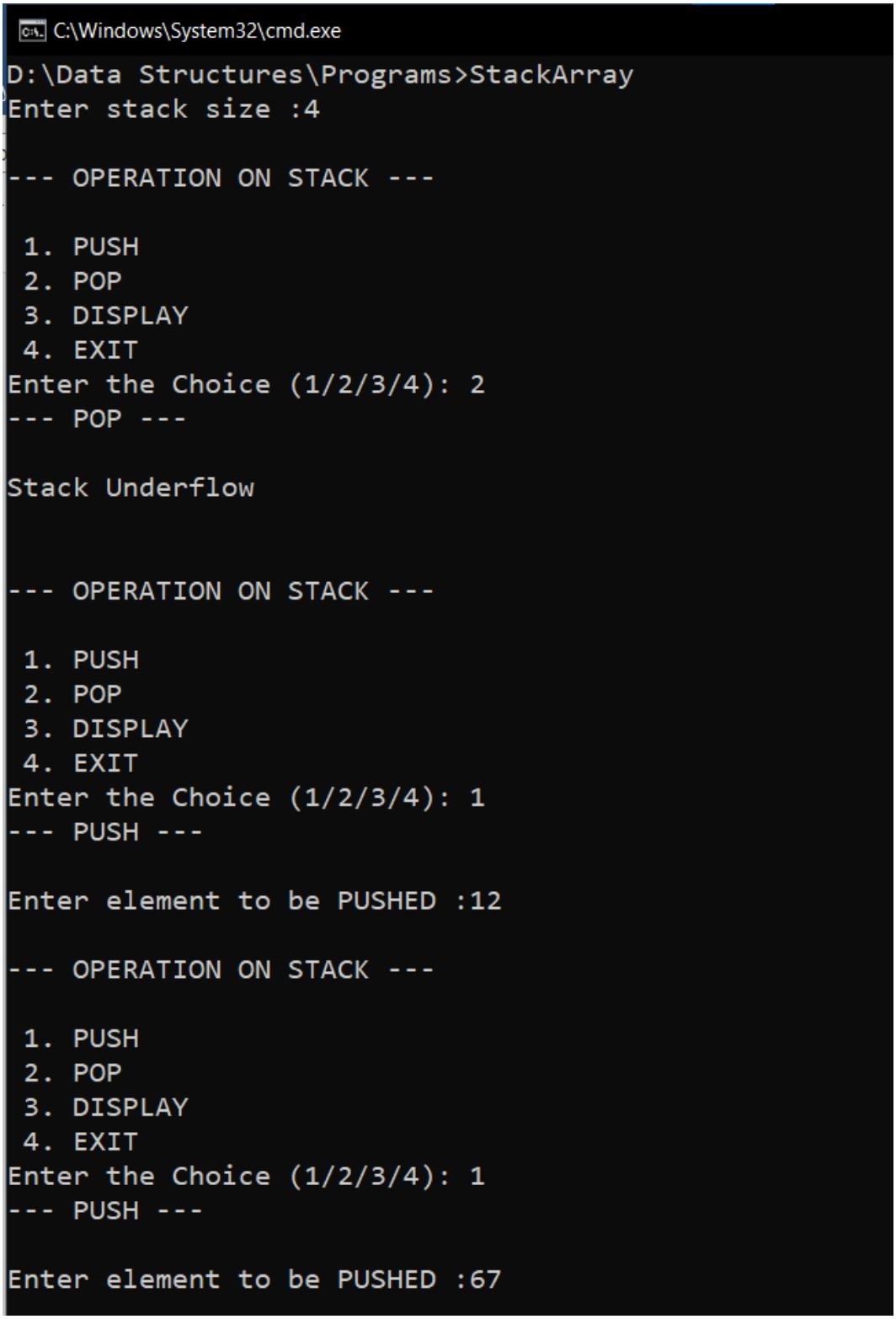
### PROGRAM:

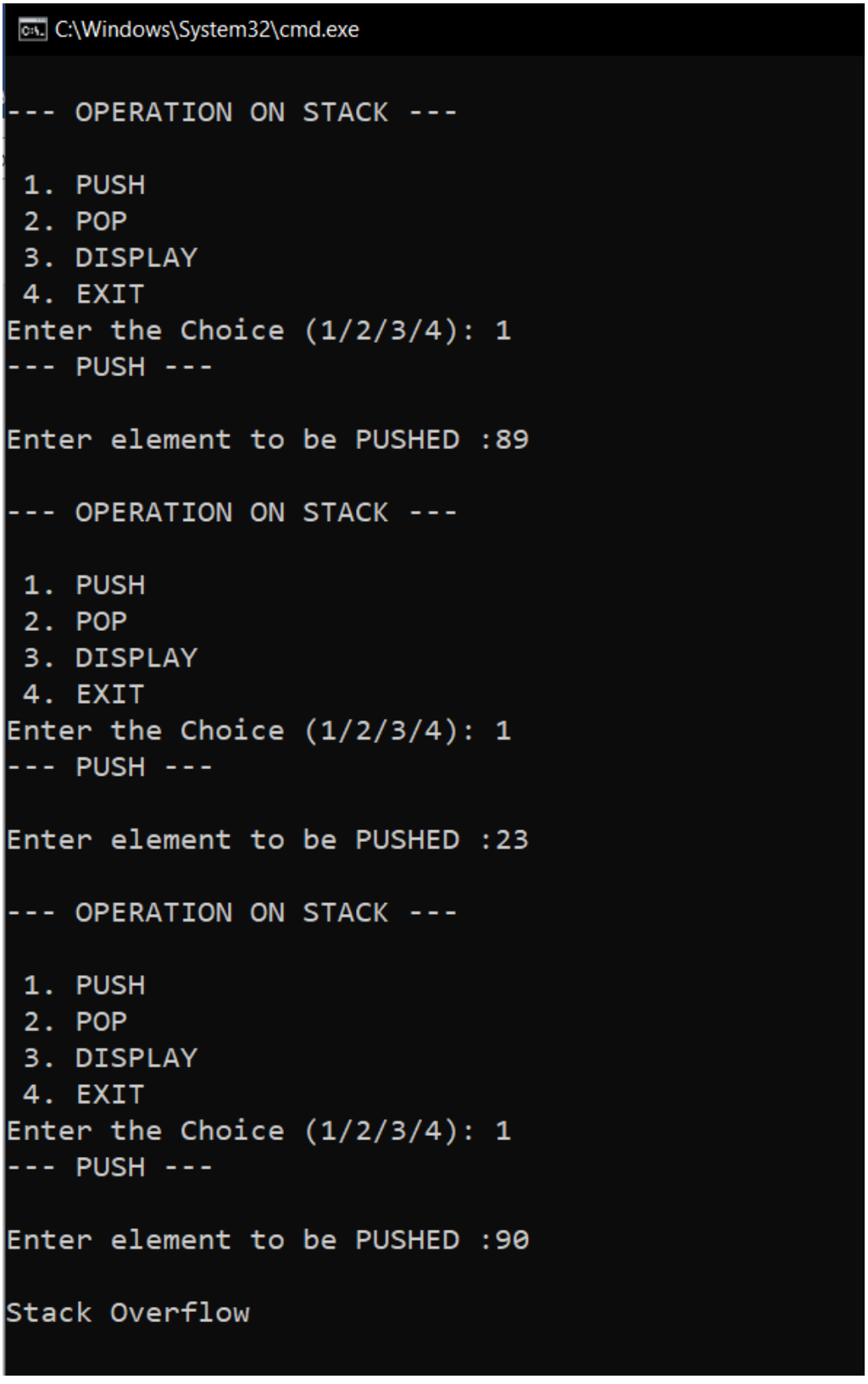
```
#include <stdio.h>
#include <stdlib.h>
struct stack{
   int size;
   int top;
   int *arr;
};
```

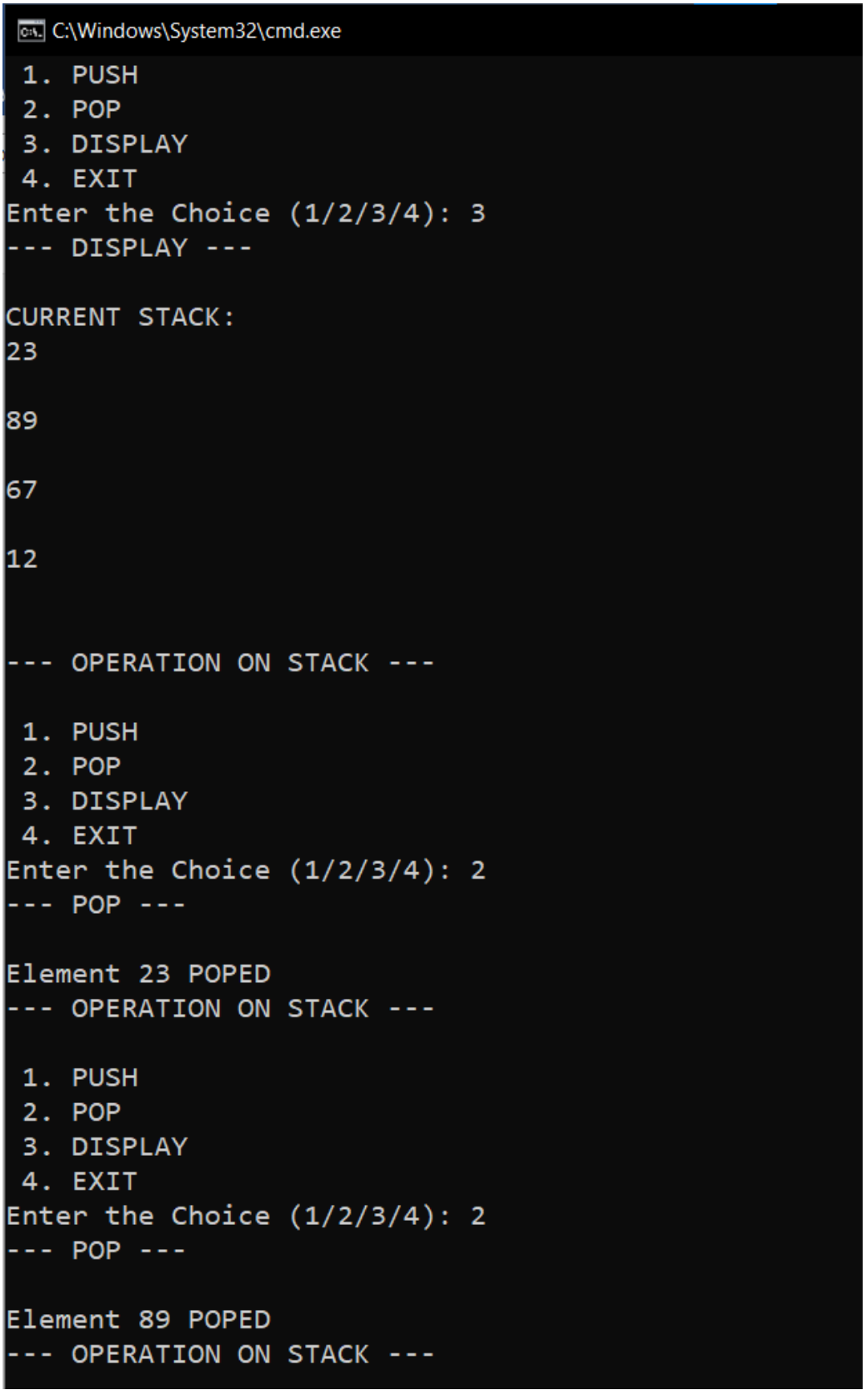
```
int isFull(struct stack *st){
   if(st->top >= st->size-1){
      return 1;
   }
   return 0;
}

int isEmpty(struct stack *st){
   if(st->top == -1){
      return 1;
   }
   return 0;
}

void push(struct stack *st,int pushitem){
   if(isFull(st)){
      printf("\nStack Overflow\n\n");
   }
   else{
      st->arr[++st->top] = pushitem;
   }
}
int pop(struct stack *st){
   if(isEmpty(st)){
      printf("\nStack Underflow\n\n");
   }
   else{
      int popitem = st->arr[st->top];
      st->top--;
      return popitem;
   }
}

void display(struct stack *st){
   printf("\nCURRENT STACK:\n");
   for(int i=st->top; i>=0; i--){
      printf("%d\n", st->arr[i]);
      printf("\n");
   }
}

void main(){
 struct stack st;
 int n,x,y;
 char ans='y';
 printf("Enter stack size :");
```

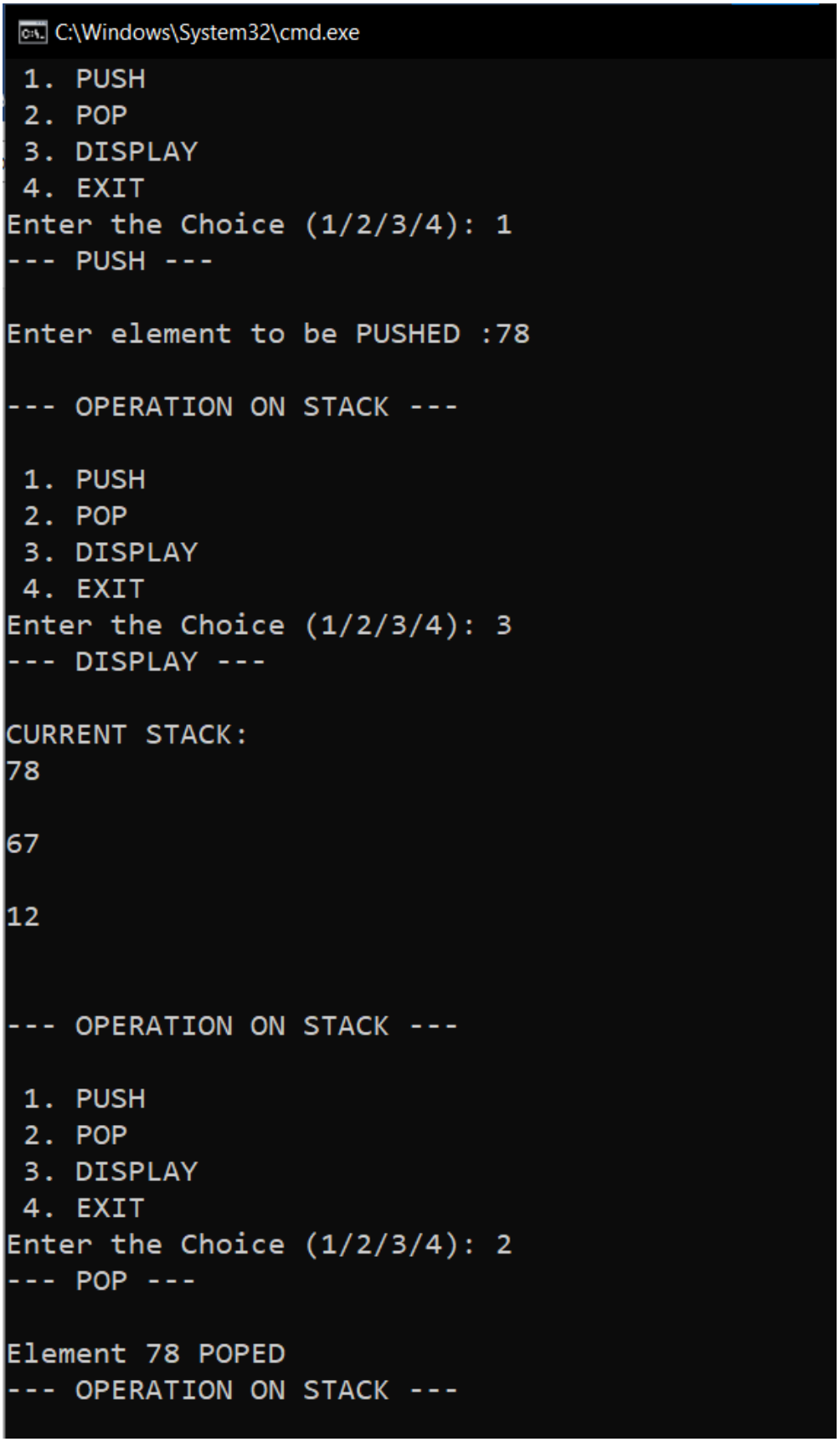
```
scanf("%d", &st.size);
st.arr = (int*) malloc (st.size * sizeof(int));
st.top = -1;
while(ans=='y'){
   printf("\n--- OPERATION ON STACK --- \n\n");
   printf(" 1. PUSH \n");
   printf(" 2. POP\n");
   printf(" 3. DISPLAY\n");
   printf(" 4. EXIT\n");
   printf("Enter the Choice (1/2/3/4): ");
   scanf("%d",&n);
   switch(n){
      case 1:printf("--- PUSH ---\n");
            printf("\nEnter element to be PUSHED :");
            scanf("%d", &x);
            push(&st,x);
            break;
      case 2:printf("--- POP ---\n");
            y=pop(&st);
            printf("\nElement %d POPED ",y);
            break;
      case 3:printf("--- DISPLAY ---\n");
            display(&st);
            break;
      case 4:ans='n';
            break;
     default:printf("Enter a Valid Input\n");
   }
}
}
```

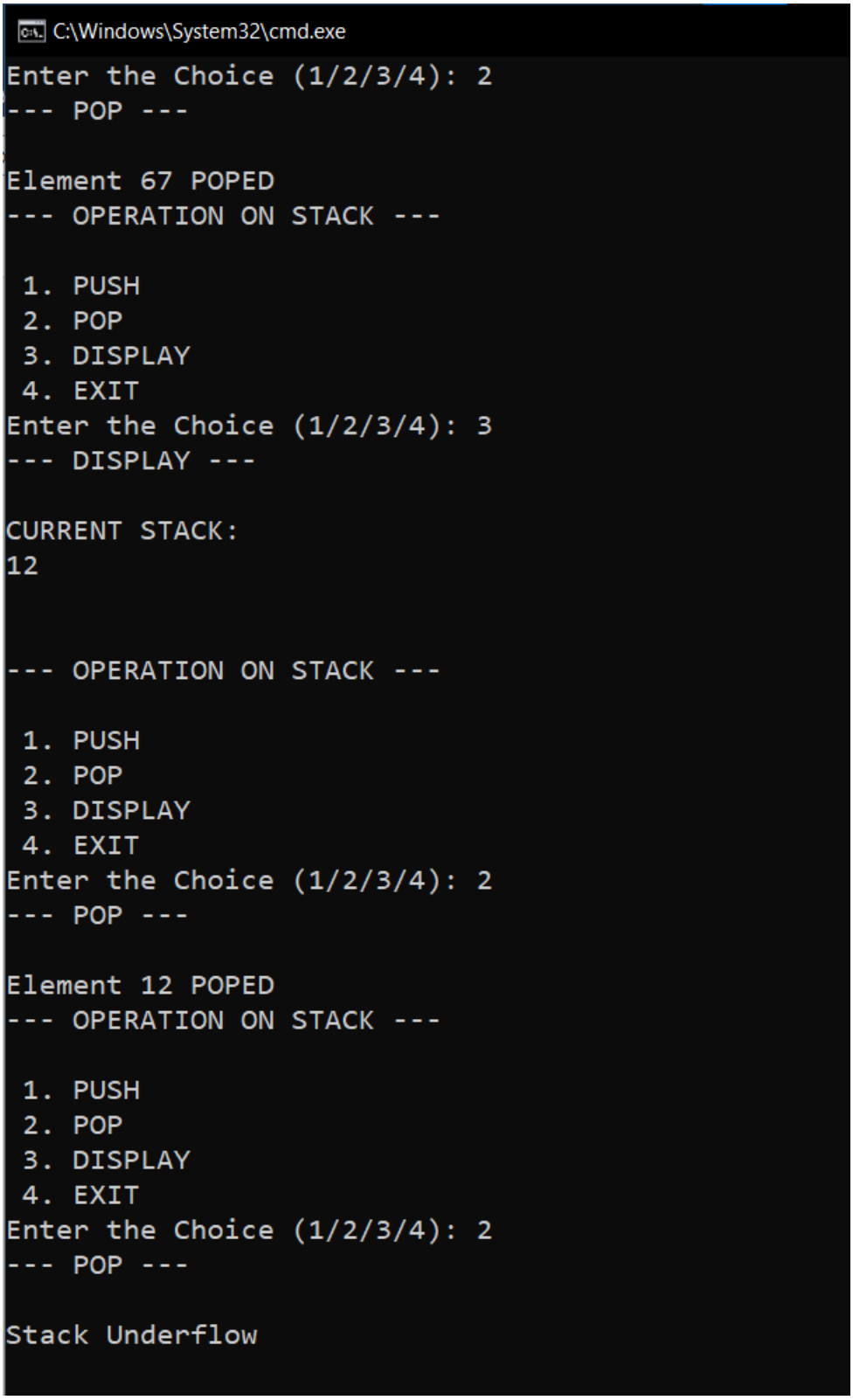
**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>StackArray
Enter stack size :4
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 2
--- POP ---
Stack Underflow
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be PUSHED :12
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be PUSHED :67


C:\Windows\System32\cmd.exe
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be PUSHED :89
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be PUSHED :23
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be PUSHED :90
Stack Overflow


C:\Windows\System32\cmd.exe
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
CURRENT STACK:
23
89
67
12
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 2
--- POP ---
Element 23 POPED
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 2
--- POP ---
Element 89 POPED
--- OPERATION ON STACK ---


C:\Windows\System32\cmd.exe
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be PUSHED :78
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
CURRENT STACK:
78
67
12
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 2
--- POP ---
Element 78 POPED
--- OPERATION ON STACK ---




**RESULT:**

A Stack data structure is implemented using an array. Push(), Pop() and Display() operations were performed on it.

24/10/2020

## Experiment No:7

# INFIX TO POSTFIX AND EVALUATION

### AIM:

Write a program to convert a given infix expression to its postfix expression and evaluate it.

### DATA STRUCTURES USED:

Stack

### ALGORITHM:

```
Algorithm INFIX_TO_POSTFIX()
START
1. TOP = -1, push('(')
2. While TOP > -1 do
3.    ITEM = Readsymbol()
4.         X = pop()
5.         Case : ITEM = Operand
6.              push(X)
7.              print ITEM
8.         Case : ITEM = ')'
9.             While X != '('
10.               print X
11.               X = pop()
12.            EndWhile
13.        Case : ISP(X) >= ICP(ITEM)
14.            While ISP(X) >= ICP(ITEM) do
15.               print X
16.               X = pop()
17.            EndWhile
18.            push(X)
19.            push(ITEM)
20.         Case : ISP(X) < ICP(ITEM)
21.            push(X)
22.            push(ITEM)
23.         Otherwise :
24.             Print "Invalid Expression"
25. EndWhile
STOP
```

Algorithm POSTFIX_CONVERSION()
START
1. While (TOP >= -1) do
2. ITEM = Readsymbol()
3. Case : ITEM = Operand
4. push(ITEM)
5. Case : ITEM = Operator
6. x2 = pop()
7. x1 = pop()
8. x = Operation(x1, x2, ITEM)
9. push(x)
10. Otherwise :
11. Print “Invalid Expression”
12. EndWhile
STOP

**PROGRAM:**

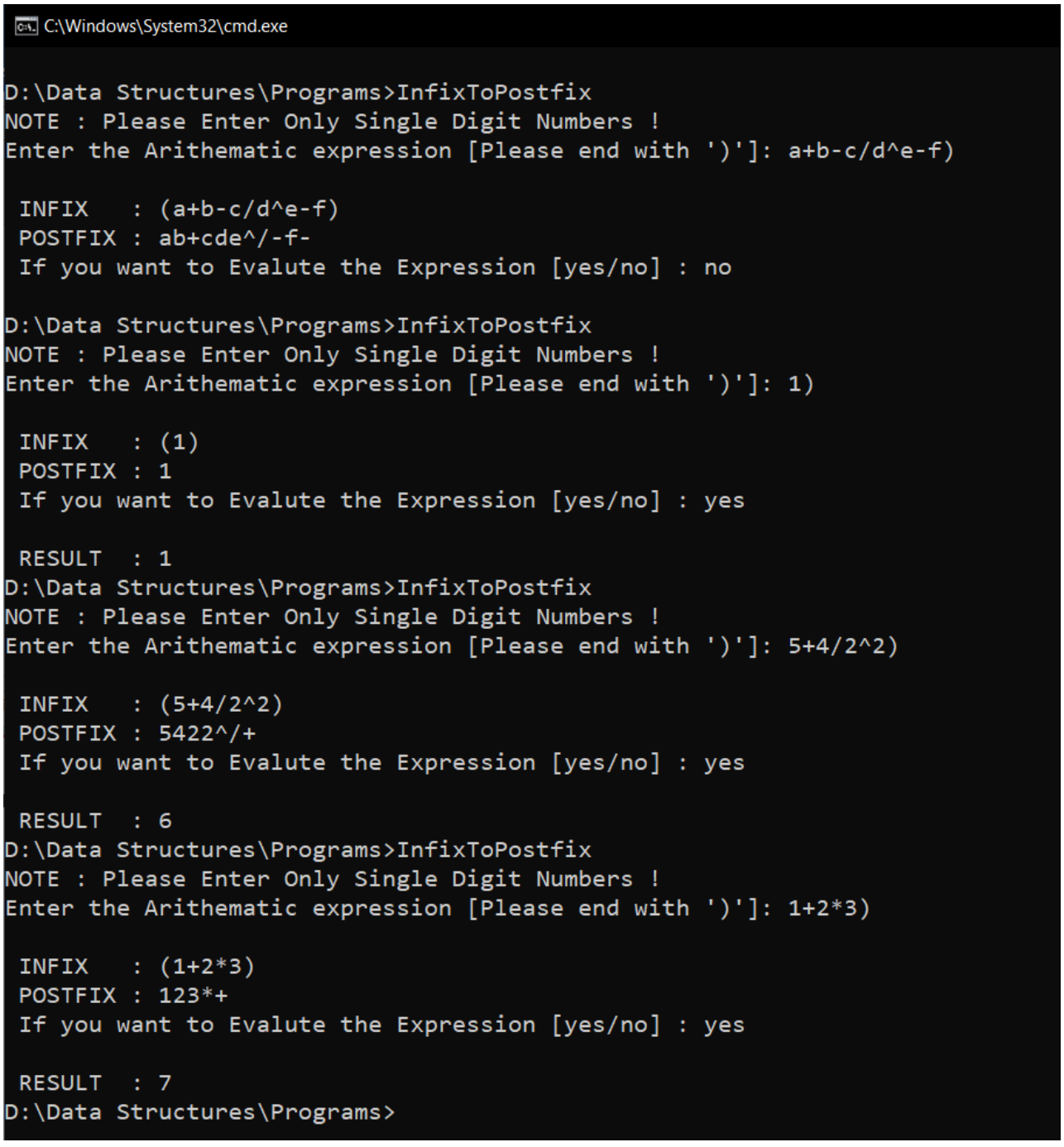
```
#include<stdio.h>
#include<ctype.h>
#include<math.h>
#include<string.h>

char stack[50];
int top = -1;
void push(char x){
   stack[++top] = x;
}

char pop(){
    if(top == -1)
       return -1;
    else
      return stack[top--];
}

int Istack[50];
int Itop = -1;

void Ipush(int x){
   Istack[++Itop] = x;
}

int Ipop(){
   if(Itop == -1)
      return 0;
   else
```

```
        return Istack[Itop--];
}

int ISP(char y){
   if(y == '(')
        return 0;
   if(y == '+' || y == '-')
        return 1;
   if(y == '*' || y == '/')
        return 4;
   if(y =='^')
        return 5;
   return 0;
}
int ICP(char y){
   if(y == '(')
      return 0;
   if(y == '+' || y == '-')
      return 1;
   if(y == '*' || y == '/')
      return 3;
   if(y =='^')
      return 6;
   return 0;
}

void main()
{
   char input[100];
   char postfix[100];
   char *p,*t,x;
   char ans[5]="no";
   // INFIX TO POSTFIX CONVERSION

   printf("NOTE : Please Enter Only Single Digit Numbers !\n");
   printf("Enter the Arithematic expression [Please end with \')\']: ");
   scanf("%s",input);
   printf("\n");
   p=input;
   t=postfix;
   push('(');
   printf(" INFIX   : (%s",input);
   printf("\n POSTFIX : ");
   while(top!=-1){
      if(isalnum(*p)){

          printf("%c",*p);
```

```
        *t=*p;
        t++;

    }else{
        x=pop();
        if(*p == '('){

            push(*p);

        }else if(*p == ')'){

        while( x!= '('){
            printf("%c",x);
            *t=x;
            t++;
            x=pop();
            }

        }else if(ISP(x)>= ICP(*p)){

        while(ISP(x)>=ICP(*p)){
            printf("%c",x);
            *t=x;
            t++;
            x=pop();
            }
        push(x);
        push(*p);

    }else if(ISP(x) < ICP(*p)){
        push(x);
        push(*p);

    }else{

        printf("Invalid Expression");

    }
    }

    p++;

  }


  *t='\0';
printf("\n");
```

```
// POSTFIX EVALUATION
   printf(" If you want to Evalute the Expression [yes/no] : ");
   scanf("%s",ans);
   if(strcmp(ans,"yes")==0){
     t = postfix;
     int a,b,c;
     while(*t!='\0'){
        if(isdigit(*t)){
           Ipush(*t-48);
        }else{
           b= Ipop();
           a= Ipop();
           switch(*t)
           {
              case '+': c=a+b;

                   break;


              case '-': c=a-b;

                   break;

              case '*': c=a*b;

                   break;

              case '/': c=a/b;

                   break;

              case '^': c=pow(a,b);

                   break;
        }

        Ipush(c);
     }
     t++;
  }
  int result=Ipop();
  printf("\n RESULT  : %d",result);
   }
}
```

**OUTPUT:**




**RESULT:**

Given infix expression is converted to postfix form and then the result of the expression is displayed.

Time complexity for infix to postfix conversion = O(n)
Time complexity for postfix evaluation = O(n)

31/10/2020

## Experiment No:8

# QUEUE USING ARRAYS

### AIM:

Write a program to implement Queue using arrays.

### DATA STRUCTURES USED:

Queue

### ALGORITHM:

Algorithm_ENQUEUE (ITEM)

1. If (REAR=N-1) // N is the size of Queue
2. print “Queue is full”
3. Exit
4. Else
5. If (REAR =-1 && FRONT =-1)
6. FRONT=REAR=0
7. Queue[REAR]=ITEM
8. Else
9. Queue[++REAR]=ITEM
10. EndIf
11. EndIf

Algorithm_DEQUEUE

1. If (FRONT=-1)
2. Print “Queue is empty”
3. Exit
4. Else
5. ITEM = Queue[FRONT]
6. If (FRONT == REAR)
7. FRONT=REAR=-1
8. Else
9. FRONT++
10. EndIf
11. EndIf

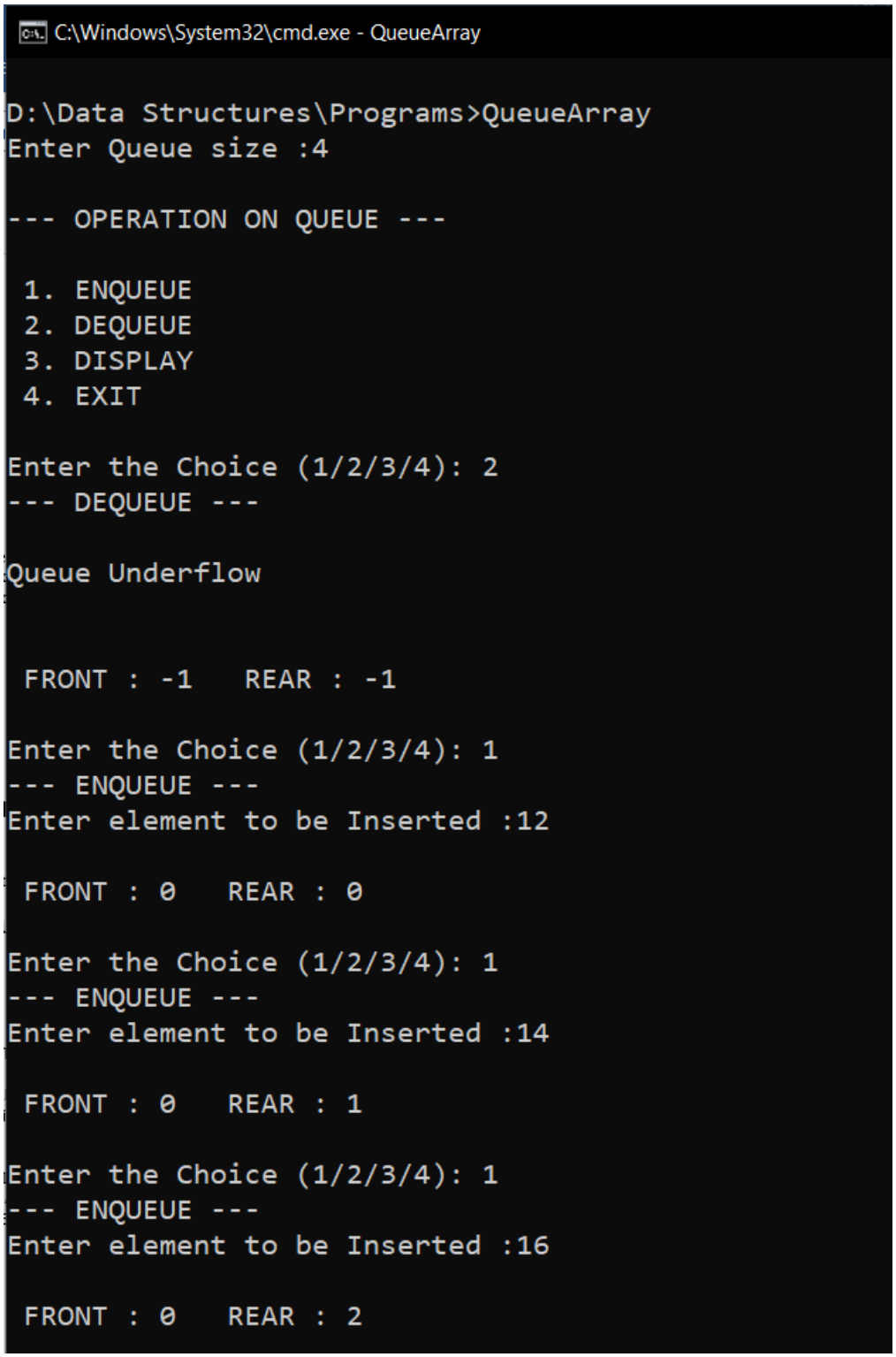
### PROGRAM:

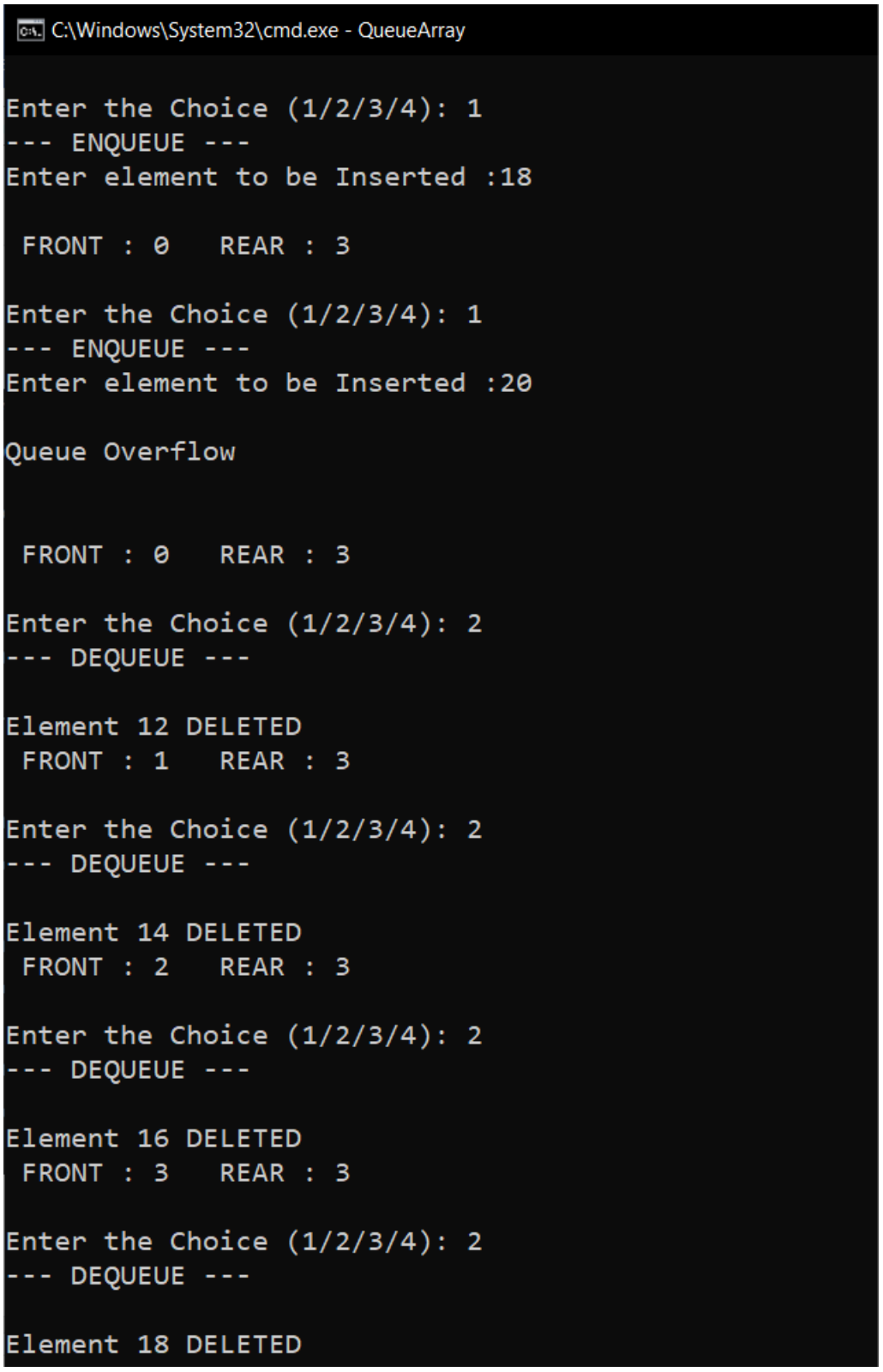
```
#include <stdio.h>
#include <stdlib.h>
int size;
int front;
```

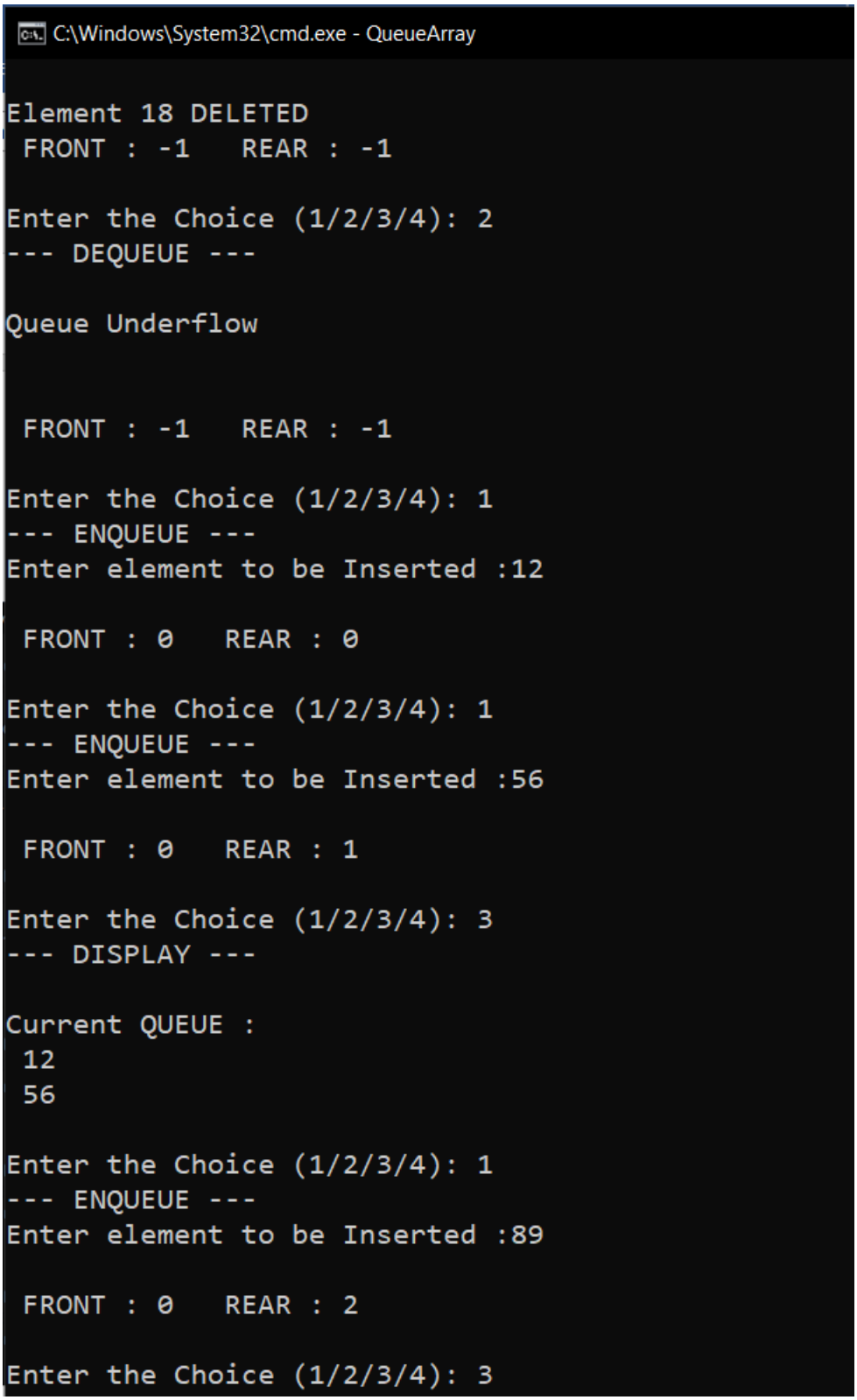
```
int rear;
int *arr;

int isFull(){
   if(rear==size-1){
      return 1;
   }
   return 0;
}

int isEmpty(){
   if(rear==-1){
      return 1;
   }
   return 0;
}

void insert(int item){
   if(isFull()){
      printf("\nQueue Overflow\n\n");
   }
   else if(front==-1){
      arr[++rear] = item;
      front++;
   }
   else {
      arr[++rear] = item;
   }
   printf("\n FRONT : %d   REAR : %d\n",front,rear);
}
void delete(){
   if(isEmpty()){
      printf("\nQueue Underflow\n\n");
   }
   else if(front==rear){
      int item = arr[front];
      printf("\nElement %d DELETED ",item);
      front=-1;
      rear=-1;

   }else{
      int item = arr[front];
      front++;
      printf("\nElement %d DELETED ",item);
   }
   printf("\n FRONT : %d   REAR : %d\n",front,rear);
}
```

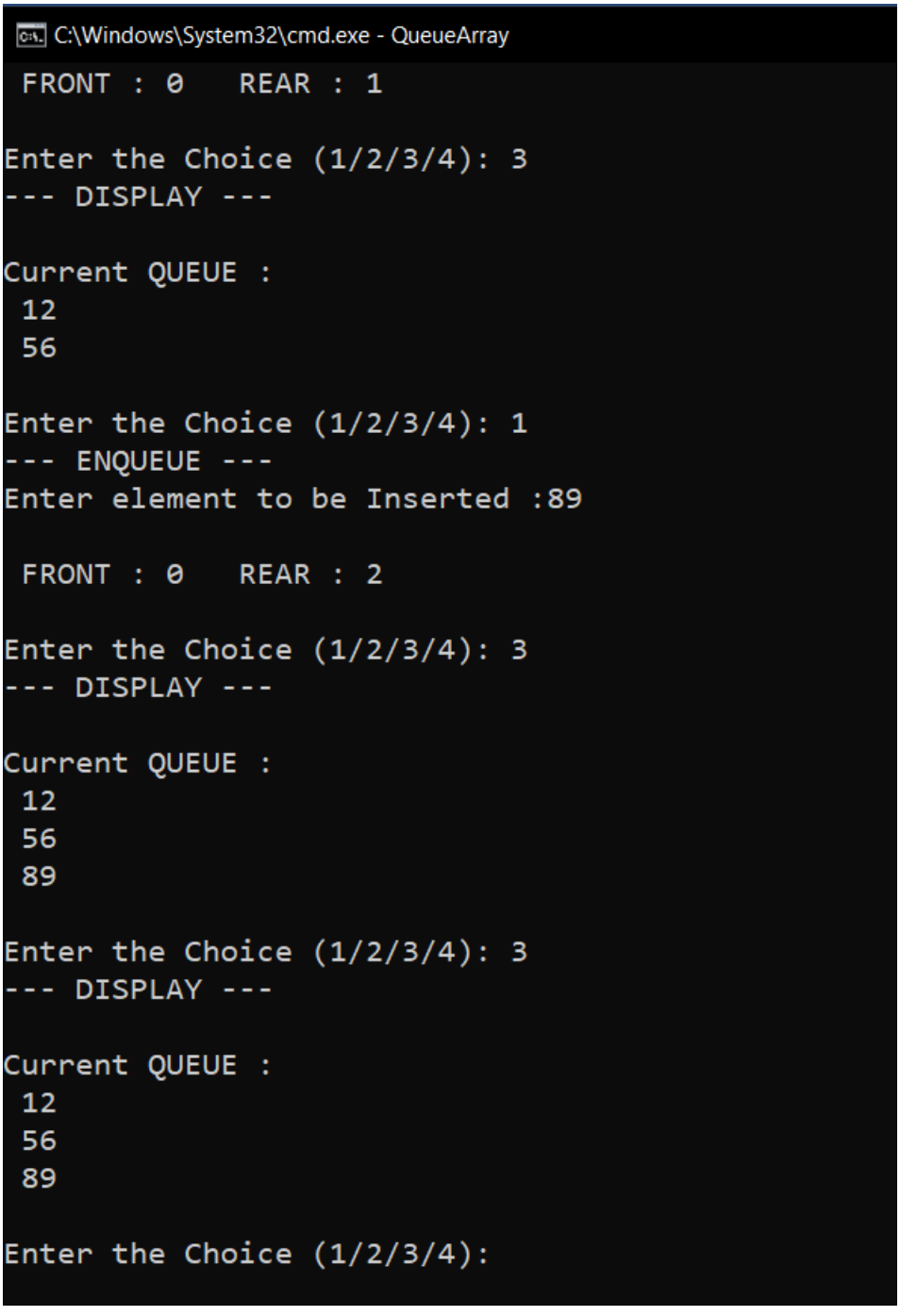
```
void display(){
   printf("\nCurrent QUEUE :\n");
   if(isEmpty()){
      printf("\nQueue is Empty \n");
   }else{
      for(int i=front; i<=rear; i++){
      printf(" %d \n",arr[i]);
      }
   }
}

void main(){
 int n,x,y;
 char ans='y';
 printf("Enter Queue size :");
 scanf("%d", &size);
 arr = (int*) malloc (size * sizeof(int));
 front=-1,rear=-1;
 printf("\n--- OPERATION ON QUEUE --- \n\n");
 printf(" 1. ENQUEUE \n");
 printf(" 2. DEQUEUE\n");
 printf(" 3. DISPLAY\n");
 printf(" 4. EXIT\n");
 while(ans=='y'){
    printf("\nEnter the Choice (1/2/3/4): ");
    scanf("%d",&n);
    switch(n){
       case 1:printf("--- ENQUEUE ---\n");
              printf("Enter element to be Inserted :");
              scanf("%d", &x);
              insert(x);
              break;
       case 2:printf("--- DEQUEUE ---\n");
              delete();
              break;
       case 3:printf("--- DISPLAY ---\n");
              display();
              break;
       case 4:ans='n';
              break;
      default:printf("Enter a Valid Input\n");
    }
 }
}
```

**OUTPUT:**


C:\Windows\System32\cmd.exe - QueueArray
D:\Data Structures\Programs>QueueArray
Enter Queue size :4
--- OPERATION ON QUEUE ---
1. ENQUEUE
2. DEQUEUE
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Queue Underflow
FRONT : -1 REAR : -1
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :12
FRONT : 0 REAR : 0
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :14
FRONT : 0 REAR : 1
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :16
FRONT : 0 REAR : 2


C:\Windows\System32\cmd.exe - QueueArray
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :18
FRONT : 0 REAR : 3
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :20
Queue Overflow
FRONT : 0 REAR : 3
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 12 DELETED
FRONT : 1 REAR : 3
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 14 DELETED
FRONT : 2 REAR : 3
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 16 DELETED
FRONT : 3 REAR : 3
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 18 DELETED


C:\Windows\System32\cmd.exe - QueueArray
Element 18 DELETED
FRONT : -1 REAR : -1
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Queue Underflow
FRONT : -1 REAR : -1
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :12
FRONT : 0 REAR : 0
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :56
FRONT : 0 REAR : 1
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Current QUEUE :
12
56
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :89
FRONT : 0 REAR : 2
Enter the Choice (1/2/3/4): 3




**RESULT:**

The Insert() and Delete() operation on Queue was implemented

Time complexity of Insert() operation is O(1).

Time complexity of Delete() operation is O(1).

03/11/2020

## Experiment No: 9

# CIRCULAR QUEUE USING ARRAYS

### AIM:

Write a program to implement Circular Queue using arrays.

### DATA STRUCTURES USED:

Queue

### ALGORITHM:

```
Algorithm_ENQUEUE (ITEM)
FRONT=-1 REAR=-1
12. If (FRONT==(REAR+1)%N)                    // N is the size of Queue
13.     print "Queue is full"
14.     Exit
15. Else
16.     If (FRONT= =-1)
17.         FRONT=REAR=0
18.         CQueue[REAR]=ITEM
19.     Else
20.         REAR=(REAR+1)%N
21.         CQueue[REAR]=ITEM
22.     EndIf
23. EndIf

Algorithm_DEQUEUE ()
12. If (FRONT=-1)
13.     Print "Queue is empty"
14.     Exit
15. Else
16.     If (FRONT == REAR)
17.         ITEM = CQueue[FRONT]
18.         FRONT=REAR=-1
19.     Else
20.         FRONT=(FRONT+1)%N
21.         ITEM = CQueue[FRONT]
22.         EndIf
23. EndIf
```

**PROGRAM:**

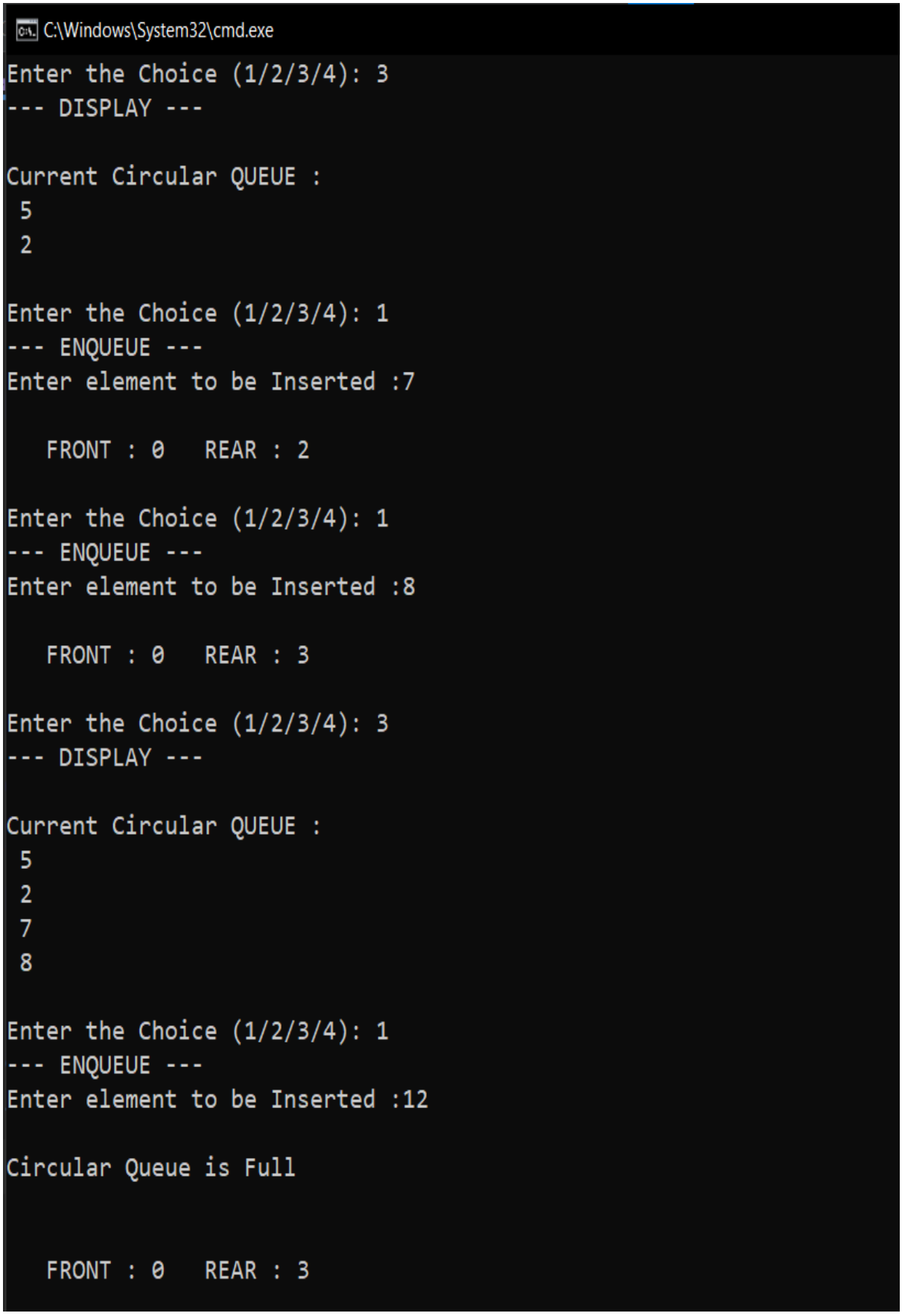
```
#include <stdio.h>
#include <stdlib.h>
int size;
int front;
int rear;
int *arr;

int isFull(){
   if(front==(rear+1)%size){
      return 1;
   }
   return 0;
}

int isEmpty(){
   if(front==-1){
      return 1;
   }
   return 0;
}

void insert(int item){
   if(isFull()){
      printf("\nCircular Queue is Full\n\n");
   }
   else if(front==-1){
      arr[++rear] = item;
      front++;
   }
   else {
      rear=(rear+1)%size;
      arr[rear] = item;
   }
   printf("\n   FRONT : %d   REAR : %d \n",front,rear);
}
void delete(){
   if(isEmpty()){
      printf("\nCircular Queue is Empty\n\n");
   }
   else if(front==rear){
      int item = arr[front];
      printf("\nElement %d DELETED ",item);
      front=-1;
      rear=-1;

   }else{
```

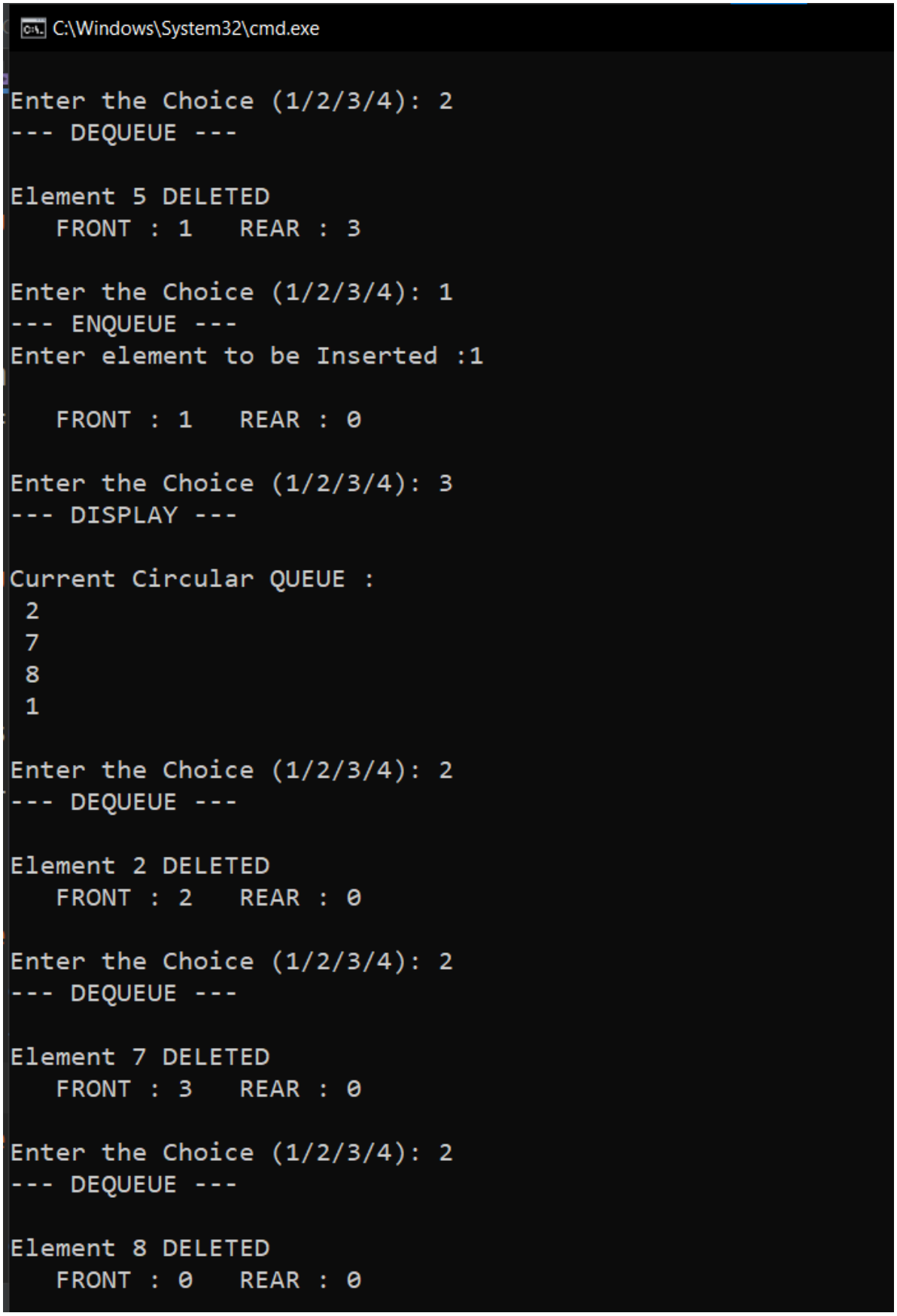
```
        int item = arr[front];
        front=(front+1)%size;
        printf("\nElement %d DELETED ",item);
    }
    printf("\n   FRONT : %d   REAR : %d \n",front,rear);
}

void display(){
    printf("\nCurrent Circular QUEUE :\n");
    if(isEmpty()){
        printf("\nCircular Queue is Empty \n");
    }else if (rear >= front){
        for(int i=front;i<=rear;i++){
            printf(" %d\n",arr[i]);
            }
    }
    else{
        for(int i=front;i<size;i++){
            printf(" %d\n",arr[i]);
            }
        for(int i=0;i<=rear;i++){
            printf(" %d\n",arr[i]);
        }
     }
}

void main(){
 int n,x,y;
 char ans='y';
 printf("Enter Circular Queue size :");
 scanf("%d", &size);
 arr = (int*) malloc (size * sizeof(int));
 front=-1,rear=-1;
 printf("\n--- OPERATION ON CIRCULAR QUEUE --- \n\n");
 printf(" 1. ENQUEUE \n");
 printf(" 2. DEQUEUE\n");
 printf(" 3. DISPLAY\n");
 printf(" 4. EXIT\n");
 while(ans=='y'){
    printf("\nEnter the Choice (1/2/3/4): ");
    scanf("%d",&n);
    switch(n){
       case 1:printf("--- ENQUEUE ---\n");
            printf("Enter element to be Inserted :");
            scanf("%d", &x);
            insert(x);
            break;
```

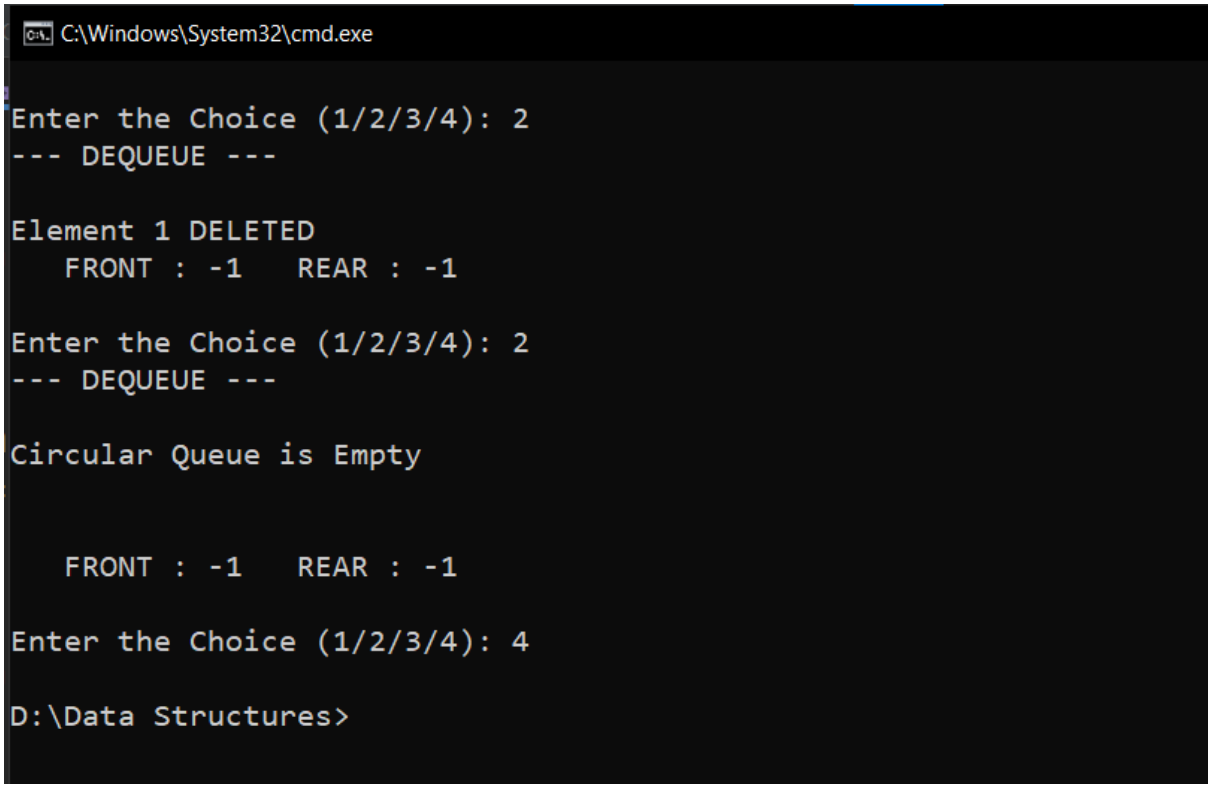
```
            case 2:printf("--- DEQUEUE ---\n");
                   delete();
                   break;
            case 3:printf("--- DISPLAY ---\n");
                   display();
                   break;
            case 4:ans='n';
                   break;
           default:printf("Enter a Valid Input\n");
          }
       }
      }
```

**OUTPUT:**

```
C:\Windows\System32\cmd.exe
D:\Data Structures>gcc -o CircularQueueArray CircularQueueArray.c

D:\Data Structures>CircularQueueArray
Enter Circular Queue size :4

--- OPERATION ON CIRCULAR QUEUE ---

 1. ENQUEUE
 2. DEQUEUE
 3. DISPLAY
 4. EXIT

Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :5

   FRONT : 0   REAR : 0

Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :2

   FRONT : 0   REAR : 1

Enter the Choice (1/2/3/4): 7
Enter a Valid Input

Enter the Choice (1/2/3/4): 13
Enter a Valid Input
```


C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Current Circular QUEUE :
5
2
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :7
FRONT : 0 REAR : 2
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :8
FRONT : 0 REAR : 3
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Current Circular QUEUE :
5
2
7
8
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :12
Circular Queue is Full
FRONT : 0 REAR : 3


C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 5 DELETED
FRONT : 1 REAR : 3
Enter the Choice (1/2/3/4): 1
--- ENQUEUE ---
Enter element to be Inserted :1
FRONT : 1 REAR : 0
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Current Circular QUEUE :
2
7
8
1
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 2 DELETED
FRONT : 2 REAR : 0
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 7 DELETED
FRONT : 3 REAR : 0
Enter the Choice (1/2/3/4): 2
--- DEQUEUE ---
Element 8 DELETED
FRONT : 0 REAR : 0




**RESULT:**

The Enqueue() and Dequeue() operation on circular queue was implemented.

Time complexity of Enqueue() operation is O(1).

Time complexity of Dequeue() operation is O(1).

04/11/2020

## Experiment No: 10

# PRIORITY QUEUE USING ARRAYS

**AIM**:

Write a program to implement Priority Queue using arrays.

**DATA STRUCTURES USED:**

Queue

**ALGORITHM:**

Algorithm INSERT (ITEM, VALUE) // N is the size

1. If (REAR=N-1)
2. print “Queue is full”
3. Exit
4. Else
5. If (REAR =-1 && FRONT =-1)
6. FRONT=REAR=0
7. Queue[REAR]=ITEM
8. PRIORITY[REAR]=VALUE
9. Else
10. Queue[++REAR]=ITEM
11. PRIORITY[REAR]=VALUE
12. EndIf
13. EndIf

Algorithm DELETE

24. If (FRONT=-1)
25. Print “Queue is empty”
26. Exit
27. Else
28. If (FRONT == REAR)
29. ITEM = Queue[FRONT]
30. VALUE=PRIORITY[FRONT]
31. FRONT=REAR=-1
32. Else
33. SORT() // Sort According to the Priority(Descending Order)
34. VALUE=PRIORITY[FRONT]
35. ITEM = Queue[FRONT]
36. FRONT++

37. EndIf
38. EndIf

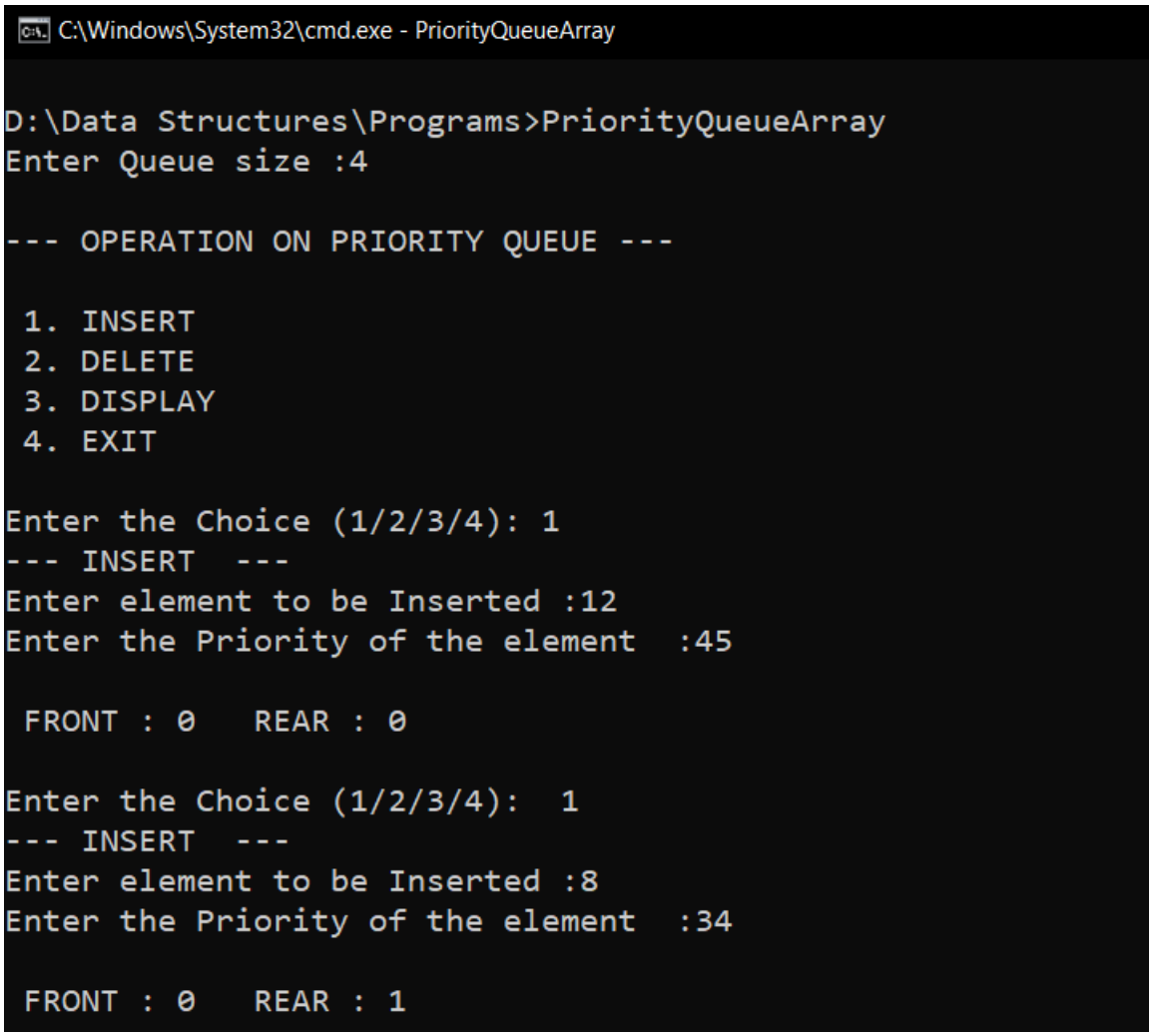
**PROGRAM:**

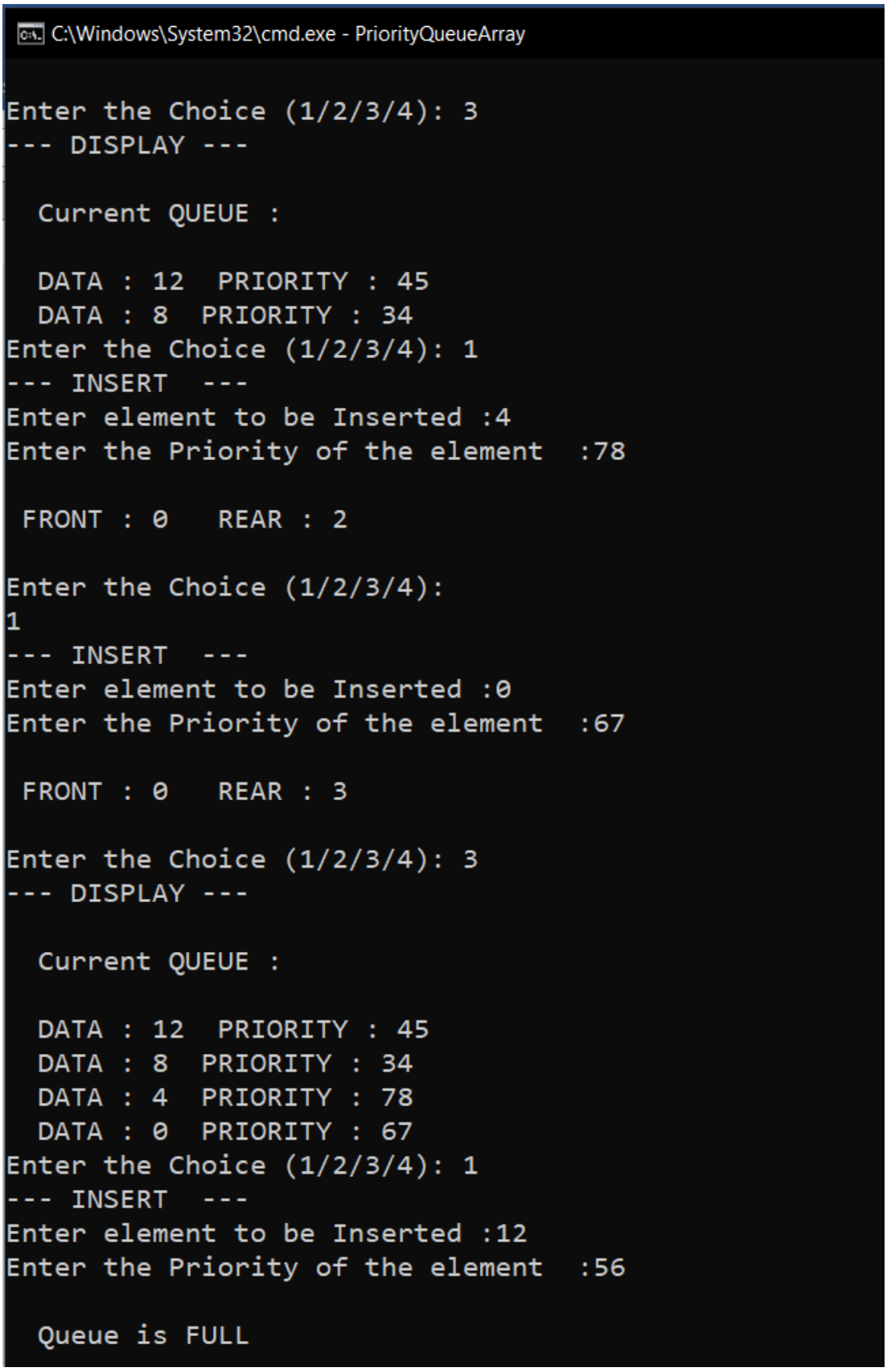
```
#include <stdio.h>
#include <stdlib.h>
int size;
int front=-1;
int rear=-1;
int *arr;
int *pty;

void enqueue (int item,int priority){
   if(rear==size-1){
      printf("\n  Queue is FULL\n\n");
   }
   else if(front==-1){
      arr[++front] = item;
      pty[front] = priority;
      ++rear;
   }
   else {
      arr[++rear] = item;
      pty[rear] = priority;
   }
  printf("\n FRONT : %d   REAR : %d \n",front,rear);

}
void dequeue(){
   if(front==-1){
      printf("\n  Queue is EMPTY\n\n");
   }
   else if(front==rear){
      int item = arr[front];
      int priority = pty[front];
      printf("\n  DELETED   DATA : %d  PRIORITY : %d ",item,priority);
      front=-1;
      rear=-1;

   }else{
      //Sorting the Queue according to Priority
      int i,j,n,temp1,temp2;
      for (i=0 ; i<rear-front;i++){
         for (j=0 ; j<rear-front-i;j++){
```

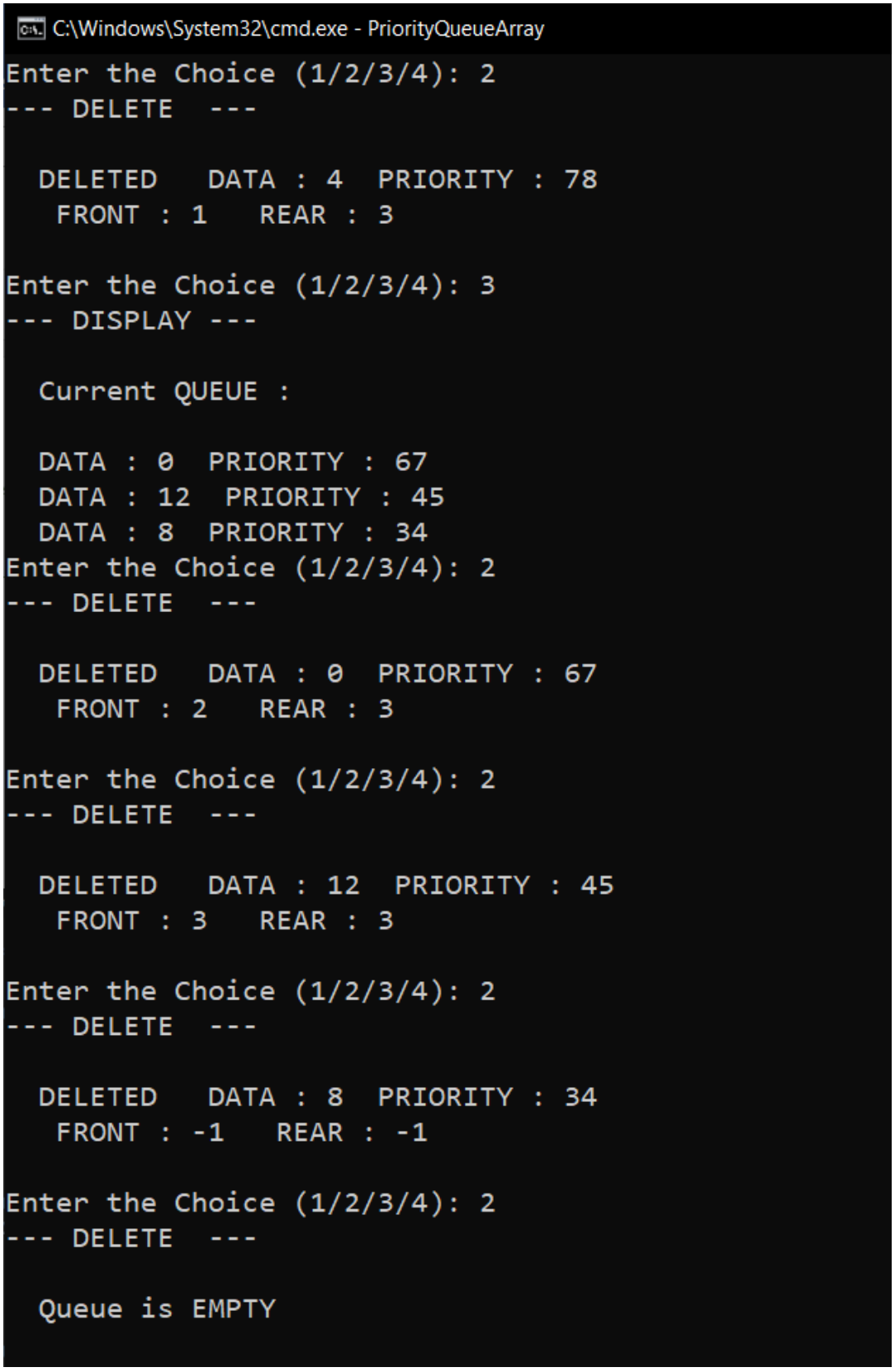
```
            if (pty[j] < pty[j+1]){
               temp1=pty[j];
               pty[j]=pty[j+1];
               pty[j+1]=temp1;
               temp2=arr[j];
               arr[j]=arr[j+1];
               arr[j+1]=temp2;
            }
         }
      }
      int item = arr[front];
      int priority = pty[front];
      printf("\n  DELETED   DATA : %d  PRIORITY : %d ",item,priority);
      front++;
   }
   printf("\n   FRONT : %d   REAR : %d \n",front,rear);
}

void display(){
   printf("\n  Current QUEUE :\n");
   if(front==-1){
      printf("\n  Queue is EMPTY \n");
   }else{
      for(int i=front; i<=rear; i++){
      printf("\n  DATA : %d  PRIORITY : %d ",arr[i],pty[i]);
      }
   }
}

void main(){
 int n,x,y;
 char ans='y';
 printf("Enter Queue size :");
 scanf("%d", &size);
 arr = (int*) malloc (size * sizeof(int));
 pty = (int*) malloc (size * sizeof(int));
 printf("\n--- OPERATION ON PRIORITY QUEUE --- \n\n");
 printf(" 1. INSERT  \n");
 printf(" 2. DELETE\n");
 printf(" 3. DISPLAY\n");
 printf(" 4. EXIT\n");
 while(ans=='y'){
    printf("\nEnter the Choice (1/2/3/4): ");
    scanf("%d",&n);
    switch(n){
       case 1:printf("--- INSERT  ---\n");
            printf("Enter element to be Inserted :");
```

```
            scanf("%d", &x);
            printf("Enter the Priority of the element  :");
            scanf("%d", &y);
            enqueue(x,y);
            break;
       case 2:printf("--- DELETE  ---\n");
            dequeue();
            break;
       case 3:printf("--- DISPLAY ---\n");
            display();
            break;
       case 4:ans='n';
            break;
      default:printf("Enter a Valid Input\n");
    }
 }
}
```

**OUTPUT:**




C:\Windows\System32\cmd.exe - PriorityQueueArray
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Current QUEUE :
DATA : 12 PRIORITY : 45
DATA : 8 PRIORITY : 34
Enter the Choice (1/2/3/4): 1
--- INSERT ---
Enter element to be Inserted :4
Enter the Priority of the element :78
FRONT : 0 REAR : 2
Enter the Choice (1/2/3/4):
1
--- INSERT ---
Enter element to be Inserted :0
Enter the Priority of the element :67
FRONT : 0 REAR : 3
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Current QUEUE :
DATA : 12 PRIORITY : 45
DATA : 8 PRIORITY : 34
DATA : 4 PRIORITY : 78
DATA : 0 PRIORITY : 67
Enter the Choice (1/2/3/4): 1
--- INSERT ---
Enter element to be Inserted :12
Enter the Priority of the element :56
Queue is FULL


C:\Windows\System32\cmd.exe - PriorityQueueArray
Enter the Choice (1/2/3/4): 2
--- DELETE ---
DELETED DATA : 4 PRIORITY : 78
FRONT : 1 REAR : 3
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Current QUEUE :
DATA : 0 PRIORITY : 67
DATA : 12 PRIORITY : 45
DATA : 8 PRIORITY : 34
Enter the Choice (1/2/3/4): 2
--- DELETE ---
DELETED DATA : 0 PRIORITY : 67
FRONT : 2 REAR : 3
Enter the Choice (1/2/3/4): 2
--- DELETE ---
DELETED DATA : 12 PRIORITY : 45
FRONT : 3 REAR : 3
Enter the Choice (1/2/3/4): 2
--- DELETE ---
DELETED DATA : 8 PRIORITY : 34
FRONT : -1 REAR : -1
Enter the Choice (1/2/3/4): 2
--- DELETE ---
Queue is EMPTY

## RESULT:

The Priority Queue was successfully implemented and the required operations were carried out.

Time complexity of Insert() operation is O(1).
Time complexity of Delete() operation is $O(n^2)$.

04/11/2020

## Experiment No:11

# DOUBLE ENDED QUEUE (DEQUE) USING ARRAYS

### AIM:

Write a program to implement Deque using arrays.

### DATA STRUCTURES USED:

Queue

### ALGORITHM:

Algorithm INSERT_FRONT (ITEM)

```
24. If (FRONT==0)                    // N is the size of Queue
25.     print “Insertion not possible”
26.     Exit
27. Else
28.     If (FRONT =-1)
29.         FRONT=REAR=0
30.         Queue[REAR]=ITEM
31.     Else
32.         Queue[--FRONT]=ITEM
33.     EndIf
34. EndIf
```

Algorithm INSERT_REAR (ITEM)

```
14. If (REAR=N-1)
15.     print “Queue is full”
16.     Exit
17. Else
18.     If (REAR =-1 && FRONT =-1)
19.         FRONT=REAR=0
20.         Queue[REAR]=ITEM
21.     Else
22.         Queue[++REAR]=ITEM
23.     EndIf
24. EndIf
```

Algorithm DELETE_FRONT

```
39. If (FRONT=-1)
40.     Print “Queue is empty”
41.     Exit
```

42. Else
43. If (FRONT == REAR)
44. ITEM = Queue[FRONT]
45. FRONT=REAR=-1
46. Else
47. ITEM = Queue[FRONT]
48. FRONT++
49. EndIf
50. EndIf

Algorithm DELETE_REAR

1. If (REAR=N-1)
2. Print “Deletion not possible”
3. Exit
4. Else
5. If (FRONT == REAR)
6. ITEM = Queue[FRONT]
7. FRONT=REAR=-1
8. Else
9. ITEM = Queue[FRONT]
10. REAR--
11. EndIf
12. EndIf

**PROGRAM:**

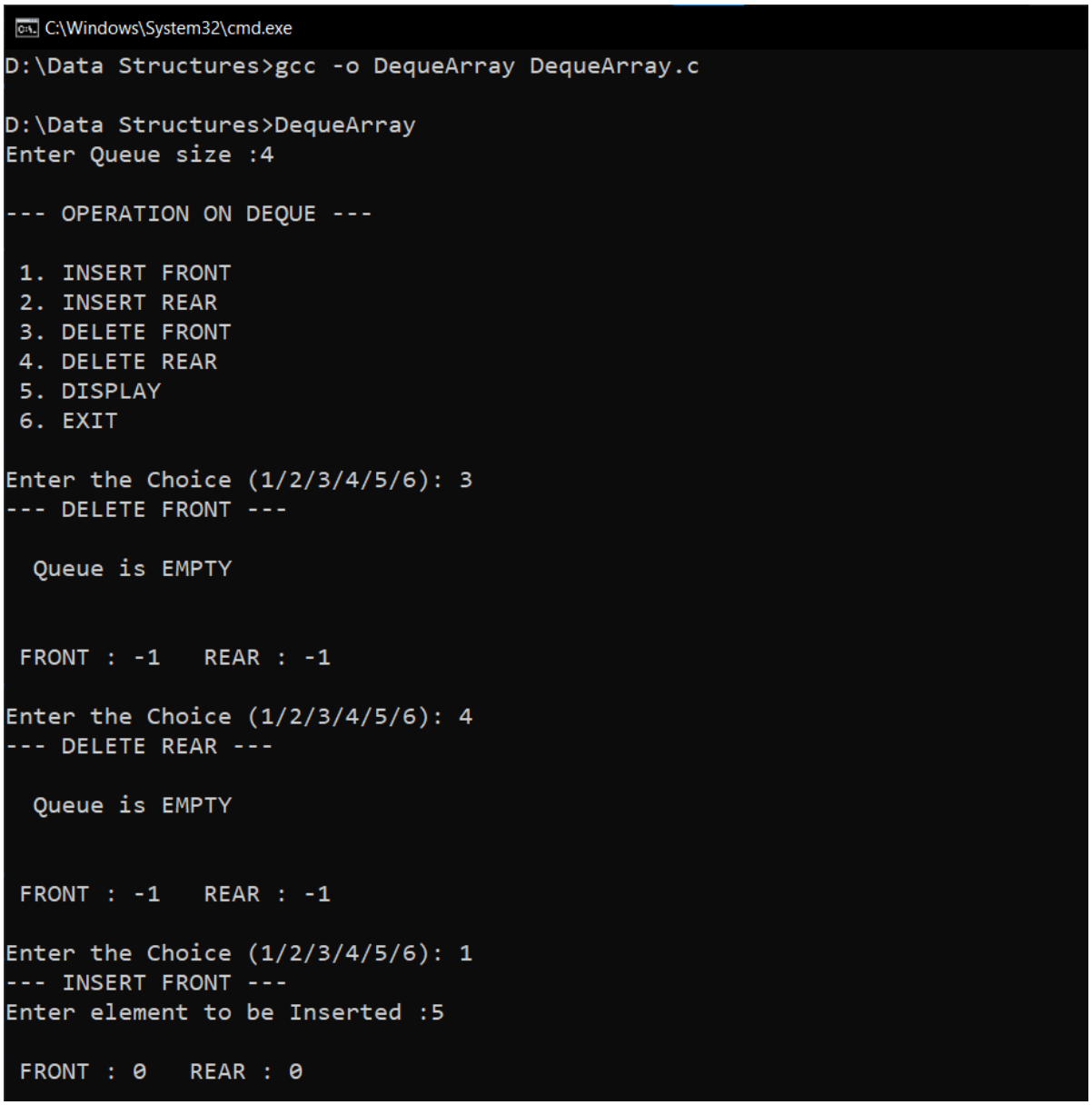
```
#include <stdio.h>
#include <stdlib.h>
int size;
int front;
int rear;
int *arr;

void insertFront(int item){
   if(front==0){
      printf("\n  Insertion Not Possible \n\n");
   }
   else if(front==-1){
      arr[++front] = item;
      rear++;
   }
   else {
      arr[--front] = item;
   }
   printf("\n FRONT : %d   REAR : %d \n",front,rear);
}
void insertRear(int item){
   if(rear==size-1){
```

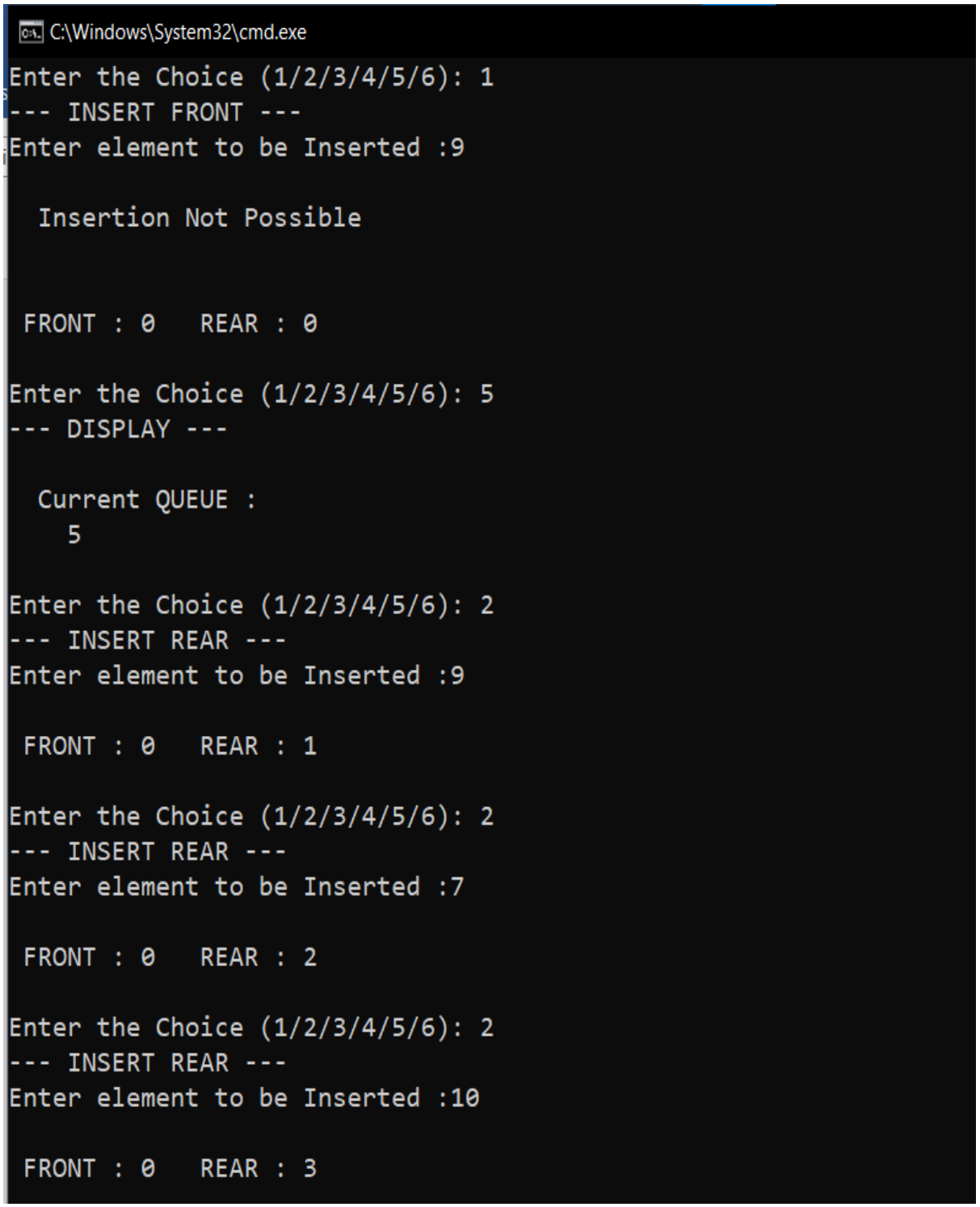
```
        printf("\n  Queue is FULL\n\n");
    }
    else if(front==-1){
        arr[++front] = item;
        ++rear;
    }
    else {
        arr[++rear] = item;
    }
   printf("\n FRONT : %d   REAR : %d \n",front,rear);
}
void deleteFront(){
    if(front==-1){
        printf("\n  Queue is EMPTY\n\n");
    }
    else if(front==rear){
        int item = arr[front];
        printf("\n  DELETED : %d  ",item);
        front=-1;
        rear=-1;

    }else{
        int item = arr[front];
        front++;
        printf("\n  DELETED : %d  ",item);
    }
    printf("\n FRONT : %d   REAR : %d \n",front,rear);
}
void deleteRear(){
    if(rear==-1){
        printf("\n  Queue is EMPTY\n\n");
    }
    else if(front==rear){
        int item = arr[front];
        printf("\n  DELETED : %d  ",item);
        front=-1;
        rear=-1;

    }else{
        int item = arr[rear];
        --rear;
        printf("\n  DELETED : %d  ",item);
    }
   printf("\n FRONT : %d   REAR : %d \n",front,rear);
}
void display(){
    printf("\n  Current QUEUE :\n");
```

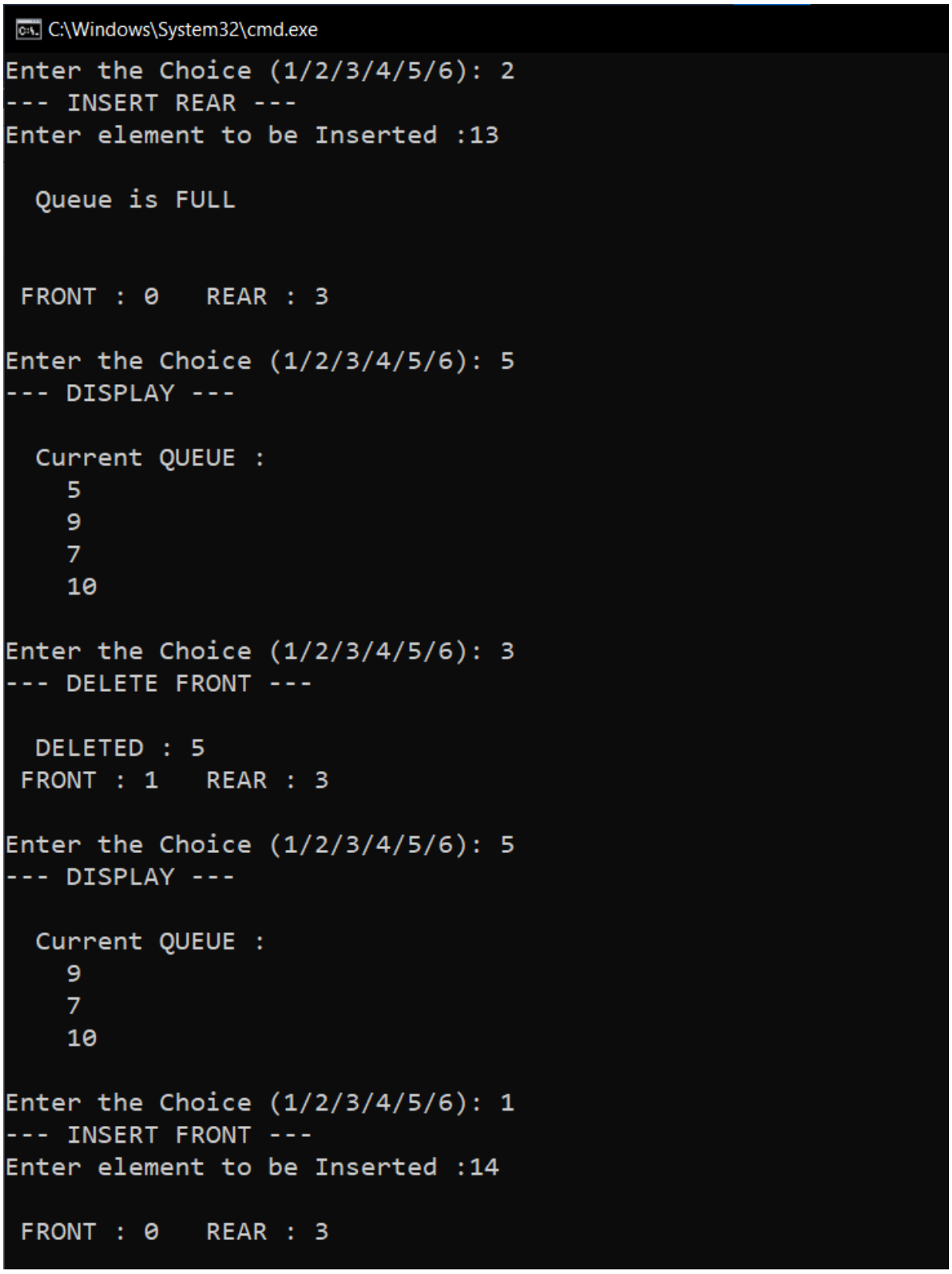
```
   if(front==-1){
      printf("\n  Queue is EMPTY \n");
   }else{
      for(int i=front; i<=rear; i++){
      printf("    %d \n",arr[i]);
      }
   }
}

void main(){
 int n,x,y;
 char ans='y';
 printf("Enter Queue size :");
 scanf("%d", &size);
 arr = (int*) malloc (size * sizeof(int));
 front=-1,rear=-1;
 printf("\n--- OPERATION ON DEQUE --- \n\n");
 printf(" 1. INSERT FRONT \n");
 printf(" 2. INSERT REAR\n");
 printf(" 3. DELETE FRONT\n");
 printf(" 4. DELETE REAR\n");
 printf(" 5. DISPLAY\n");
 printf(" 6. EXIT\n");
 while(ans=='y'){
    printf("\nEnter the Choice (1/2/3/4/5/6): ");
    scanf("%d",&n);
    switch(n){
       case 1:printf("--- INSERT FRONT ---\n");
            printf("Enter element to be Inserted :");
            scanf("%d", &x);
            insertFront(x);
            break;
       case 2:printf("--- INSERT REAR ---\n");
            printf("Enter element to be Inserted :");
            scanf("%d", &x);
            insertRear(x);
            break;
       case 3:printf("--- DELETE FRONT ---\n");
            deleteFront();
            break;
       case 4:printf("--- DELETE REAR ---\n");
            deleteRear();
            break;
       case 5:printf("--- DISPLAY ---\n");
            display();
            break;
       case 6:ans='n';
```

```
            break;
        default:printf("Enter a Valid Input\n");
      }
   }
  }
```

**OUTPUT:**

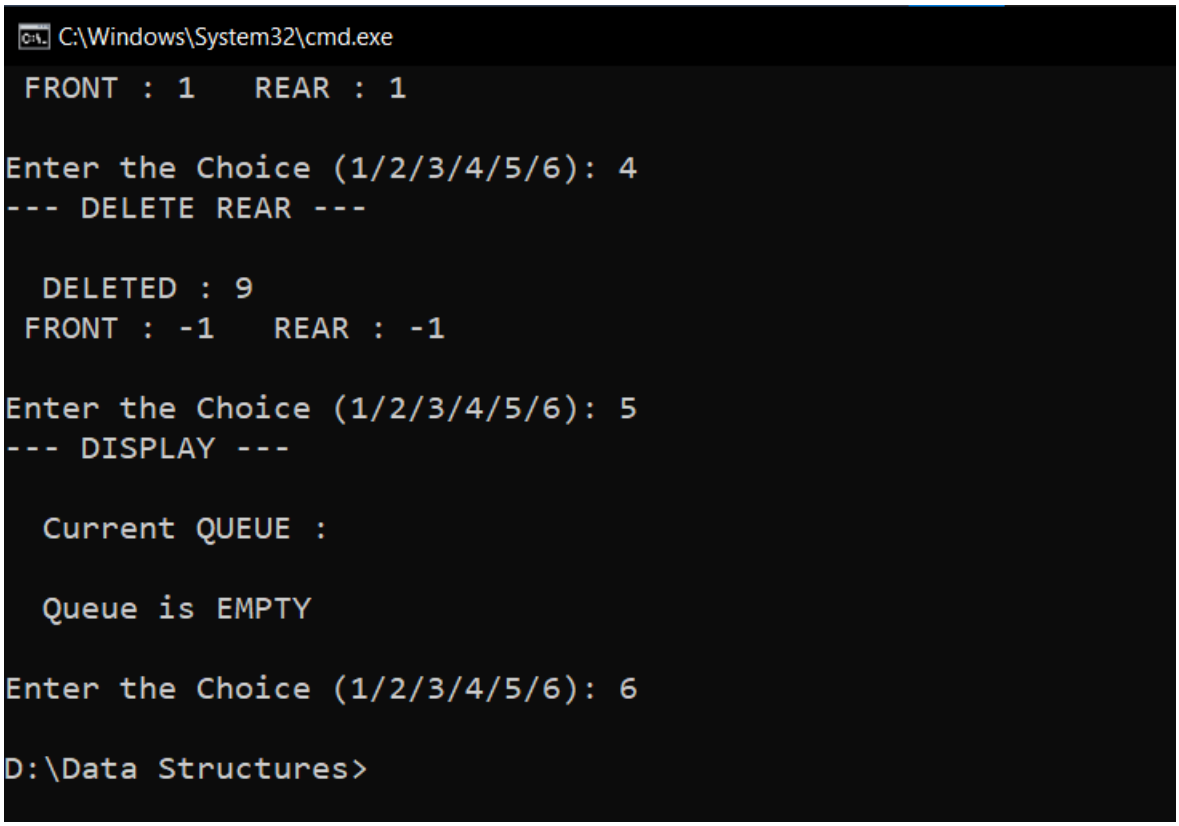



C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4/5/6): 1
--- INSERT FRONT ---
Enter element to be Inserted :9
Insertion Not Possible
FRONT : 0 REAR : 0
Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---
Current QUEUE :
5
Enter the Choice (1/2/3/4/5/6): 2
--- INSERT REAR ---
Enter element to be Inserted :9
FRONT : 0 REAR : 1
Enter the Choice (1/2/3/4/5/6): 2
--- INSERT REAR ---
Enter element to be Inserted :7
FRONT : 0 REAR : 2
Enter the Choice (1/2/3/4/5/6): 2
--- INSERT REAR ---
Enter element to be Inserted :10
FRONT : 0 REAR : 3


C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4/5/6): 2
--- INSERT REAR ---
Enter element to be Inserted :13
Queue is FULL
FRONT : 0 REAR : 3
Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---
Current QUEUE :
5
9
7
10
Enter the Choice (1/2/3/4/5/6): 3
--- DELETE FRONT ---
DELETED : 5
FRONT : 1 REAR : 3
Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---
Current QUEUE :
9
7
10
Enter the Choice (1/2/3/4/5/6): 1
--- INSERT FRONT ---
Enter element to be Inserted :14
FRONT : 0 REAR : 3

C:\Windows\System32\cmd.exe

```
 FRONT : 0   REAR : 3

Enter the Choice (1/2/3/4/5/6): 4
--- DELETE REAR ---

  DELETED : 10
 FRONT : 0   REAR : 2

Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---

  Current QUEUE :
    14
    9
    7

Enter the Choice (1/2/3/4/5/6): 3
--- DELETE FRONT ---

  DELETED : 14
 FRONT : 1   REAR : 2

Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---

  Current QUEUE :
    9
    7

Enter the Choice (1/2/3/4/5/6): 4
--- DELETE REAR ---

  DELETED : 7
 FRONT : 1   REAR : 1
```




**RESULT:**

The Deque was successfully implemented and the required output was obtained.

Time complexity of INSERT_REAR() operation is O(1).
Time complexity of DELETE_FRONT() operation is O(1).
Time complexity of INSERT_FRONT() operation is O(1).
Time complexity of DELETE_REAR() operation is O(1).

13/11/2020

## Experiment No:12

# LINKED LISTS

### AIM:

Write a program to implement operations on Linked List.

### DATA STRUCTURES USED:

Linked List

### ALGORITHM:

Algorithm INSERT_FRONT (ITEM)

1. new = GetNode(Node)
2. If (new = NULL) then
3. Print ”memory underflow”
4. Exit
5. Else
6. new->LINK=HEADER->LINK
7. new-> DATA=ITEM
8. HEADER->LINK=new
9. Endif
10. stop

Algorithm INSERT_REAR (ITEM)

1. new= GetNodes(Node)
2. if (new = NULL) then
3. print”memory underflow”
4. Exit
5. Else
6. ptr=HEADER
7. While(ptr-> LINK!=NULL)do
8. ptr=ptr->LINK
9. Endwhile
10. ptr->LINK= new
11. new->DATA=ITEM
12. new->LINK=NULL
13. Stop

Algorithm INSERT_ANY (ITEM,KEY)

1. new= GetNode(Node)
2. if (new = NULL) then
3. print ”memory underflow”
4. Exit
5. Else

```
6.      ptr=HEADER
7.      While(ptr->DATA!=KEY) and(ptr-> LINK != NULL)do
8.          ptr=ptr->LINK
9.      Endwhile
10.     If(ptr->LINK=NULL)
11.         Print"KEY NOT FOUND"
12.         Exit
13.     Else
14.         new-> LINK=ptr->LINK
15.         new->DATA=x
16.         ptr->LINK=new
17.     Endif
18. Endif
19. stop
```

Algorithm DELETE_FRONT

```
51. ptr=HEADER->LINK
52. if(ptr=NULL)then
53.     print "The list is empty"
54.     Exit
55.  Else
56.      HEADER->LINK=ptr->LINK
57.      ReturnNode(ptr)
58. stop
```

Algorithm DELETE_REAR

```
13. ptr=HEADER
14. if (ptr->LINK =NULL)then
15.     print"the list is empty"
16.     exit
17. else
18.     while(ptr->LINK!=NULL)
19.         ptr1=ptr
20.         ptr=ptr->LINK
21.     endwhile
22.     ptr->LINK=NULL
23.     ReturnNode(ptr)
24. Endif
25. Stop
```

Algorithm DELETE_ANY

```
1.  ptr1=HEADER
2.  ptr=ptr1->LINK
3.  while(ptr!=NULL)
4.      if(ptr->DATA!= KEY)
5.          ptr1=ptr
6.          ptr=ptr->LINK
7.      else
8.          ptr1->LINK=ptr->LINK
9.          ReturnNode(ptr)
```

10. Exit
11. Endif
12. Endwhile
13. If ptr=NULL
14. Print"Node with key doesn't exist"
15. Endif
16. Stop

**PROGRAM:**

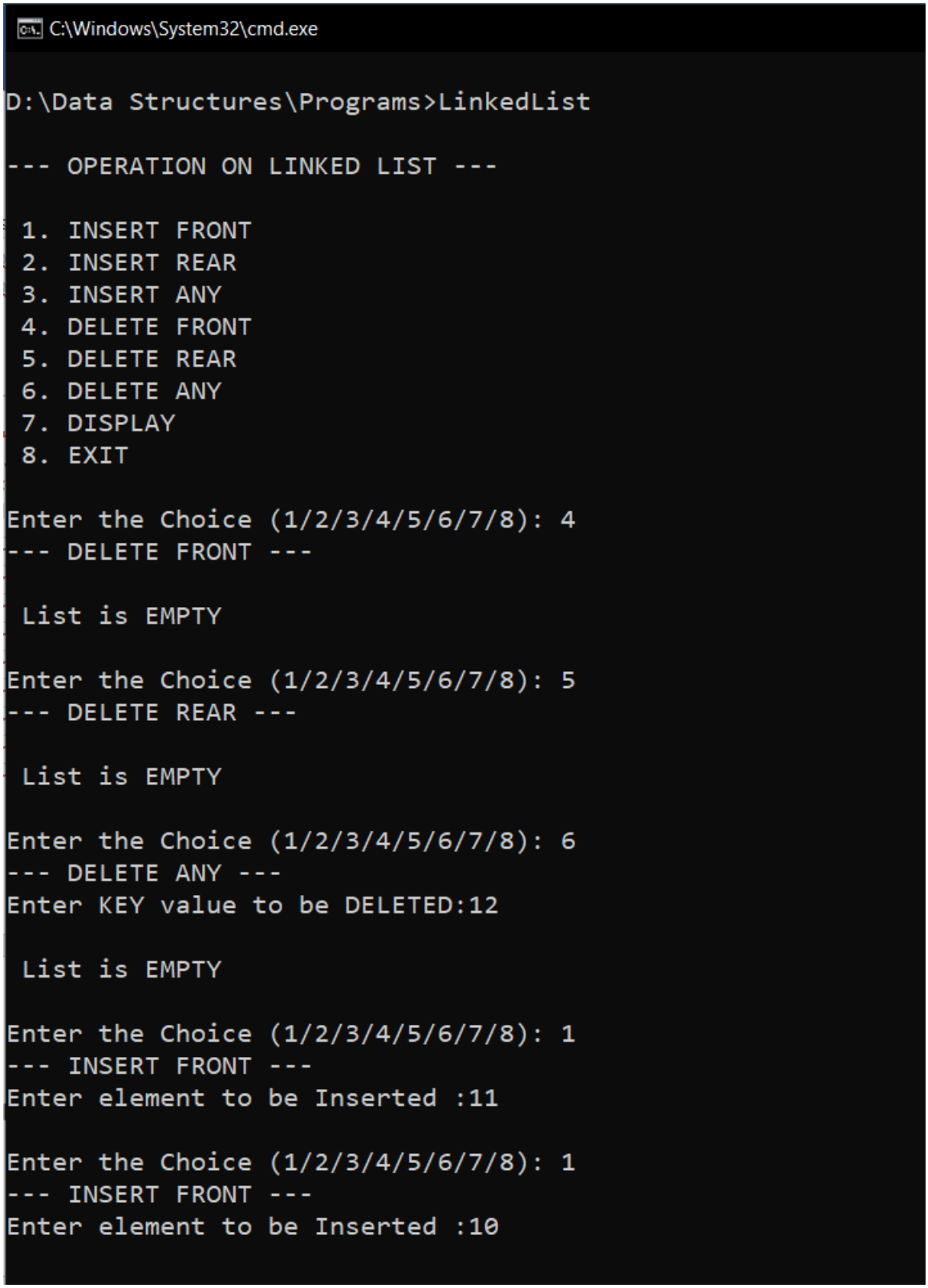
```
#include<stdio.h>
#include<stdlib.h>
struct node{
   int data;
   struct node *link;
};

void insert_front(struct node* header,int x){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   new->data=x;
   new->link=NULL;
   if(new==NULL){
      printf("\nMEMORY Underflow\n");
   }else{
      if(header->link==NULL){
         header->link=new;
      }else{
         new->link=header->link;
         header->link=new;
         }
   }
}

void insert_rear(struct node* header,int x){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   new->data=x;
   new->link=NULL;
   if(new==NULL){
      printf("\nMEMORY Underflow\n");
   }else{
      if(header->link==NULL){
         header->link=new;
      }else{
         struct node* ptr=header;
         while(ptr->link!=NULL){
            ptr=ptr->link;
         }
         ptr->link=new;
```

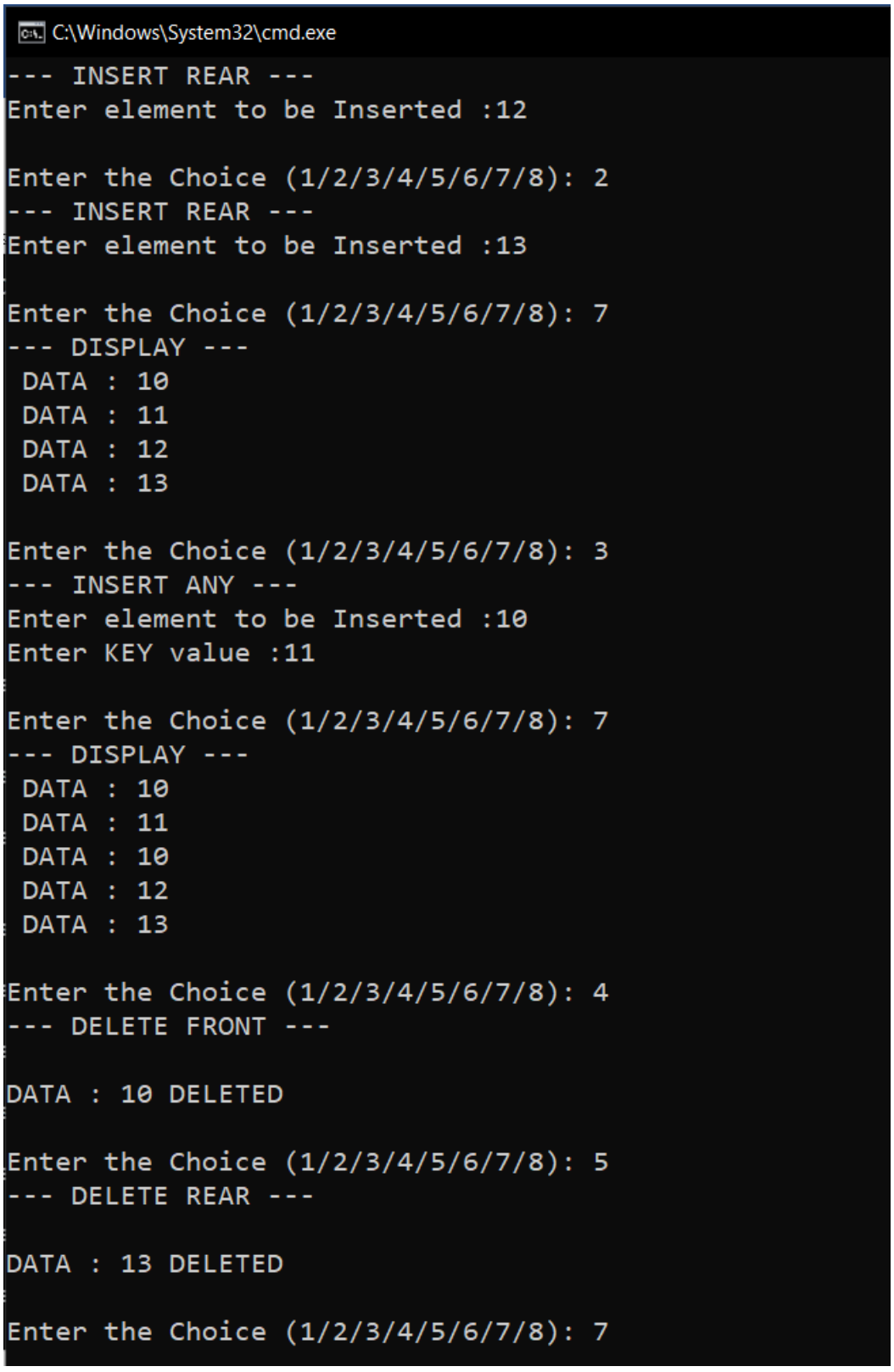
```
      }
   }
}
void insert_any(struct node* header,int x,int key){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   new->data=x;
   new->link=NULL;
   if(new==NULL){
      printf("\nMEMORY Underflow\n");
   }else{
      if(header->link==NULL){
         printf("KEY Not Found\n");
      }else{
         struct node* ptr=header;
         while(ptr->data!=key && ptr->link!=NULL){
            ptr=ptr->link;
         }
         if(ptr->data==key){
            new->link=ptr->link;
            ptr->link=new;
         }else{
            printf("KEY Not Found\n");
         }

      }
   }
}
void delete_front(struct node* header){
    struct node* ptr=header->link;
     if(ptr==NULL){
       printf("\n List is EMPTY\n");
    }else{
        header->link=ptr->link;
        printf("\nDATA : %d DELETED\n",ptr->data);
        free(ptr);
     }
}
void delete_rear(struct node* header){

    struct node* ptr=header;
    struct node* ptr1;
     if(ptr->link==NULL){
       printf("\n List is EMPTY\n");
     }else{
        while(ptr->link!=NULL){
            ptr1=ptr;
            ptr=ptr->link;
```

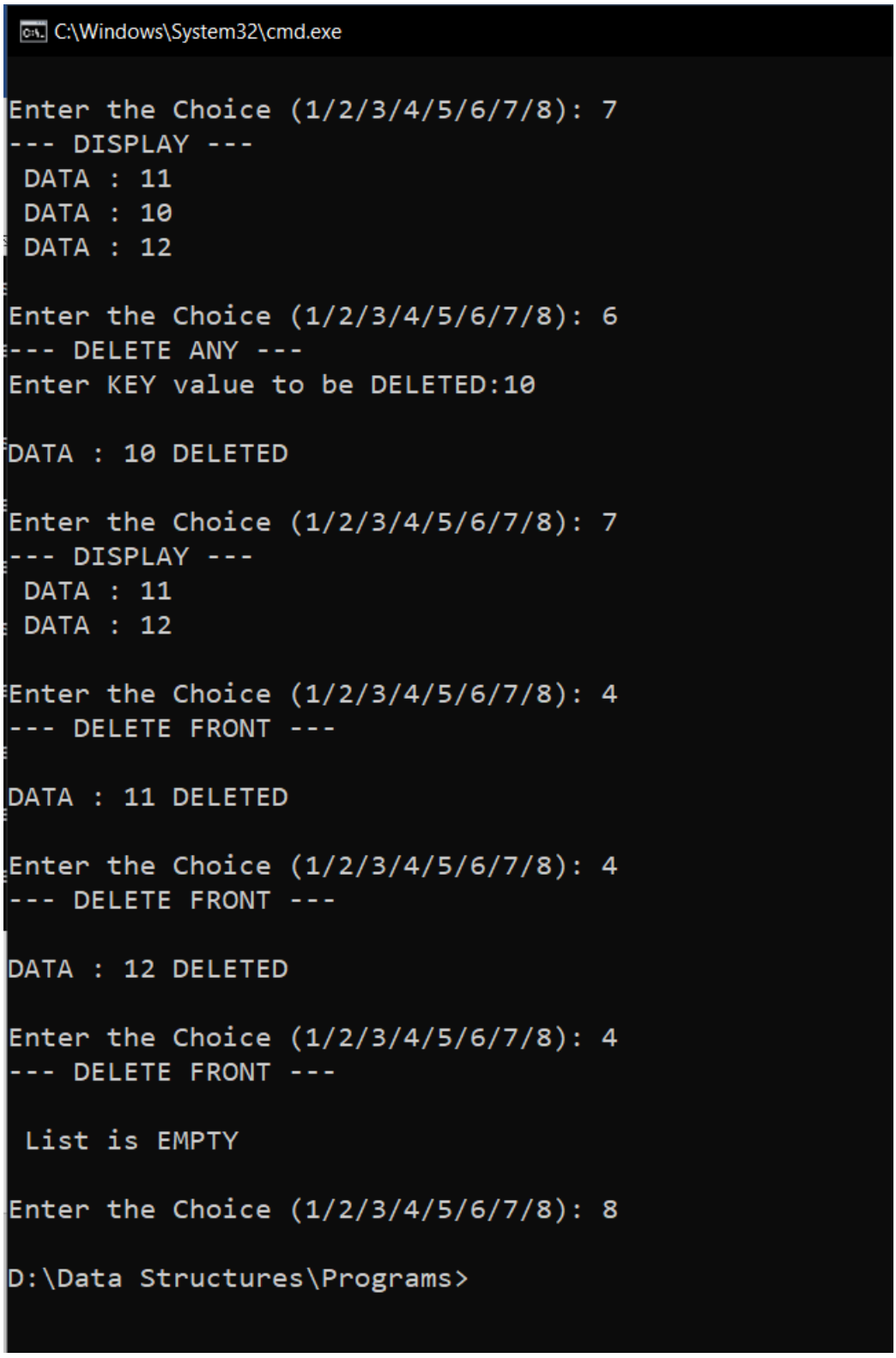
```
        }
        ptr1->link=NULL;
        printf("\nDATA : %d DELETED\n",ptr->data);
        free(ptr);
    }
}
void delete_any(struct node* header,int key){
    struct node* ptr1=header;
    struct node* ptr=ptr1->link;
    if(ptr==NULL){
      printf("\n List is EMPTY\n");
    }else{
      while(ptr->data!=key && ptr->link!=NULL){
         ptr1=ptr;
         ptr=ptr->link;
       }
     if(ptr->data==key){
       ptr1->link=ptr->link;
       printf("\nDATA : %d DELETED\n",ptr->data);
       free(ptr);
     }else{
        printf("\nKEY Not Found\n");
     }
    }
}
void display(struct node* header){
   struct node* ptr=header;
   while(ptr->link!=NULL){
      ptr=ptr->link;
      printf(" DATA : %d\n",ptr->data);
   }
}

void main(){
 int n,x,y,key;
 char ans='y';
 struct node* header = (struct node*)malloc(sizeof(struct node));
 header->link=NULL;
 printf("\n--- OPERATION ON LINKED LIST --- \n\n");
 printf(" 1. INSERT FRONT \n");
 printf(" 2. INSERT REAR \n");
 printf(" 3. INSERT ANY \n");
 printf(" 4. DELETE FRONT \n");
 printf(" 5. DELETE REAR \n");
 printf(" 6. DELETE ANY \n");
 printf(" 7. DISPLAY\n");
 printf(" 8. EXIT\n");
```

```
while(ans=='y'){
   printf("\nEnter the Choice (1/2/3/4/5/6/7/8): ");
   scanf("%d",&n);
   switch(n){
      case 1:printf("--- INSERT FRONT ---\n");
            printf("Enter element to be Inserted :");
            scanf("%d", &x);
            insert_front(header,x);
            break;
      case 2:printf("--- INSERT REAR ---\n");
            printf("Enter element to be Inserted :");
            scanf("%d", &x);
            insert_rear(header,x);
            break;
      case 3:printf("--- INSERT ANY ---\n");
            printf("Enter element to be Inserted :");
            scanf("%d", &x);
            printf("Enter KEY value :");
            scanf("%d", &key);
            insert_any(header,x,key);
            break;
      case 4:printf("--- DELETE FRONT ---\n");
            delete_front(header);
            break;
      case 5:printf("--- DELETE REAR ---\n");
            delete_rear(header);
            break;
      case 6:printf("--- DELETE ANY ---\n");
            printf("Enter KEY value to be DELETED:");
            scanf("%d", &key);
            delete_any(header,key);
            break;
      case 7:printf("--- DISPLAY ---\n");
            display(header);
            break;
      case 8:ans='n';
            break;
     default:printf("Enter a Valid Input\n");
   }
 }
}
```

**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>LinkedList
--- OPERATION ON LINKED LIST ---
1. INSERT FRONT
2. INSERT REAR
3. INSERT ANY
4. DELETE FRONT
5. DELETE REAR
6. DELETE ANY
7. DISPLAY
8. EXIT
Enter the Choice (1/2/3/4/5/6/7/8): 4
--- DELETE FRONT ---
List is EMPTY
Enter the Choice (1/2/3/4/5/6/7/8): 5
--- DELETE REAR ---
List is EMPTY
Enter the Choice (1/2/3/4/5/6/7/8): 6
--- DELETE ANY ---
Enter KEY value to be DELETED:12
List is EMPTY
Enter the Choice (1/2/3/4/5/6/7/8): 1
--- INSERT FRONT ---
Enter element to be Inserted :11
Enter the Choice (1/2/3/4/5/6/7/8): 1
--- INSERT FRONT ---
Enter element to be Inserted :10


C:\Windows\System32\cmd.exe
--- INSERT REAR ---
Enter element to be Inserted :12
Enter the Choice (1/2/3/4/5/6/7/8): 2
--- INSERT REAR ---
Enter element to be Inserted :13
Enter the Choice (1/2/3/4/5/6/7/8): 7
--- DISPLAY ---
DATA : 10
DATA : 11
DATA : 12
DATA : 13
Enter the Choice (1/2/3/4/5/6/7/8): 3
--- INSERT ANY ---
Enter element to be Inserted :10
Enter KEY value :11
Enter the Choice (1/2/3/4/5/6/7/8): 7
--- DISPLAY ---
DATA : 10
DATA : 11
DATA : 10
DATA : 12
DATA : 13
Enter the Choice (1/2/3/4/5/6/7/8): 4
--- DELETE FRONT ---
DATA : 10 DELETED
Enter the Choice (1/2/3/4/5/6/7/8): 5
--- DELETE REAR ---
DATA : 13 DELETED
Enter the Choice (1/2/3/4/5/6/7/8): 7


C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4/5/6/7/8): 7
--- DISPLAY ---
DATA : 11
DATA : 10
DATA : 12
Enter the Choice (1/2/3/4/5/6/7/8): 6
--- DELETE ANY ---
Enter KEY value to be DELETED:10
DATA : 10 DELETED
Enter the Choice (1/2/3/4/5/6/7/8): 7
--- DISPLAY ---
DATA : 11
DATA : 12
Enter the Choice (1/2/3/4/5/6/7/8): 4
--- DELETE FRONT ---
DATA : 11 DELETED
Enter the Choice (1/2/3/4/5/6/7/8): 4
--- DELETE FRONT ---
DATA : 12 DELETED
Enter the Choice (1/2/3/4/5/6/7/8): 4
--- DELETE FRONT ---
List is EMPTY
Enter the Choice (1/2/3/4/5/6/7/8): 8
D:\Data Structures\Programs>

## RESULT:

The given operations are performed on a Linked List.

Time complexity of INSERT_FRONT() operation is O(1).
Time complexity of INSERT_REAR() operation is O(n).
Time complexity of INSERT_ANY() operation is O(n).
Time complexity of DELETE_FRONT() operation is O(1).
Time complexity of DELETE_REAR() operation is O(n).
Time complexity of DELETE_ANY() operation is O(n).

13/11/2020

## Experiment No: 13

# STACK USING LINKED LISTS

### AIM:

Write a program to implement Stack using Linked List.

### DATA STRUCTURES USED:

Stack

### ALGORITHM:

Algorithm POP (ITEM)

11. new = GetNode(Node)
12. If (new = NULL) then
13. Print ”memory underflow”
14. Exit
15. Else
16. new->LINK=TOP->LINK
17. new-> DATA=ITEM
18. TOP->LINK=new
19. Endif
20. Stop

Algorithm POP()

59. ptr=TOP->LINK
60. if(ptr=NULL)then
61. print “The stack is empty”
62. Exit
63. Else
64. TOP->LINK=ptr->LINK
65. ReturnNode(ptr)
66. stop

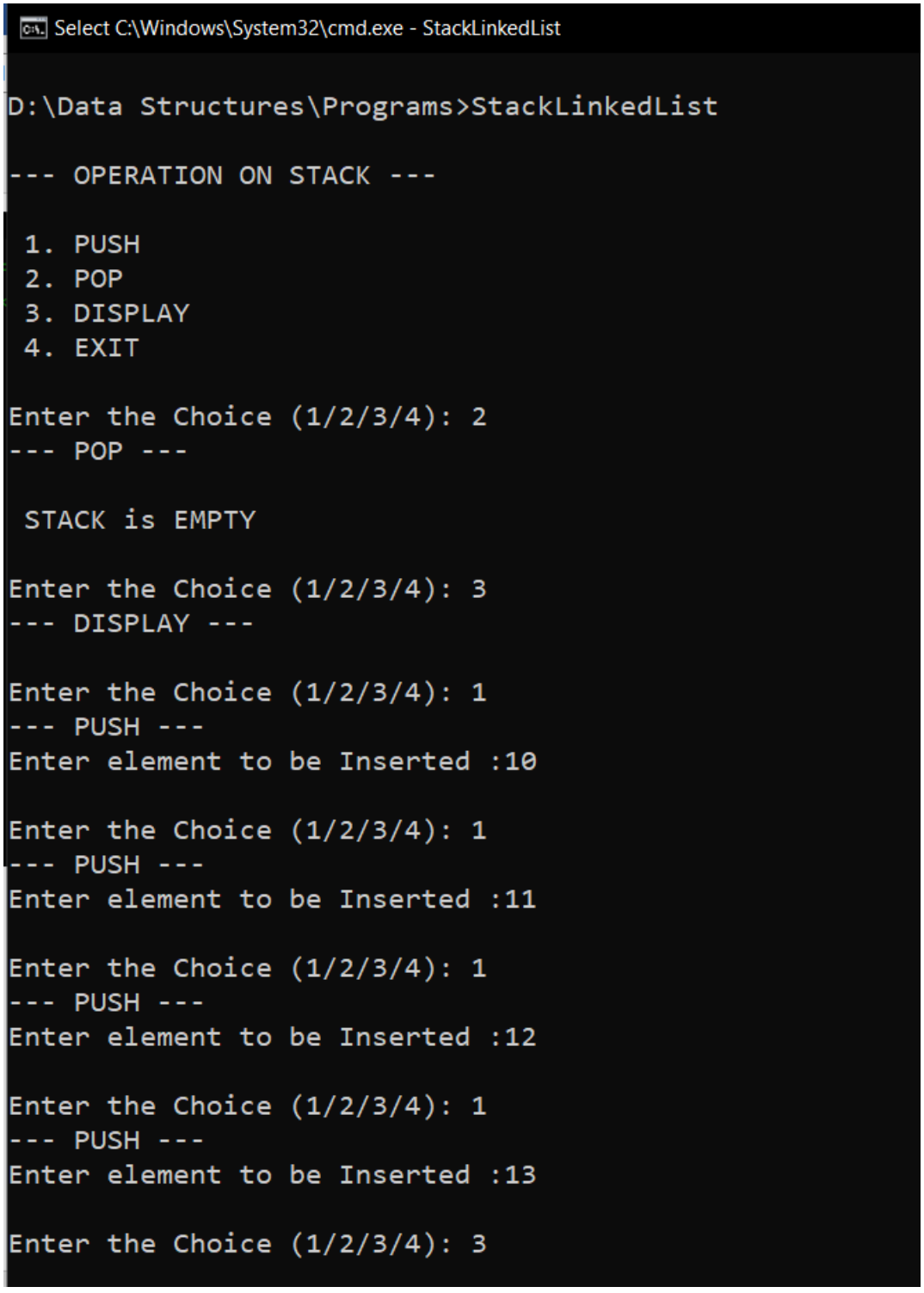
### PROGRAM:

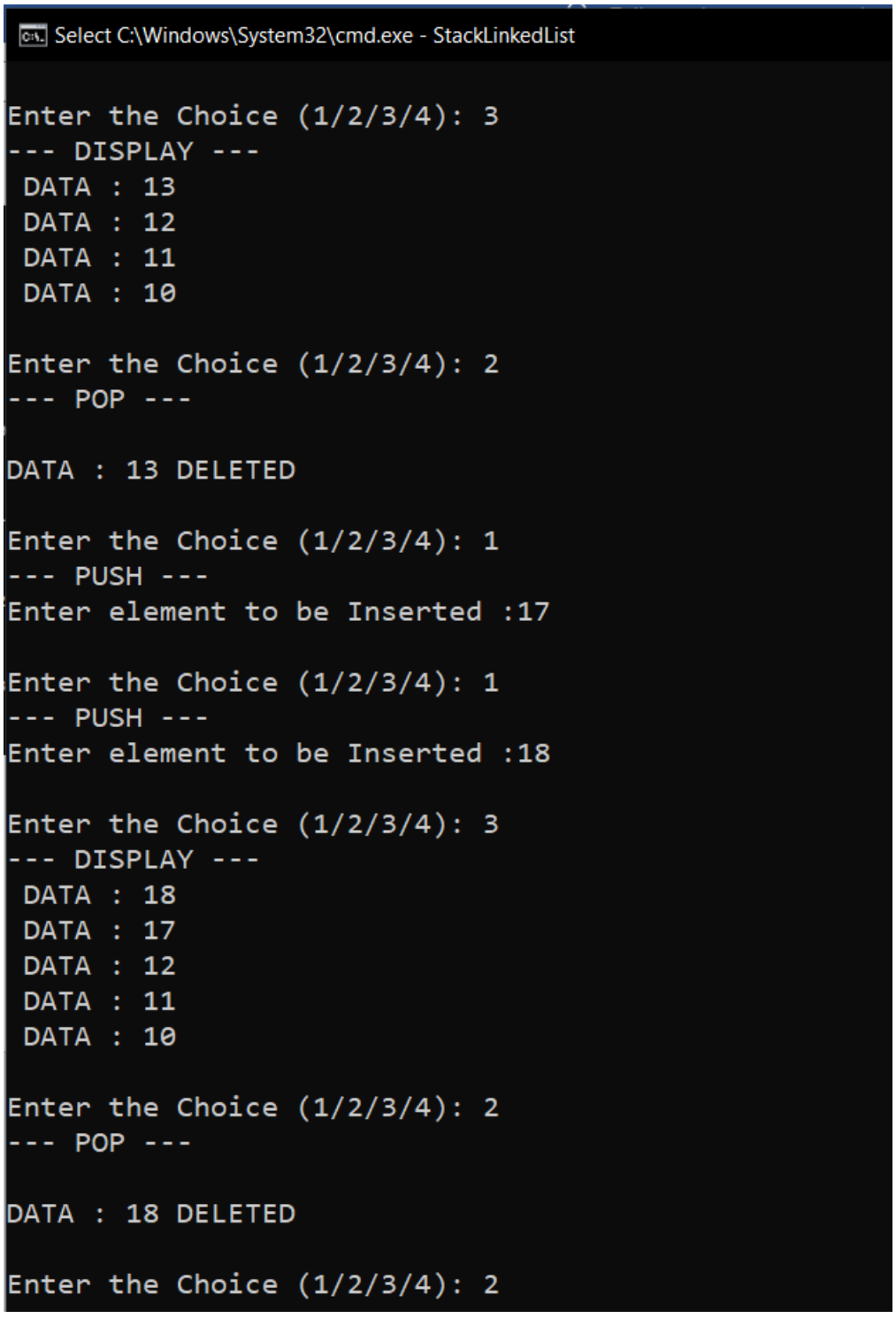
```
#include<stdio.h>
#include<stdlib.h>
struct node{
   int data;
   struct node *link;
};
```

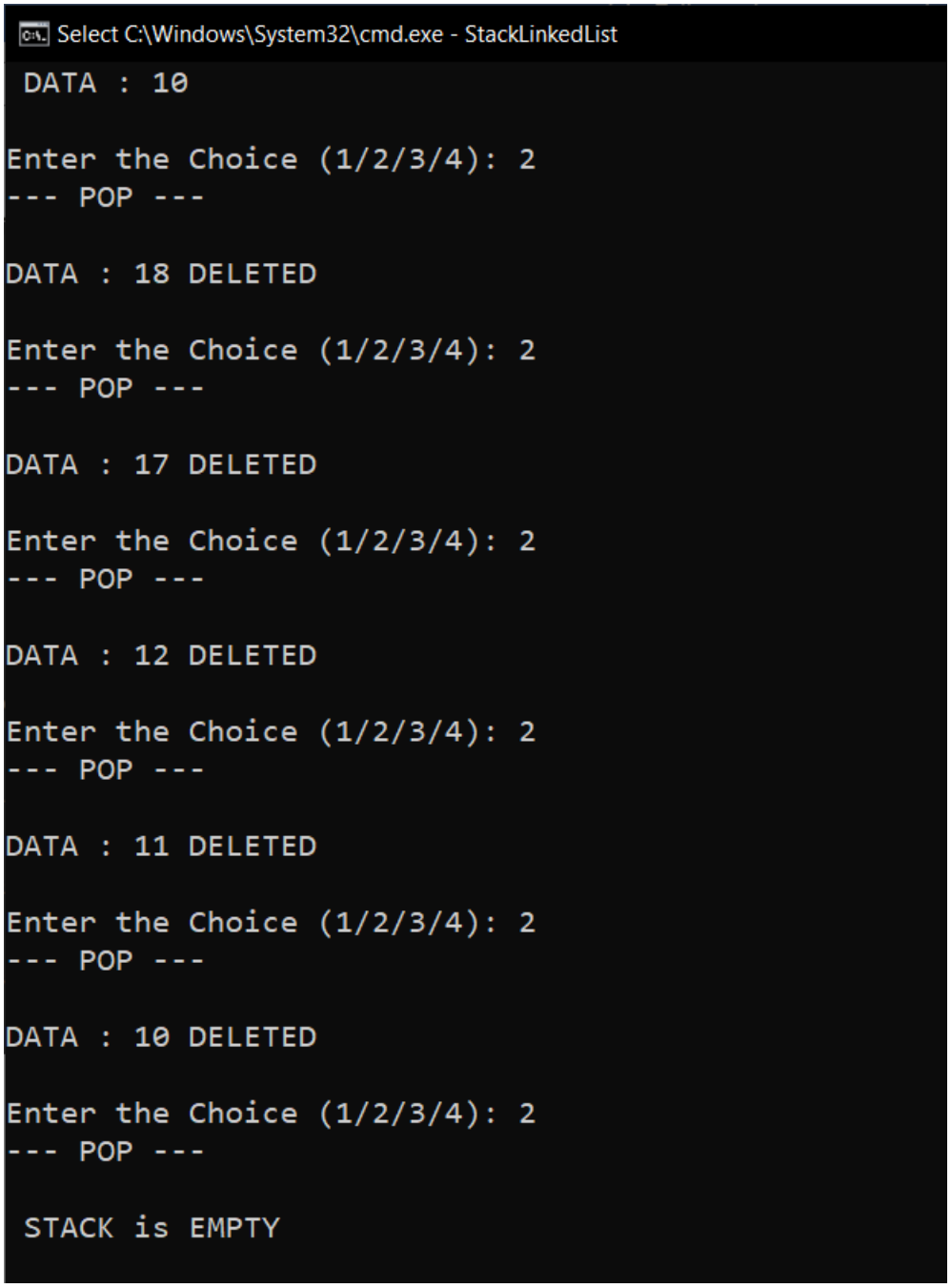
```
void push(struct node* top,int x){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   new->data=x;
   new->link=NULL;
   if(new==NULL){
      printf("\nMEMORY Underflow\n");
   }else{
      if(top->link==NULL){
         top->link=new;
      }else{
         new->link=top->link;
         top->link=new;
         }
   }
}

void pop(struct node* top){
    struct node* ptr=top->link;
     if(ptr==NULL){
       printf("\n STACK is EMPTY\n");
    }else{
        top->link=ptr->link;
        printf("\nDATA : %d DELETED\n",ptr->data);
        free(ptr);
     }
}

void display(struct node* top){
   struct node* ptr=top;
   while(ptr->link!=NULL){
      ptr=ptr->link;
      printf(" DATA : %d\n",ptr->data);
   }
}

void main(){
 int n,x,y,key;
 char ans='y';
 struct node* top = (struct node*)malloc(sizeof(struct node));
 top->link=NULL;
 printf("\n--- OPERATION ON STACK --- \n\n");
 printf(" 1. PUSH \n");
 printf(" 2. POP \n");
 printf(" 3. DISPLAY \n");
 printf(" 4. EXIT \n");
 while(ans=='y'){
    printf("\nEnter the Choice (1/2/3/4): ");
```

```
    scanf("%d",&n);
    switch(n){
       case 1:printf("--- PUSH ---\n");
              printf("Enter element to be Inserted :");
              scanf("%d", &x);
              push(top,x);
              break;
       case 2:printf("--- POP ---\n");
              pop(top);
              break;
       case 3:printf("--- DISPLAY ---\n");
              display(top);
              break;
       case 4:ans='n';
              break;
      default:printf("Enter a Valid Input\n");
    }
  }
}
```

**OUTPUT:**


Select C:\Windows\System32\cmd.exe - StackLinkedList
D:\Data Structures\Programs>StackLinkedList
--- OPERATION ON STACK ---
1. PUSH
2. POP
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 2
--- POP ---
STACK is EMPTY
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be Inserted :10
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be Inserted :11
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be Inserted :12
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be Inserted :13
Enter the Choice (1/2/3/4): 3


Select C:\Windows\System32\cmd.exe - StackLinkedList
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
DATA : 13
DATA : 12
DATA : 11
DATA : 10
Enter the Choice (1/2/3/4): 2
--- POP ---
DATA : 13 DELETED
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be Inserted :17
Enter the Choice (1/2/3/4): 1
--- PUSH ---
Enter element to be Inserted :18
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
DATA : 18
DATA : 17
DATA : 12
DATA : 11
DATA : 10
Enter the Choice (1/2/3/4): 2
--- POP ---
DATA : 18 DELETED
Enter the Choice (1/2/3/4): 2




**RESULT:**

The given operations are performed on a Stack implemented using linked list.

Time complexity of PUSH() operation is O(1).

Time complexity of POP() operation is O(1).

13/11/2020

## Experiment No:14

# QUEUE USING LINKED LISTS

### AIM:

Write a program to implement Queue using on Linked List.

### DATA STRUCTURES USED:

Queue

### ALGORITHM:

Algorithm INSERT(ITEM)

14. new= GetNodes(Node)
15. new->DATA=ITEM
16. new->LINK=NULL
17. if (new = NULL) then
18. print"memory underflow"
19. Exit
20. Else
21. If (FRONT->LINK=NULL)
22. FRONT->LINK=new
23. REAR->LINK=new
24. else
25. REAR->LINK->LINK= new
26. REAR->LINK=new
27. EndIf
28. EndIf
29. Stop

Algorithm DELETE()

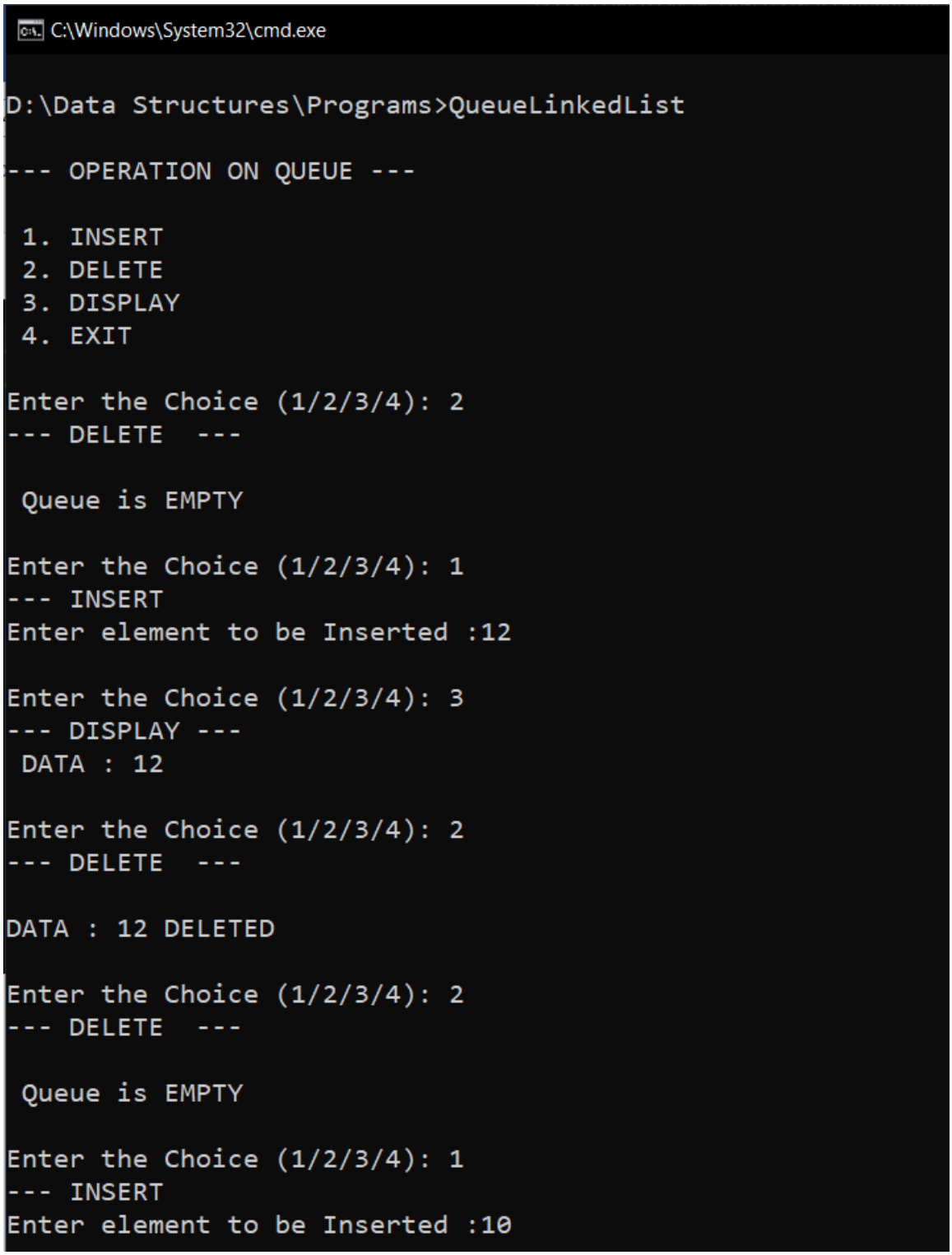
67. ptr=HEADER->LINK
68. if(ptr=NULL)then
69. print "The Queue is empty"
70. Exit
71. Else
72. FRONT->LINK=ptr->LINK
73. ReturnNode(ptr)
74. stop

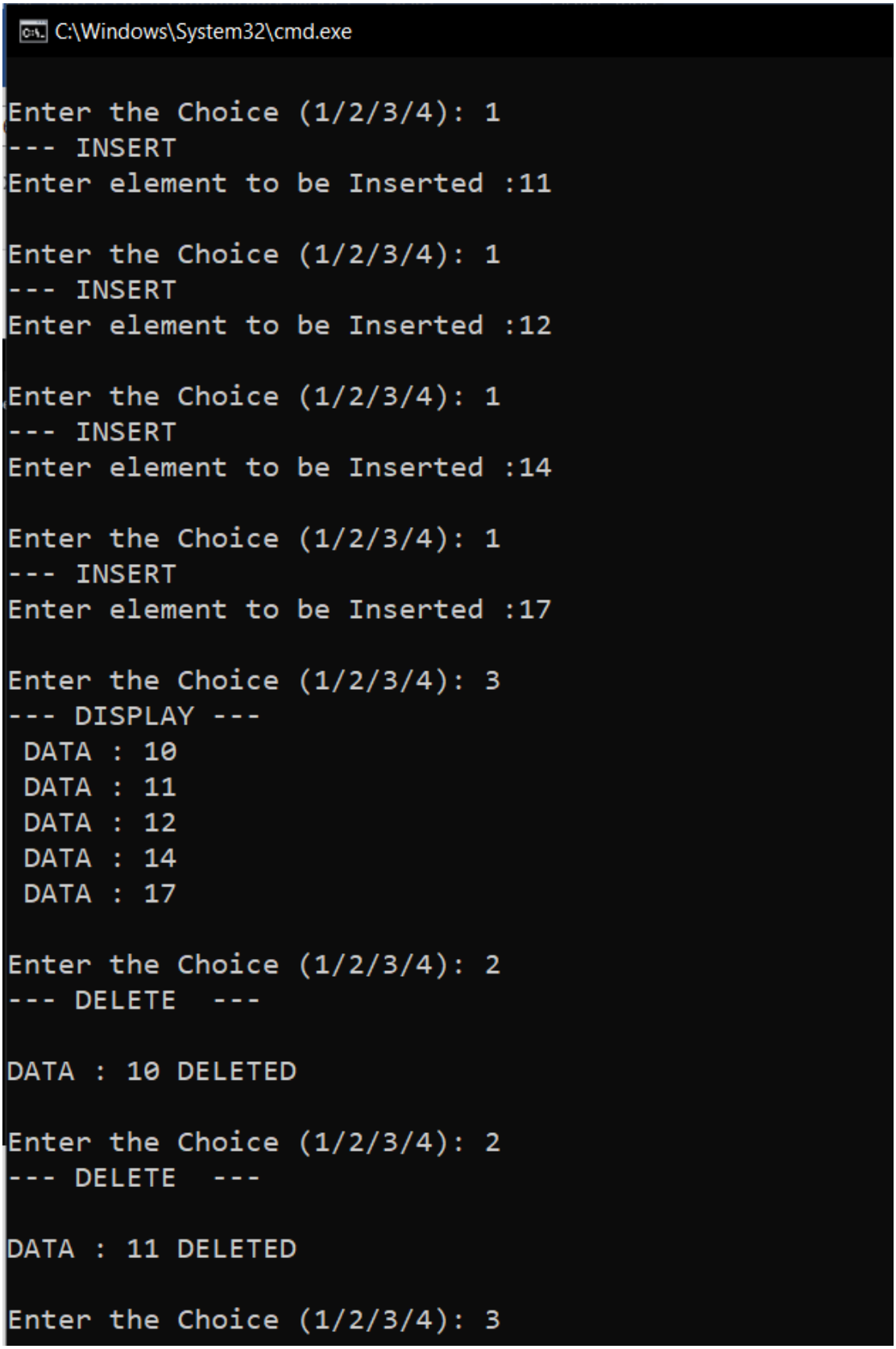
**PROGRAM:**

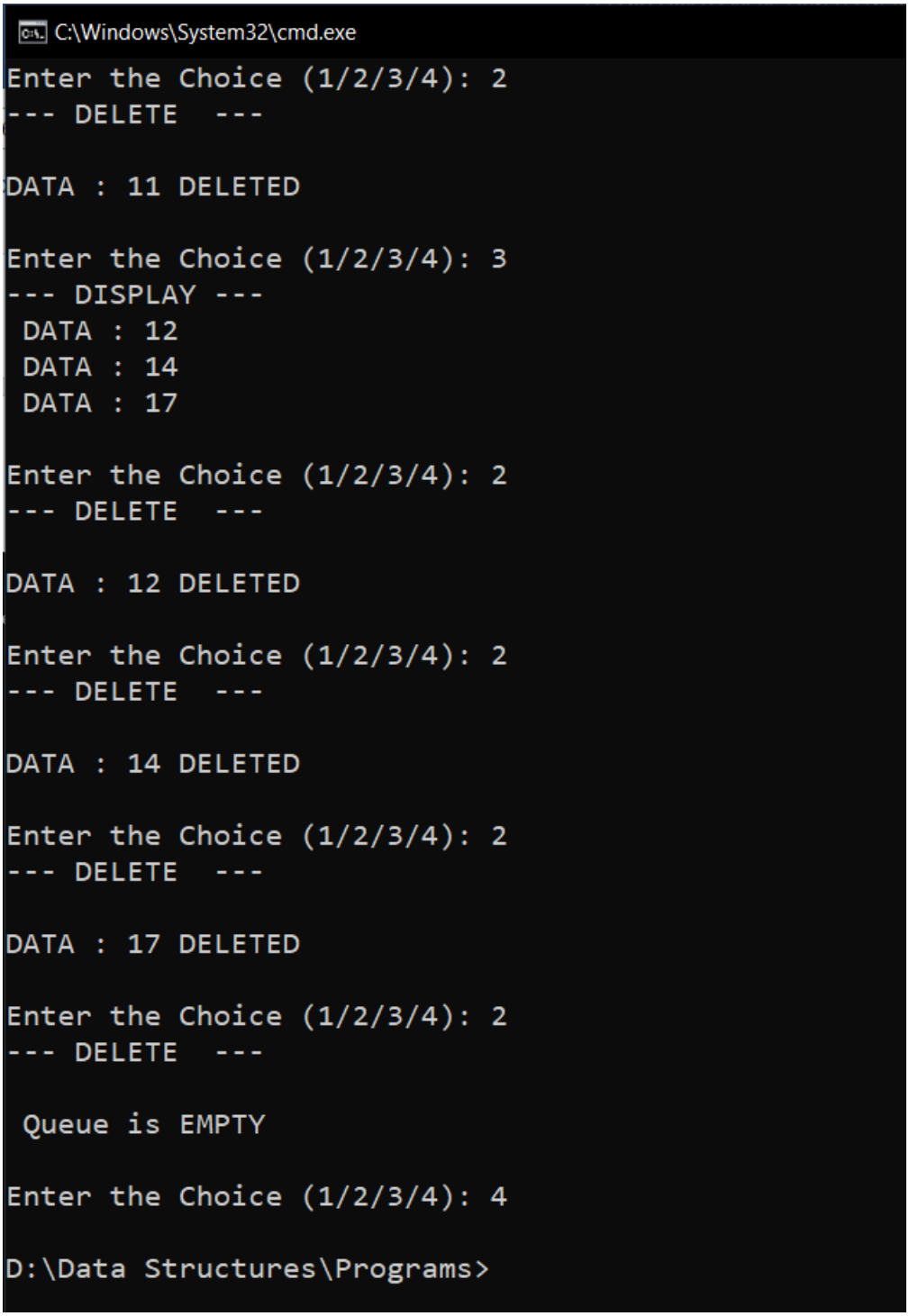
```
#include<stdio.h>
#include<stdlib.h>
struct node{
   int data;
   struct node *link;
};

void insert(struct node* front,struct node* rear,int x){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   new->data=x;
   new->link=NULL;
   if(new==NULL){
      printf("\nMEMORY Underflow\n");
   }else{
      if(front->link==NULL){
         front->link=new;
         rear->link=new;
      }else{
         rear->link->link=new;
         rear->link=new;
      }
   }
}
void delete(struct node* front,struct node* rear){
    struct node* ptr=front->link;
     if(ptr==NULL){
      printf("\n Queue is EMPTY\n");
    }else{
        front->link=ptr->link;
        printf("\nDATA : %d DELETED\n",ptr->data);
        free(ptr);
     }
}
void display(struct node* front,struct node* rear){
   struct node* ptr=front;
   while(ptr->link!=NULL){
      ptr=ptr->link;
      printf(" DATA : %d\n",ptr->data);
   }
}

void main(){
 int n,x,y;
 char ans='y';
 struct node* front = (struct node*)malloc(sizeof(struct node));
 struct node* rear = (struct node*)malloc(sizeof(struct node));
```

```
front->link=NULL;
rear->link=NULL;
printf("\n--- OPERATION ON QUEUE --- \n\n");
printf(" 1. INSERT \n");
printf(" 2. DELETE \n");
printf(" 3. DISPLAY\n");
printf(" 4. EXIT\n");
while(ans=='y'){
   printf("\nEnter the Choice (1/2/3/4): ");
   scanf("%d",&n);
   switch(n){
      case 1:printf("--- INSERT \n");
            printf("Enter element to be Inserted :");
            scanf("%d", &x);
            insert(front,rear,x);
            break;
      case 2:printf("--- DELETE  ---\n");
            delete(front,rear);
            break;
      case 3:printf("--- DISPLAY ---\n");
            display(front,rear);
            break;
      case 4:ans='n';
            break;
     default:printf("Enter a Valid Input\n");
   }
 }
}
```

**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>QueueLinkedList
--- OPERATION ON QUEUE ---
1. INSERT
2. DELETE
3. DISPLAY
4. EXIT
Enter the Choice (1/2/3/4): 2
--- DELETE ---
Queue is EMPTY
Enter the Choice (1/2/3/4): 1
--- INSERT
Enter element to be Inserted :12
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
DATA : 12
Enter the Choice (1/2/3/4): 2
--- DELETE ---
DATA : 12 DELETED
Enter the Choice (1/2/3/4): 2
--- DELETE ---
Queue is EMPTY
Enter the Choice (1/2/3/4): 1
--- INSERT
Enter element to be Inserted :10


C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4): 1
--- INSERT
Enter element to be Inserted :11
Enter the Choice (1/2/3/4): 1
--- INSERT
Enter element to be Inserted :12
Enter the Choice (1/2/3/4): 1
--- INSERT
Enter element to be Inserted :14
Enter the Choice (1/2/3/4): 1
--- INSERT
Enter element to be Inserted :17
Enter the Choice (1/2/3/4): 3
--- DISPLAY ---
DATA : 10
DATA : 11
DATA : 12
DATA : 14
DATA : 17
Enter the Choice (1/2/3/4): 2
--- DELETE ---
DATA : 10 DELETED
Enter the Choice (1/2/3/4): 2
--- DELETE ---
DATA : 11 DELETED
Enter the Choice (1/2/3/4): 3




**RESULT:**

The given operations are performed on a Queue implemented using linked list.

Time complexity of INSERT() operation is O(1).

Time complexity of DELETE() operation is O(1).

20/11/2020

## Experiment No: 15

# POLYNOMIAL USING LINKED LISTS

### AIM:

Write a program to read two polynomials and store them using linked list. Calculate the sum and product and display the first polynomial, second polynomial and the resultant polynomial.

### DATA STRUCTURES USED:

Linked List

### ALGORITHM:

Algorithm POLYNOMIAL_ADDITION()

1. Pptr =PHEADER->LINK
2. Qptr=QHEADER->LINK
3. RHEADER=GetNode(NODE)
4. RHEADER->LINK=NULL
5. RHEADER->Coeff=NULL
6. RHEADER->Exp=NULL
7. Rptr=RHEADER
8. While(Pptr!=NULL and Qptr!=NULL)
9. Case : Pptr->Exp=Qptr->Exp
10. new=GetNode(NODE)
11. Rptr->LINK=new
12. Rptr=new
13. Rptr->Coeff=Pptr->Coeff+Qptr->Coeff
14. Rptr->Exp=Pptr->Exp
15. Rptr->LINK=NULL
16. Pptr=Pptr->LINK
17. Qptr=Qptr->LINK
18. Case : Pptr->Exp>Qptr->Exp
19. new=GetNode(NODE)
20. Rptr->LINK=new
21. Rptr=new
22. Rptr->Coeff=Pptr->Coeff
23. Rptr->Exp=Pptr->Exp
24. Rptr->LINK=NULL
25. Pptr=Pptr->LINK
26. Case : Pptr->Exp<Qptr->Exp
27. new=GetNode(NODE)
28. Rptr->LINK=new

```
29.             Rptr=new
30.             Rptr->Coeff=Qptr->Coeff
31.             Rptr->Exp=Qptr->Exp
32.             Rptr->LINK=NULL
33.             Qptr=Qptr->LINK
34. EndWhile
35. If(Pptr!=NULL and Qptr=NULL)
36.     While(Pptr!=NULL)
37.             new=GetNode(NODE)
38.             Rptr->LINK=new
39.             Rptr=new
40.             Rptr->Coeff=Pptr->Coeff
41.             Rptr->Exp=Pptr->Exp
42.             Rptr->LINK=NULL
43.             Pptr=Pptr->LINK
44.     EndWhile
45. EndIf
46. If(Pptr=NULL and Qptr!=NULL)
47.     While(Qptr!=NULL)
48.             new=GetNode(NODE)
49.             Rptr->LINK=new
50.             Rptr=new
51.             Rptr->Coeff=Qptr->Coeff
52.             Rptr->Exp=Qptr->Exp
53.             Rptr->LINK=NULL
54.             Qptr=Qptr->LINK
55.     EndWhile
56. EndIf
```

Algorithm POLYNOMIAL_MULTIPLICATION()

```
1.  Pptr =PHEADER->LINK
2.  Qptr=QHEADER->LINK
3.  RHEADER=GetNode(NODE)
4.  RHEADER->LINK=NULL
5.  RHEADER->Coeff=NULL
6.  RHEADER->Exp=NULL
7.  If(Pptr!=NULL and Qptr=NULL)
8.      While(Pptr!=NULL)
9.              new=GetNode(NODE)
10.             Rptr->LINK=new
11.             Rptr=new
12.             Rptr->Coeff=Pptr->Coeff
13.             Rptr->Exp=Pptr->Exp
14.             Rptr->LINK=NULL
15.             Pptr=Pptr->LINK
16.     EndWhile
17. Else If(Pptr=NULL and Qptr!=NULL)
```

```
18.      While(Qptr!=NULL)
19.              new=GetNode(NODE)
20.              Rptr->LINK=new
21.              Rptr=new
22.              Rptr->Coeff=Qptr->Coeff
23.              Rptr->Exp=Qptr->Exp
24.              Rptr->LINK=NULL
25.              Qptr=Qptr->LINK
26.      EndWhile
27. Else
28.     While(Pptr!=NULL)
29.          Qptr=QHEADER->LINK
30.              While(Qptr!=NULL)
31.                   new=GetNode(NODE)
32.                   Rptr->LINK=new
33.                   Rptr=new
34.                   Rptr->Coeff=Pptr->Coeff*Qptr->Coeff
35.                   Rptr->Exp=Pptr->Exp+Qptr->Exp
36.                   Rptr->LINK=NULL
37.                   Qptr=Qptr->LINK
38.              EndWhile
39.         Pptr=Pptr->LINK
40.     EndWhile
41. EndIf
42. SORT() //Sort According To Exp and Combine the Add Coeff of same Exp
```

**PROGRAM:**

```
#include<stdio.h>
#include<stdlib.h>
struct node{
   int coeff;
   int exp;
   struct node *link;
};

void insert(struct node* header){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   printf(" Exponent : ");
   scanf("%d",&new->exp);
   printf(" Coefficient for Exponent : ");
   scanf("%d",&new->coeff);
   new->link=NULL;
   if(new==NULL){
      printf("\nMEMORY Underflow\n");
   }else{
      if(header->link==NULL){
         header->link=new;
```

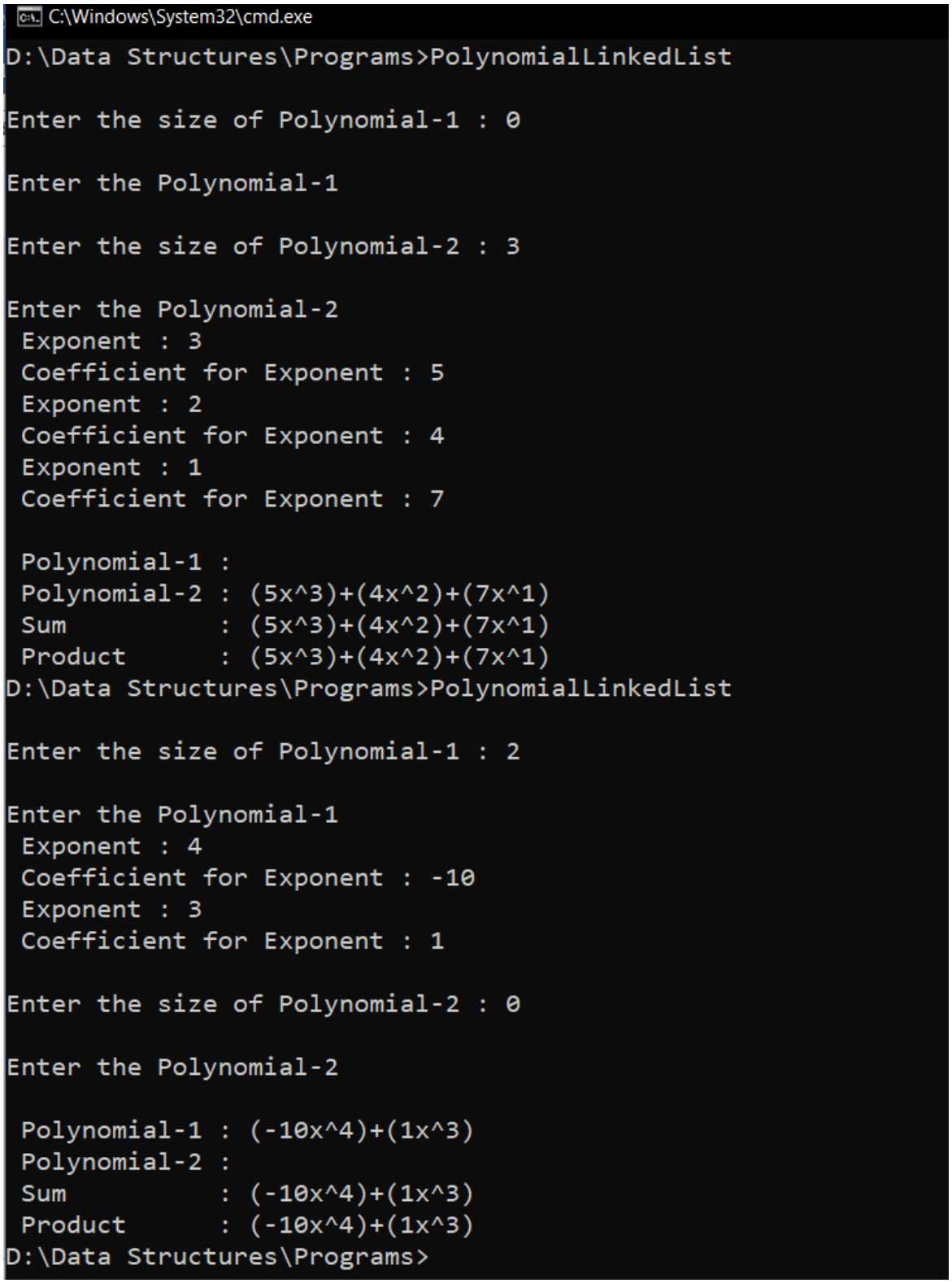
```
        }else{
            struct node* ptr=header;
            while(ptr->link!=NULL){
                ptr=ptr->link;
            }
            ptr->link=new;
        }
    }
}
void sum(struct node* header1,struct node* header2,struct node* header3){
    struct node* ptr1=header1->link;
    struct node* ptr2=header2->link;
    struct node* ptr3=header3;
    while(ptr1!=NULL && ptr2!=NULL){
        if(ptr1->exp==ptr2->exp){
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr3->link=new;
            ptr3=new;
            ptr3->coeff=ptr1->coeff+ptr2->coeff;
            ptr3->exp=ptr1->exp;
            ptr3->link=NULL;
            ptr1=ptr1->link;
            ptr2=ptr2->link;
        }else if(ptr1->exp>ptr2->exp){
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr3->link=new;
            ptr3=new;
            ptr3->coeff=ptr1->coeff;
            ptr3->exp=ptr1->exp;
            ptr3->link=NULL;
            ptr1=ptr1->link;
        }else{
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr3->link=new;
            ptr3=new;
            ptr3->coeff=ptr2->coeff;
            ptr3->exp=ptr2->exp;
            ptr3->link=NULL;
            ptr2=ptr2->link;
        }
    }
    if(ptr1!=NULL && ptr2==NULL){
        while(ptr1!=NULL){
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr3->link=new;
            ptr3=new;
            ptr3->coeff=ptr1->coeff;
```

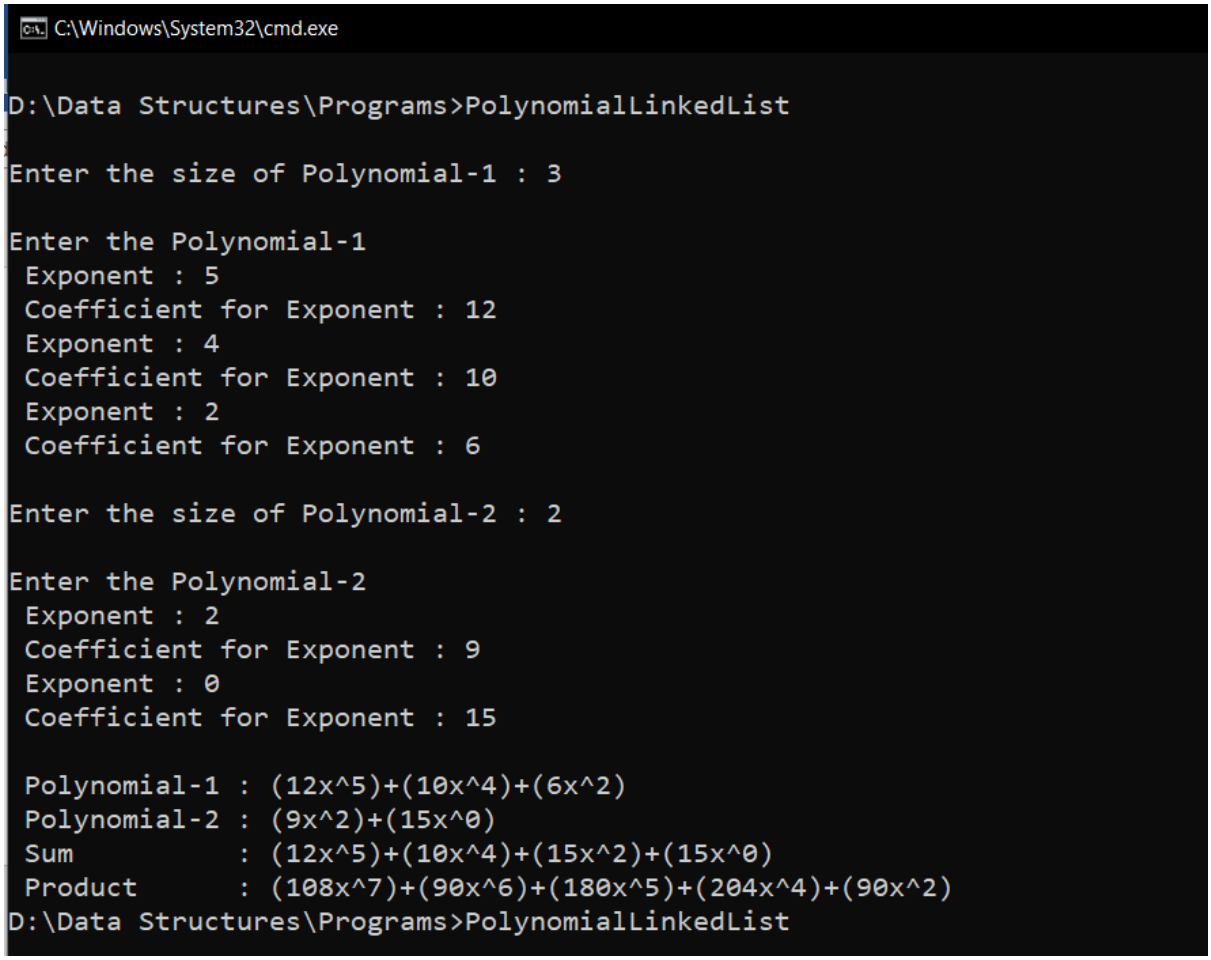
```
            ptr3->exp=ptr1->exp;
            ptr3->link=NULL;
            ptr1=ptr1->link;
        }
    }
    if(ptr1==NULL && ptr2!=NULL){
        while(ptr2!=NULL){
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr3->link=new;
            ptr3=new;
            ptr3->coeff=ptr2->coeff;
            ptr3->exp=ptr2->exp;
            ptr3->link=NULL;
            ptr2=ptr2->link;
        }
    }
}
void product(struct node* header1,struct node* header2,struct node* header4){
    struct node* ptr1=header1->link;
    struct node* ptr2=header2->link;
    struct node* ptr4=header4;
    if(ptr1==NULL && ptr2!=NULL){
        while(ptr2!=NULL){
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr4->link=new;
            ptr4=new;
            ptr4->coeff=ptr2->coeff;
            ptr4->exp=ptr2->exp;
            ptr4->link=NULL;
            ptr2=ptr2->link;
        }
    }else if(ptr1!=NULL && ptr2==NULL){
        while(ptr1!=NULL){
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr4->link=new;
            ptr4=new;
            ptr4->coeff=ptr1->coeff;
            ptr4->exp=ptr1->exp;
            ptr4->link=NULL;
            ptr1=ptr1->link;
        }
    }else{
        while(ptr1!=NULL){
        ptr2=header2->link;
        while(ptr2!=NULL){
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr4->link=new;
```

```
            ptr4=new;
            ptr4->coeff=ptr1->coeff*ptr2->coeff;
            ptr4->exp=ptr1->exp+ptr2->exp;
            ptr4->link=NULL;
            ptr2=ptr2->link;
        }
        ptr1=ptr1->link;
    }
    }
}
void sort(struct node* header,struct node* header5){
    struct node* ptr=header->link;
    struct node* ptr1=header->link;
    struct node* ptr5=header5;
    int exp,coeff;
    if(ptr==NULL){
    }else if(ptr->link==NULL){
    }else{
        while(ptr1->link!=NULL){
            ptr=header->link;
            while(ptr->link!=NULL){
                if(ptr->exp < ptr->link->exp){
                    exp=ptr->exp;
                    coeff=ptr->coeff;
                    ptr->exp=ptr->link->exp;
                    ptr->coeff=ptr->link->coeff;
                    ptr->link->exp=exp;
                    ptr->link->coeff=coeff;
                }
                ptr=ptr->link;
            }
            ptr1=ptr1->link;
        }
    }
    ptr=header->link;
    while(ptr!=NULL){
        if(ptr5->exp==ptr->exp){
            ptr5->coeff=ptr5->coeff+ptr->coeff;
            ptr5->exp=ptr->exp;
            ptr=ptr->link;
        }else{
            struct node* new = (struct node*)malloc(sizeof(struct node));
            ptr5->link=new;
            ptr5=new;
            ptr5->coeff=ptr->coeff;
            ptr5->exp=ptr->exp;
            ptr5->link=NULL;
```

```
            ptr=ptr->link;
        }
    }

}
void display(struct node* header){
    struct node* ptr=header;
    while(ptr->link!=NULL){
        ptr=ptr->link;
        printf("(%dx^%d)",ptr->coeff,ptr->exp);
        if(ptr->link!=NULL){
            printf("+");
         }
    }
}

void main(){
 int n1,n2,i;
 struct node* header1 = (struct node*)malloc(sizeof(struct node));
 header1->link=NULL;
 struct node* header2 = (struct node*)malloc(sizeof(struct node));
 header2->link=NULL;
 struct node* header3 = (struct node*)malloc(sizeof(struct node));
 header3->link=NULL;
 struct node* header4 = (struct node*)malloc(sizeof(struct node));
 header4->link=NULL;
 struct node* header5 = (struct node*)malloc(sizeof(struct node));
 header5->link=NULL;
 printf("\nEnter the size of Polynomial-1 : ");
 scanf("%d",&n1);
 printf("\nEnter the Polynomial-1 \n");
 for(i=0;i<n1;i++){
    insert(header1);
 }
 printf("\nEnter the size of Polynomial-2 : ");
 scanf("%d",&n2);
 printf("\nEnter the Polynomial-2 \n");
 for(i=0;i<n2;i++){
    insert(header2);
 }
 sum(header1,header2,header3);
 product(header1,header2,header4);
 printf("\n Polynomial-1 : ");display(header1);
 printf("\n Polynomial-2 : ");display(header2);
 printf("\n Sum          : ");display(header3);
 printf("\n Product      : ");sort(header4,header5);display(header5);
}
```

**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>PolynomialLinkedList
Enter the size of Polynomial-1 : 0
Enter the Polynomial-1
Enter the size of Polynomial-2 : 3
Enter the Polynomial-2
Exponent : 3
Coefficient for Exponent : 5
Exponent : 2
Coefficient for Exponent : 4
Exponent : 1
Coefficient for Exponent : 7
Polynomial-1 :
Polynomial-2 : (5x^3)+(4x^2)+(7x^1)
Sum : (5x^3)+(4x^2)+(7x^1)
Product : (5x^3)+(4x^2)+(7x^1)
D:\Data Structures\Programs>PolynomialLinkedList
Enter the size of Polynomial-1 : 2
Enter the Polynomial-1
Exponent : 4
Coefficient for Exponent : -10
Exponent : 3
Coefficient for Exponent : 1
Enter the size of Polynomial-2 : 0
Enter the Polynomial-2
Polynomial-1 : (-10x^4)+(1x^3)
Polynomial-2 :
Sum : (-10x^4)+(1x^3)
Product : (-10x^4)+(1x^3)
D:\Data Structures\Programs>




**RESULT:**

Two polynomials are stored using linked list. Both are displayed along with their sum and product.

22/11/2020

## Experiment No:16

# STUDENT LINKED LISTS

### AIM:

The details of Student (Roll Number, Name, Total-Mark) are to be stored in a linked list. Write functions for the following operations:

1.Insert
2.Delete
3.Search
4.Sort on the basis of Roll Number.
5.Display the resultant list after every operation.

### DATA STRUCTURES USED:

Linked List

### ALGORITHM:

Algorithm INSERT ()

30. new= GetNode(Node)
31. //Input the details and Initialize it to the node
32. if (new = NULL) then
33. print"memory underflow"
34. Exit
35. Else
36. ptr=HEADER
37. While(ptr-> LINK!=NULL)do
38. ptr=ptr->LINK
39. Endwhile
40. ptr->LINK= new
41. new->LINK=NULL
42. Stop

Algorithm DELETE(KEY)

17. ptr1=HEADER
18. ptr=ptr1->LINK
19. while(ptr!=NULL)
20. if(ptr->rollno!= KEY)
21. ptr1=ptr
22. ptr=ptr->LINK

23. else
24. ptr1->LINK=ptr->LINK
25. ReturnNode(ptr)
26. Exit
27. Endif
28. Endwhile
29. If ptr=NULL
30. Print"Roll No Searched doesn't exist"
31. Endif
32. Stop

Algorithm SEARCH(KEY)

1. ptr=HEADER->LINK
2. while(ptr!=NULL)
3. if(ptr->rollno!= KEY)
4. // Display the Details of the Node
5. Endif
6. Endwhile
7. If (ptr=NULL)
8. Print"Node with key doesn't exist"
9. Endif
10. Stop

Algorithm SORT()

1. ptr1=HEADER->LINK
2. ptr2=HEADER->LINK
3. while(ptr1->LINK!=NULL)
4. ptr2=HEADER->LINK
5. while(ptr1->LINK!=NULL)
6. If(ptr2->rollno> ptr2->LINK->rollno)
7. // Interchange the Values in NODE ptr2 and ptr2->LINK
8. EndIf
9. EndWhile
10. EndWhile

**PROGRAM:**

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
struct node{
  int rollno;
  char name[50];
  float marks;
  struct node *link;
};
```

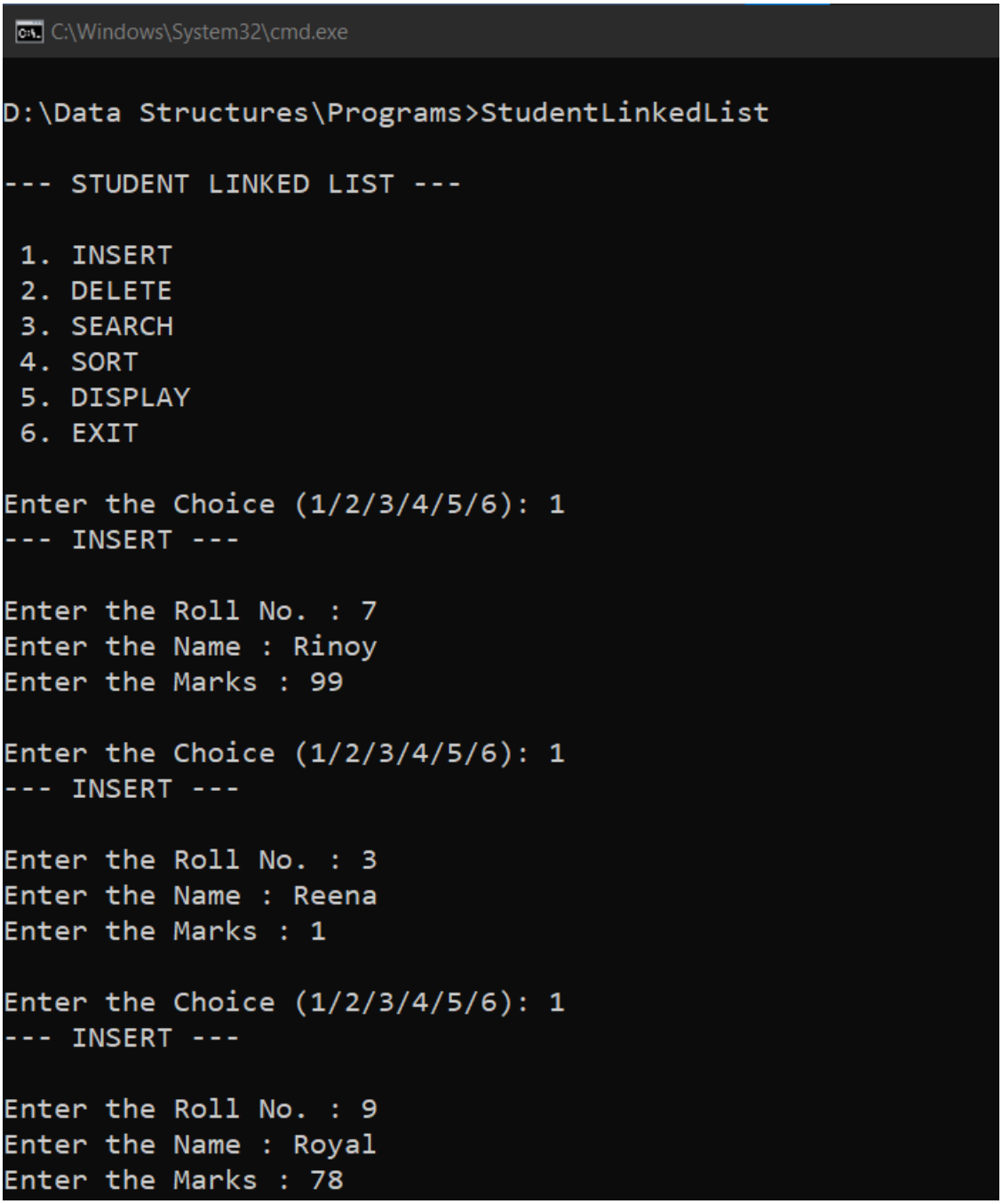
```
void insert(struct node* header){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   printf("\nEnter the Roll No. : ");
   scanf("%d",&new->rollno);
   printf("Enter the Name : ");
   scanf("%s",new->name);
   printf("Enter the Marks : ");
   scanf("%f",&new->marks);
   new->link=NULL;
   if(new==NULL){
      printf("\nMemory Underflow\n");
   }else{
      if(header->link==NULL){
         header->link=new;
      }else{
         struct node* ptr=header;
         while(ptr->link!=NULL){
            ptr=ptr->link;
         }
         ptr->link=new;
      }
   }
}

void delete(struct node* header,int key){
    struct node* ptr1=header;
    struct node* ptr=ptr1->link;
    if(ptr==NULL){
      printf("\n List is Empty\n");
    }else{
      while(ptr->rollno!=key && ptr->link!=NULL){
         ptr1=ptr;
         ptr=ptr->link;
       }
     if(ptr->rollno==key){
       ptr1->link=ptr->link;
       printf("\n--- DELETED ---\n\n");
       printf(" Roll No.    : %d\n",ptr->rollno);
       printf(" Name        : %s\n",ptr->name);
       printf(" Total Marks : %f\n",ptr->marks);
       free(ptr);
     }else{
        printf("\nRoll No. Not Found\n");
     }
    }
}
```

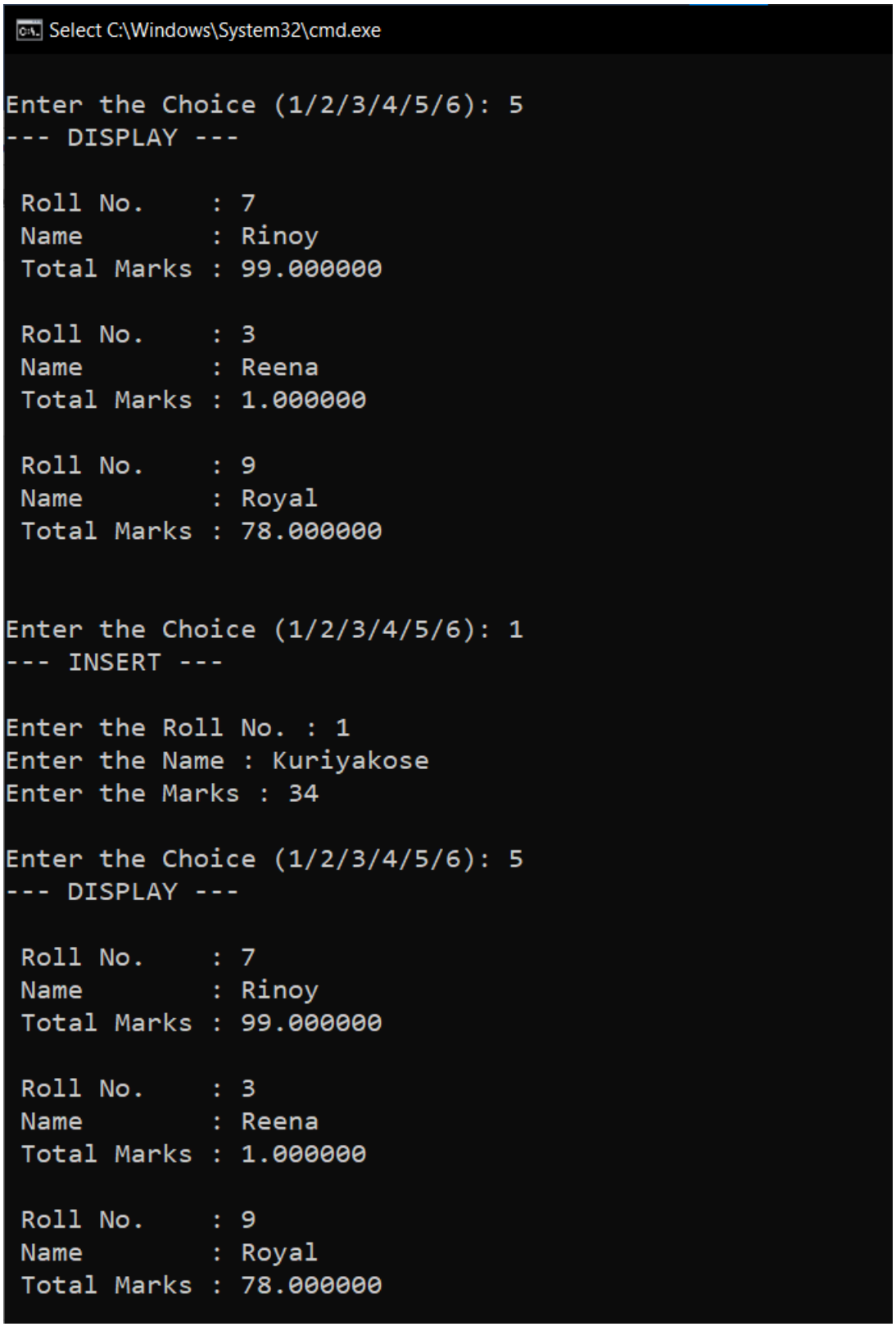
```
void search(struct node* header,int key){
   struct node* ptr=header->link;
   if(ptr==NULL){
      printf("\n List is Empty\n");
   }else{
      while(ptr->rollno!=key && ptr->link!=NULL){
         ptr=ptr->link;
      }
      if(ptr->rollno==key){
       printf("\n--- SEARCH ---\n\n");
       printf(" Roll No.    : %d\n",ptr->rollno);
       printf(" Name        : %s\n",ptr->name);
       printf(" Total Marks : %f\n",ptr->marks);
      }else{
        printf("\nRoll No. Not Found\n");
      }
   }
}
void sort(struct node* header){
   struct node* ptr=header->link;
   struct node* ptr1=header->link;
   int rollno;
   char name[50];
   float marks;
   if(ptr==NULL){
      printf("\n List is Empty\n");
   }else if(ptr->link==NULL){
      printf("\n List has only One Element\n");
   }else{
      while(ptr1->link!=NULL){
         ptr=header->link;
         while(ptr->link!=NULL){
            if(ptr->rollno > ptr->link->rollno){
               rollno=ptr->rollno;
               strcpy(name,ptr->name);
               marks=ptr->marks;
               ptr->rollno=ptr->link->rollno;
               strcpy(ptr->name,ptr->link->name);
               ptr->marks=ptr->link->marks;
               ptr->link->rollno=rollno;
               strcpy(ptr->link->name,name);
               ptr->link->marks=marks;
            }
            ptr=ptr->link;
         }
         ptr1=ptr1->link;
```

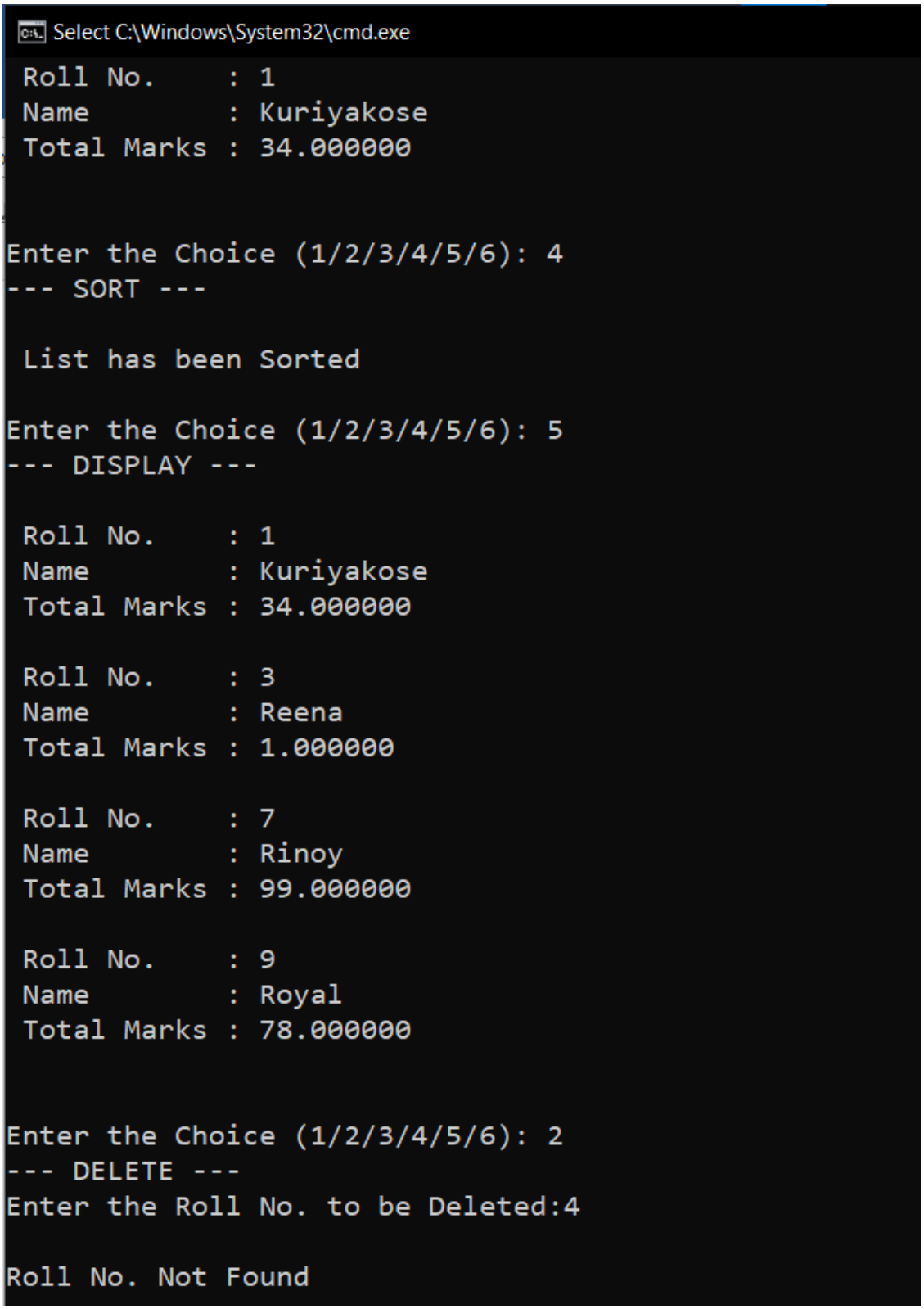
```
        }
        printf("\n List has been Sorted\n");
    }
}
void display(struct node* header){
    printf("\n");
    struct node* ptr=header;
    while(ptr->link!=NULL){
        ptr=ptr->link;
        printf(" Roll No.    : %d\n",ptr->rollno);
        printf(" Name        : %s\n",ptr->name);
        printf(" Total Marks : %f\n\n",ptr->marks);
    }
}

void main(){
 int n,x,y,key;
 char ans='y';
 struct node* header = (struct node*)malloc(sizeof(struct node));
 header->link=NULL;
 printf("\n--- STUDENT LINKED LIST --- \n\n");
 printf(" 1. INSERT  \n");
 printf(" 2. DELETE \n");
 printf(" 3. SEARCH \n");
 printf(" 4. SORT \n");
 printf(" 5. DISPLAY\n");
 printf(" 6. EXIT\n");
 while(ans=='y'){
    printf("\nEnter the Choice (1/2/3/4/5/6): ");
    scanf("%d",&n);
    switch(n){
        case 1:printf("--- INSERT ---\n");
               insert(header);
               break;
        case 2:printf("--- DELETE ---\n");
               printf("Enter the Roll No. to be Deleted:");
               scanf("%d", &key);
               delete(header,key);
               break;
        case 3:printf("--- SEARCH ---\n");
               printf("Enter the Roll No. to be Searched :");
               scanf("%d", &key);
               search(header,key);
               break;
        case 4:printf("--- SORT ---\n");
               sort(header);
               break;
```

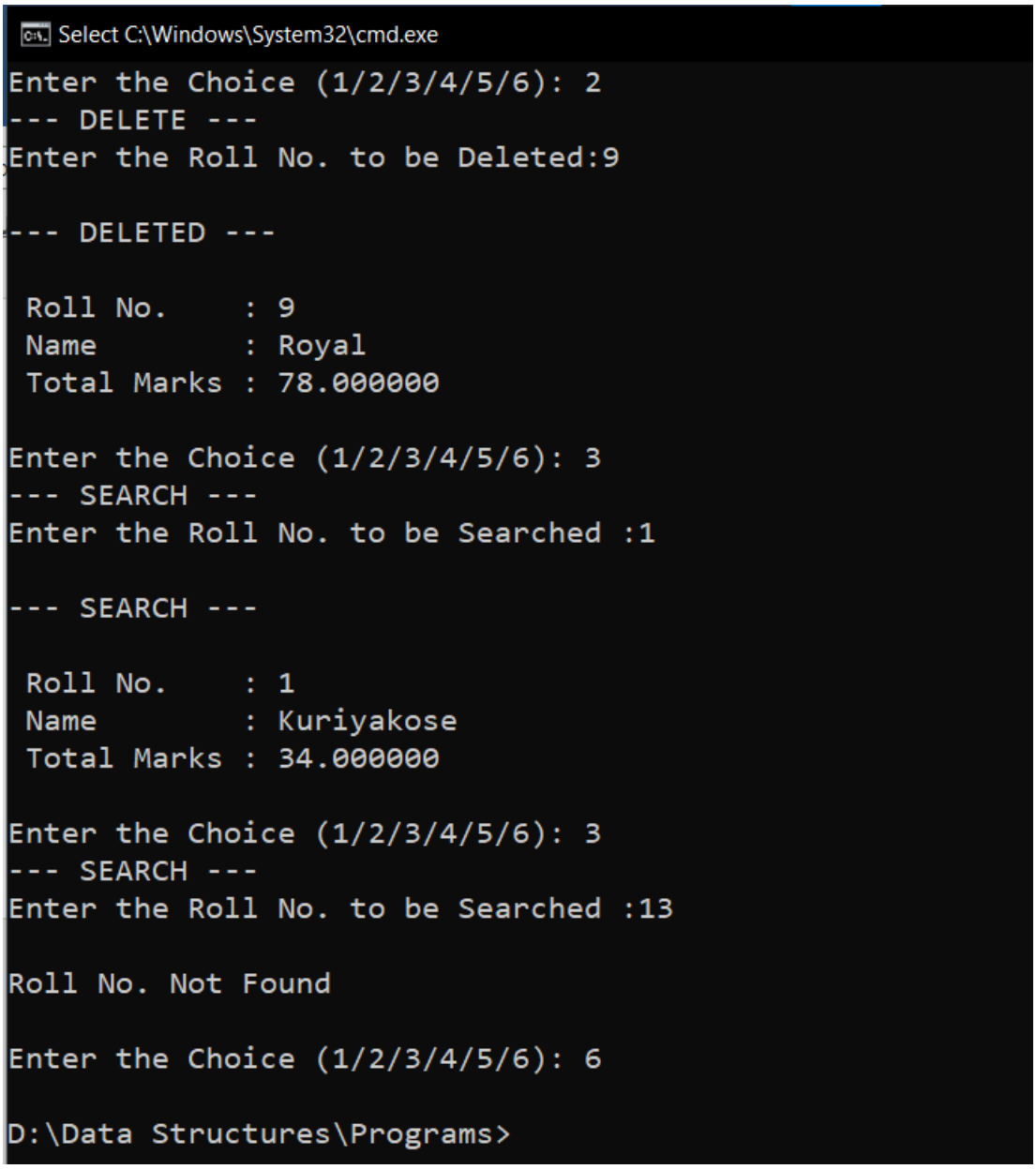
```
        case 5:printf("--- DISPLAY ---\n");
               display(header);
               break;
        case 6:ans='n';
               break;
       default:printf("Enter a Valid Input\n");
     }
  }
}
```

**OUTPUT:**




Select C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---
Roll No. : 7
Name : Rinoy
Total Marks : 99.000000
Roll No. : 3
Name : Reena
Total Marks : 1.000000
Roll No. : 9
Name : Royal
Total Marks : 78.000000
Enter the Choice (1/2/3/4/5/6): 1
--- INSERT ---
Enter the Roll No. : 1
Enter the Name : Kuriyakose
Enter the Marks : 34
Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---
Roll No. : 7
Name : Rinoy
Total Marks : 99.000000
Roll No. : 3
Name : Reena
Total Marks : 1.000000
Roll No. : 9
Name : Royal
Total Marks : 78.000000


Select C:\Windows\System32\cmd.exe
Roll No. : 1
Name : Kuriyakose
Total Marks : 34.000000
Enter the Choice (1/2/3/4/5/6): 4
--- SORT ---
List has been Sorted
Enter the Choice (1/2/3/4/5/6): 5
--- DISPLAY ---
Roll No. : 1
Name : Kuriyakose
Total Marks : 34.000000
Roll No. : 3
Name : Reena
Total Marks : 1.000000
Roll No. : 7
Name : Rinoy
Total Marks : 99.000000
Roll No. : 9
Name : Royal
Total Marks : 78.000000
Enter the Choice (1/2/3/4/5/6): 2
--- DELETE ---
Enter the Roll No. to be Deleted:4
Roll No. Not Found




**RESULT:**

The given operations are performed on a Student linked list.

22/11/2020

## Experiment No:17

# DOUBLY LINKED LISTS

**AIM**:

Create a Doubly Linked List from a string taking each character from the string. Check if the given string is palindrome in an efficient method.

## DATA STRUCTURES USED:

Doubly Linked List

## ALGORITHM:

Algorithm INSERT(ITEM)

43. new= GetNodes(Node)
44. new->DATA=ITEM
45. new->lLINK=NULL
46. new->rLINK=NULL
47. if (new = NULL) then
48. print”memory underflow”
49. Exit
50. Else
51. If (FRONT->rLINK=NULL)
52. FRONT->rLINK=new
53. REAR->lLINK=new
54. new->lLINK=FRONT
55. new->rLINK=REAR
56. else
57. REAR->lLINK->rLINK= new
58. REAR->lLINK=new
59. new->lLINK=REAR->lLINK
60. new->rLINK=REAR
61. EndIf
62. EndIf
63. Stop

Algorithm CHECK_PALINDROME()

1. ptr1=FRONT
2. ptr2=REAR
3. while(ptr1!=ptr2)

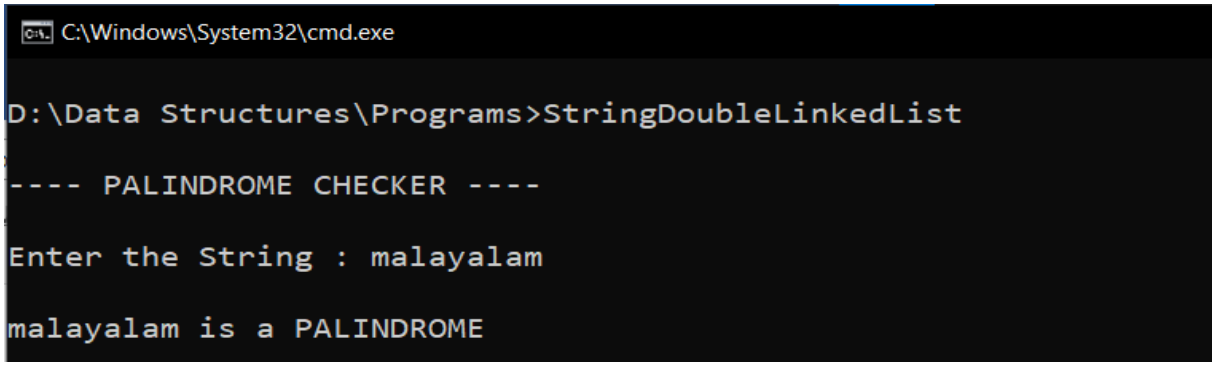
4. if(ptr1->DATA!=ptr2->DATA)
5. Return 0
6. EndIf
7. Ptr1=ptr1->lLINK
8. Ptr2=ptr2->lLINK
9. EndWhile
10. Return 1

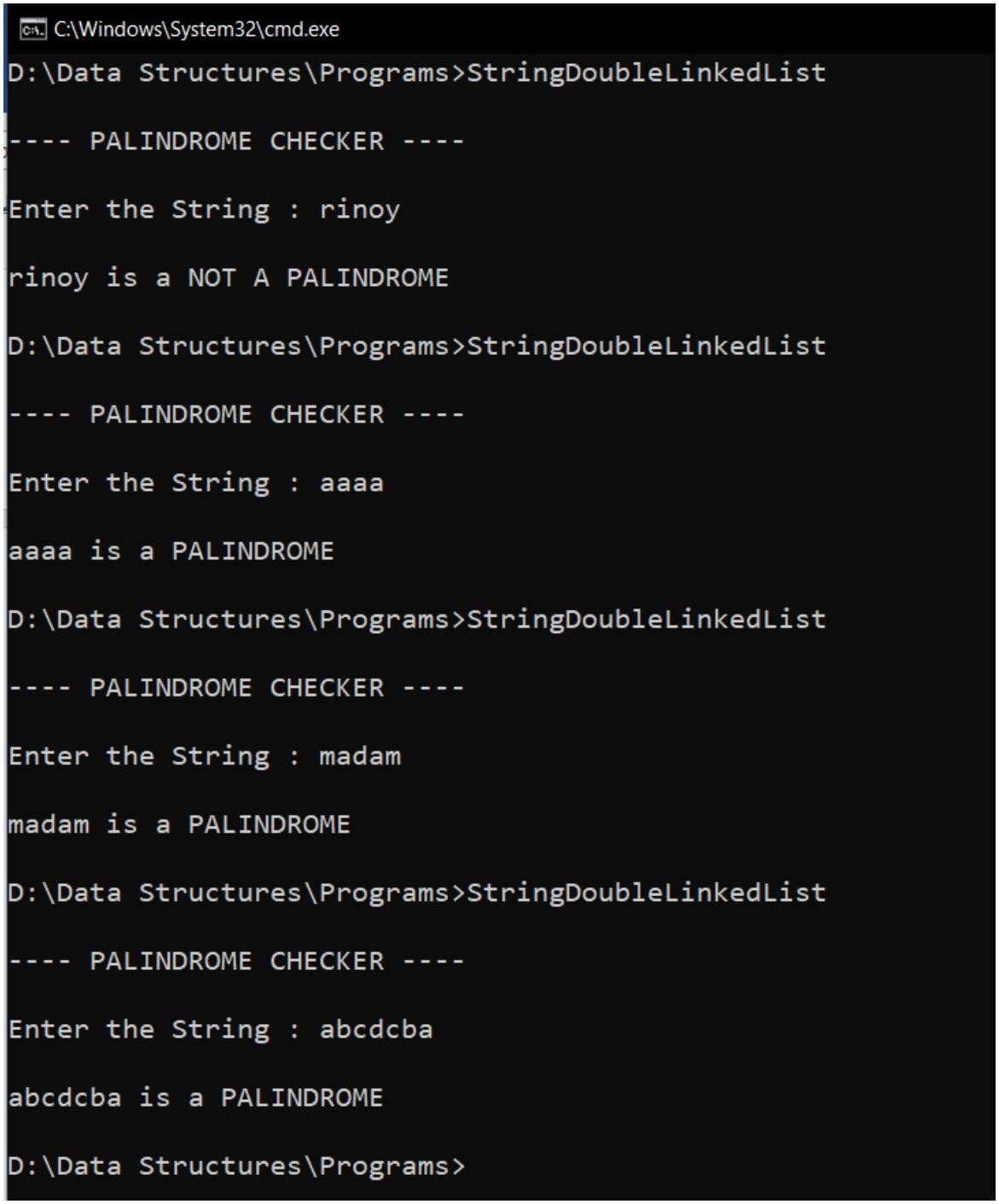
**PROGRAM:**

```
#include<stdio.h>
#include<stdlib.h>
struct node{
   char data;
   struct node *rlink;
   struct node *llink;
};

void insert(struct node* front,struct node* rear,char x){
   struct node* new = (struct node*)malloc(sizeof(struct node));
   new->data=x;
   new->rlink=NULL;
   new->llink=NULL;
   if(new==NULL){
      printf("\nMEMORY Underflow\n");
   }else{
      if(front->rlink==NULL){
         front->rlink=new;
         new->llink=front;
         rear->llink=new;
         new->rlink=rear;
      }else{
         new->llink=rear->llink;
         rear->llink->rlink=new;
         new->rlink=rear;
         rear->llink=new;
      }
   }
}


int check_palindrome(struct node* front,struct node* rear){
   struct node* ptr1=front;
   struct node* ptr2=rear;
   while(ptr1!=ptr2){
      if(ptr1->data!=ptr2->data){
         return 0;
      }
```

```
      ptr1=ptr1->rlink;
      ptr2=ptr2->llink;
   }
   return 1;
}

void main(){
 char string[50],*arr;
 struct node* front = (struct node*)malloc(sizeof(struct node));
 struct node* rear = (struct node*)malloc(sizeof(struct node));
 front->rlink=NULL;
 front->llink=NULL;
 rear->rlink=NULL;
 rear->llink=NULL;
 printf("\n---- PALINDROME CHECKER ----\n");
 printf("\nEnter the String : ");
 scanf("%s",string);
 arr=string;
   while(*arr!='\0'){
    insert(front,rear,*arr);
    arr++;
   }
 if(check_palindrome(front,rear)){
    printf("\n%s is a PALINDROME \n",string);
 }else{
    printf("\n%s is a NOT A PALINDROME \n",string);
 }
 }
```

**OUTPUT:**






**RESULT:**

The given string was checked for palindromes using Doubly Linked List.

02/01/2021

## Experiment No:18

# BINARY TREE

### AIM:

Create a Binary tree with the following operations:

1. Insert a new node.
2. Inorder traversal.
3. Preorder traversal.
4. Postorder traversal.
5. Delete a node.

### DATA STRUCTURES USED:

Tree using Linked List

### ALGORITHM:

```
Algorithm build_tree(root)
//ptr=root
1. If ptr != NULL
2.     ptr->DATA=item
3.     Read option if Node has a left child
4.     If opion = yes
5.         ptr->LC = GetNode(NODE)
6.         build_tree(ptr->LC)
7.     Else
8.         ptr->LC = NULL
9.     Endif
10.    Read option if Node has a right child
11.    If option = yes
12.        ptr->RC = GetNode(NODE)
13.        build_tree(ptr->RC)
14.    Else
15.        ptr->RC = NULL
16.    Endif
17. Endif

Algorithm search_link(ptr, KEY)

1. If ptr->DATA != KEY
```

```
2.      If ptr->LC != NULL
3.           ptr1 = SearchLink(ptr->LC, KEY)
4.           If ptr1 != NULL
5.               Return ptr1
6.           Endif
7.     Endif
8.     If ptr->RC != NULL
9.          ptr1 = SearchLink(ptr->RC, KEY)
10.         If ptr1 != NULL
11.             Return ptr1
12.         Endif
13.    Endif
14.    Return NULL
15. Else
16.    Return ptr
17. Endif

Algorithm insert_tree(ROOT,KEY)
1. ptr = search_link(ROOT, KEY)
2. If ptr = NULL
3.       Print "KEY not found"
4.      Exit
5. Else
6.      If ptr->LC = NULL or ptr->RC = NULL
7.           Read option insert as left child or right child
8.           If option = left
9.                If ptr->LC = NULL
10.                    new= GetNode(NODE)
11.                    new->LC = NULL
12.                    new->RC = NULL
13.                    new->DATA=ITEM
14.               Else
15.                    Print "KEY has a left child"
16.               Endif
17.          Else if option = right
18.               If ptr->RC = NULL
19.                   new= GetNode(NODE)
20.                   new->LC = NULL
21.                   new->RC = NULL
22.                   new->DATA=ITEM
23.               Else
24.                   Print "KEY has a right child"
25.               Endif
26.          Endif
27.     Else
28.          Print "KEY has both left child and right child"
29.     Endif
```

30. Endif

Algorithm inorder_traversal(root)

1. ptr=root
2. If ptr!= NULL
3. inorder_traversal(ptr->LC)
4. print ptr->DATA
5. inorder_traversal(ptr->RC)
6. Endif

Algorithm preorder_traversal(root)

1. ptr=root
2. If ptr!= NULL
3. print ptr->DATA
4. preorder_traversal(ptr->LC)
5. preorder_traversal(ptr->RC)
6. Endif

Algorithm postorder_traversal(root)

1. ptr=root
2. If ptr!= NULL
3. postorder_traversal(ptr->LC)
4. postorder_traversal(ptr->RC)
5. print ptr->DATA
6. Endif

Algorithm search_parent(ptr, parent,KEY)

1. If ptr->DATA != KEY
2. If ptr->LC != NULL
3. parent = SearchParent(ptr->LC, KEY, ptr)
4. If parent != NULL
5. return parent
6. Endif
7. Endif
8. If ptr->RC != NULL
9. parent = SearchParent(ptr->RC, KEY, ptr)
10. If parent != NULL
11. return parent
12. Endif
13. Endif
14. return NULL

```
15. Else
16.     return parent
17. Endif
```

Algorithm DeleteTree(ROOT,KEY)

```
1. parent = search_parent(ROOT, ROOT,KEY)
2. If parent! = NULL
3.       Ptr1=parent->LC
4.       Ptr2=parent->RC
5.     If ptr1 != NULL and ptr1->DATA = KEY
6.           If ptr1->LC = NULL and ptr1->RC = NULL
7.                 parent->LC = NULL
8.           Else
9.                 Print "KEY is not a leaf node"
10.          Endif
11.    Else
12.          If ptr2->LC = NULL and ptr2->RC = NULL
13.                parent->RC = NULL
14.          Else
15.                Print "KEY is not a leaf node"
16.          Endif
17.     Endif
18. Else
19.     Print "KEY not found"
20. Endif
```

**PROGRAM:**

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

struct node{
   int data;
   struct node *lchild;
   struct node *rchild;
};

void build_tree(struct node* ptr){
   int item ,ans;
   if(ptr!=NULL){
      printf("Enter the element :");
      scanf("%d", &item);
      ptr->data=item;
      printf("Whether Node{data = %d} has left Subtree (Yes[1]/No[0]) : ",ptr->data);
      scanf("%d", &ans);
```

```
        struct node* lcptr = (struct node*)malloc(sizeof(struct node));
        if(ans==1){
           ptr->lchild=lcptr;
           build_tree(lcptr);
        }else{
           lcptr=NULL;
           ptr->lchild=NULL;
           build_tree(lcptr);
        }
        printf("Whether Node{data = %d} has right Subtree (Yes[1]/No[0]) : ",ptr->data);
        scanf("%d", &ans);
        struct node* rcptr = (struct node*)malloc(sizeof(struct node));
        if(ans==1){
           ptr->rchild=rcptr;
           build_tree(rcptr);
        }else{
           rcptr=NULL;
           ptr->rchild=NULL;
           build_tree(rcptr);
        }
    }
}

struct node * search_link(struct node* root ,int key){
   struct node* ptr = root;
    struct node* ptr1;
   if(ptr->data != key){
      if(ptr->lchild!=NULL){
        ptr1 = search_link(ptr->lchild, key);
          if(ptr1 != NULL){
             return ptr1;
          }
      }
      if(ptr->rchild!=NULL){
        ptr1 = search_link(ptr->rchild, key);
          if(ptr1 != NULL){
             return ptr1;
          }
      }
      return NULL;
   }
   else{
      return ptr;
   }
}

void insert_tree(struct node* root,int key){
```

```
    struct node* ptr;
    int item,ans;
    printf("Enter element to be Inserted :");
    scanf("%d", &item);
    ptr=search_link(root,key);
    if(ptr==NULL){
       printf("\n Search Unsucessful \n");
    }else{
       if((ptr->lchild==NULL)||(ptr->rchild==NULL)){
          printf("Insert as left or right child (left[1]/right[0]) : ");
          scanf("%d", &ans);
          if(ans==1){
             if(ptr->lchild==NULL){
                struct node* new = (struct node*)malloc(sizeof(struct node));
                new->data=item;
                new->lchild=NULL;
                new->rchild=NULL;
                ptr->lchild=new;
             }else{
                 printf("\n Insertion not possible as left child \n");
             }
          }
          if(ans==0){
             if(ptr->rchild==NULL){
                struct node* new = (struct node*)malloc(sizeof(struct node));
                new->data=item;
                new->lchild=NULL;
                new->rchild=NULL;
                ptr->rchild=new;
             }else{
                 printf("\n Insertion not possible as right child \n");
             }

          }
       }
       else{
          printf("\n Insertion not possible Key Node has left and right child \n");
       }
    }
}


void inorder_traversal(struct node* root){
    struct node* ptr;
    ptr = root;
    if(ptr!=NULL){
       inorder_traversal(ptr->lchild);
```

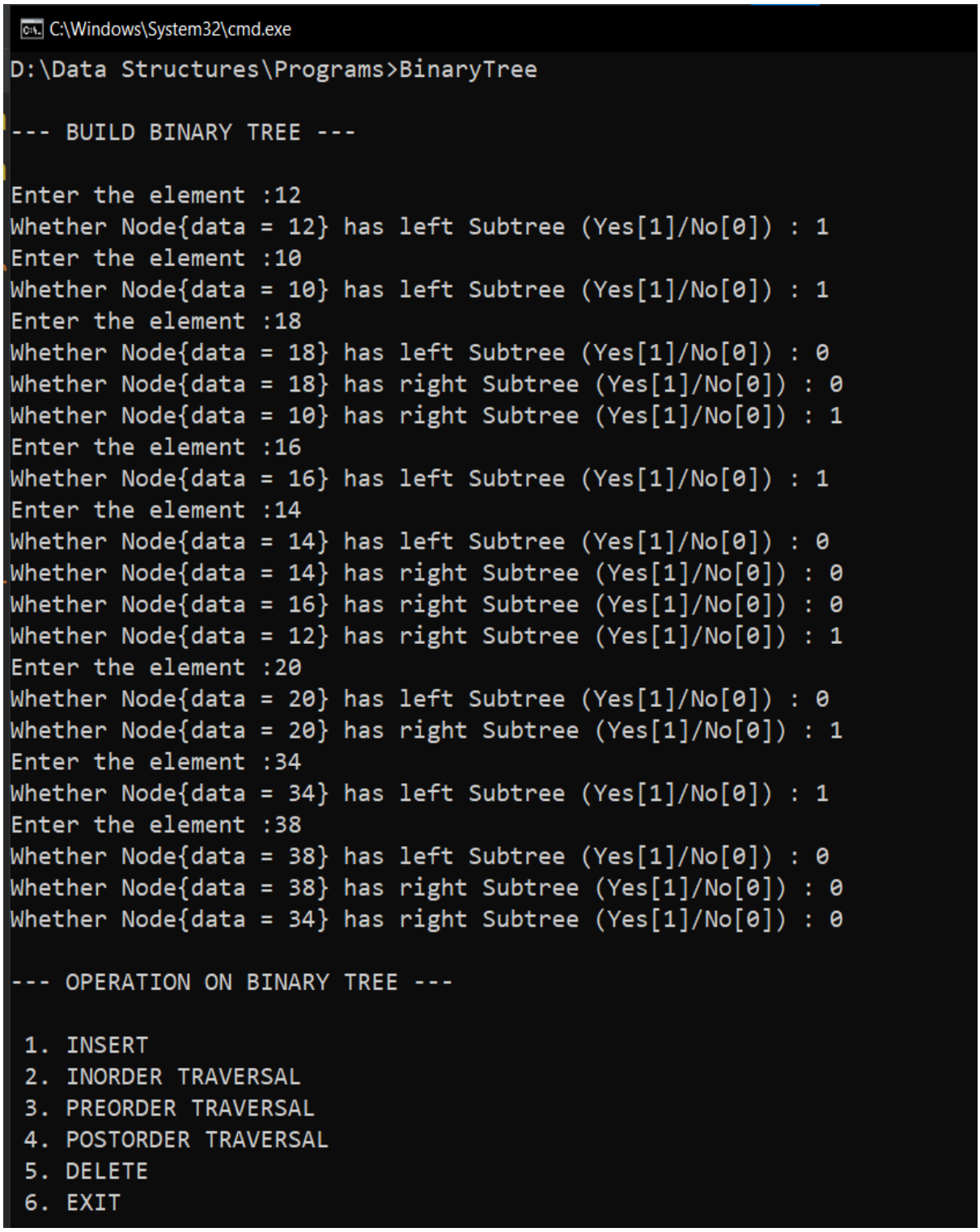
```
        printf("%d  ",ptr->data);
        inorder_traversal(ptr->rchild);
    }
}

void preorder_traversal(struct node* root){
    struct node* ptr;
    ptr = root;
    if(ptr!=NULL){
        printf("%d  ",ptr->data);
        preorder_traversal(ptr->lchild);
        preorder_traversal(ptr->rchild);
    }
}

void postorder_traversal(struct node* root){
    struct node* ptr;
    ptr = root;
    if(ptr!=NULL){
        postorder_traversal(ptr->lchild);
        postorder_traversal(ptr->rchild);
        printf("%d  ",ptr->data);
    }
}

struct node* search_parent(struct node* ptr ,struct node* parent,int item){
  if(ptr->data != item){
      if(ptr->lchild != NULL){
        parent = search_parent(ptr->lchild,ptr,item);
        if(parent != NULL)
          return parent;
      }
      if(ptr->rchild != NULL)
      {
        parent = search_parent(ptr->rchild,ptr,item);
        if(parent != NULL)
          return parent;
      }
      return NULL;
  }
  else
     return parent;
}


void delete_tree(struct node* root,int item){
    struct node* parent;
```

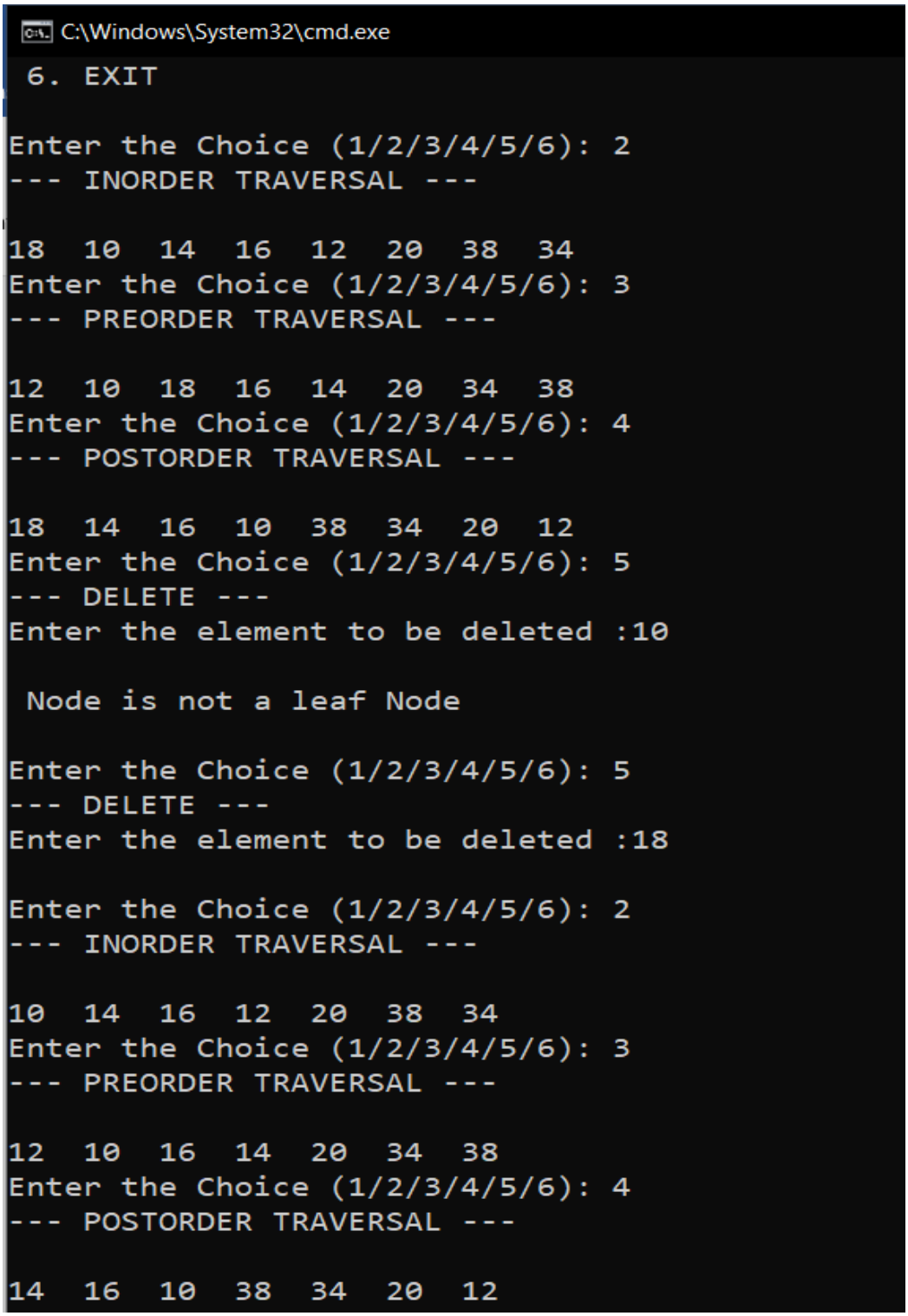
```
    struct node* ptr;
    struct node* ptr1;
    struct node* ptr2;
    ptr=root;
    if(ptr==NULL){
        printf("\n Tree is Empty\n");
    }else if(root->data == item ){
        if(root->lchild==NULL && root->rchild == NULL){
            root=NULL;
        }
        else{
            printf("\n Node is not a leaf Node\n");
        }
    }else{
        parent = search_parent(root,root,item);
        if(parent!=NULL){
            ptr1 = parent->lchild;
            ptr2 = parent->rchild;
            if(ptr1->data==item){
                if((ptr1->lchild==NULL)&&(ptr1->rchild==NULL)){
                    parent->lchild=NULL;
                }else{
                    printf("\n Node is not a leaf Node\n");
                }
            }
            if(ptr2->data==item){
                if((ptr2->lchild==NULL)&&(ptr2->rchild==NULL)){
                    parent->rchild=NULL;
                }else{
                    printf("\n Node is not a leaf Node\n");
                }
            }
        }else{
            printf("\n Node with data item doesn't exists\n");
        }
    }
}

void main(){
 int n,item,key;
 char ans='y';
 struct node* root = (struct node*)malloc(sizeof(struct node));
 root->lchild=NULL;
 root->rchild=NULL;
 printf("\n--- BUILD BINARY TREE --- \n\n");
 build_tree(root);
 printf("\n--- OPERATION ON BINARY TREE --- \n\n");
```

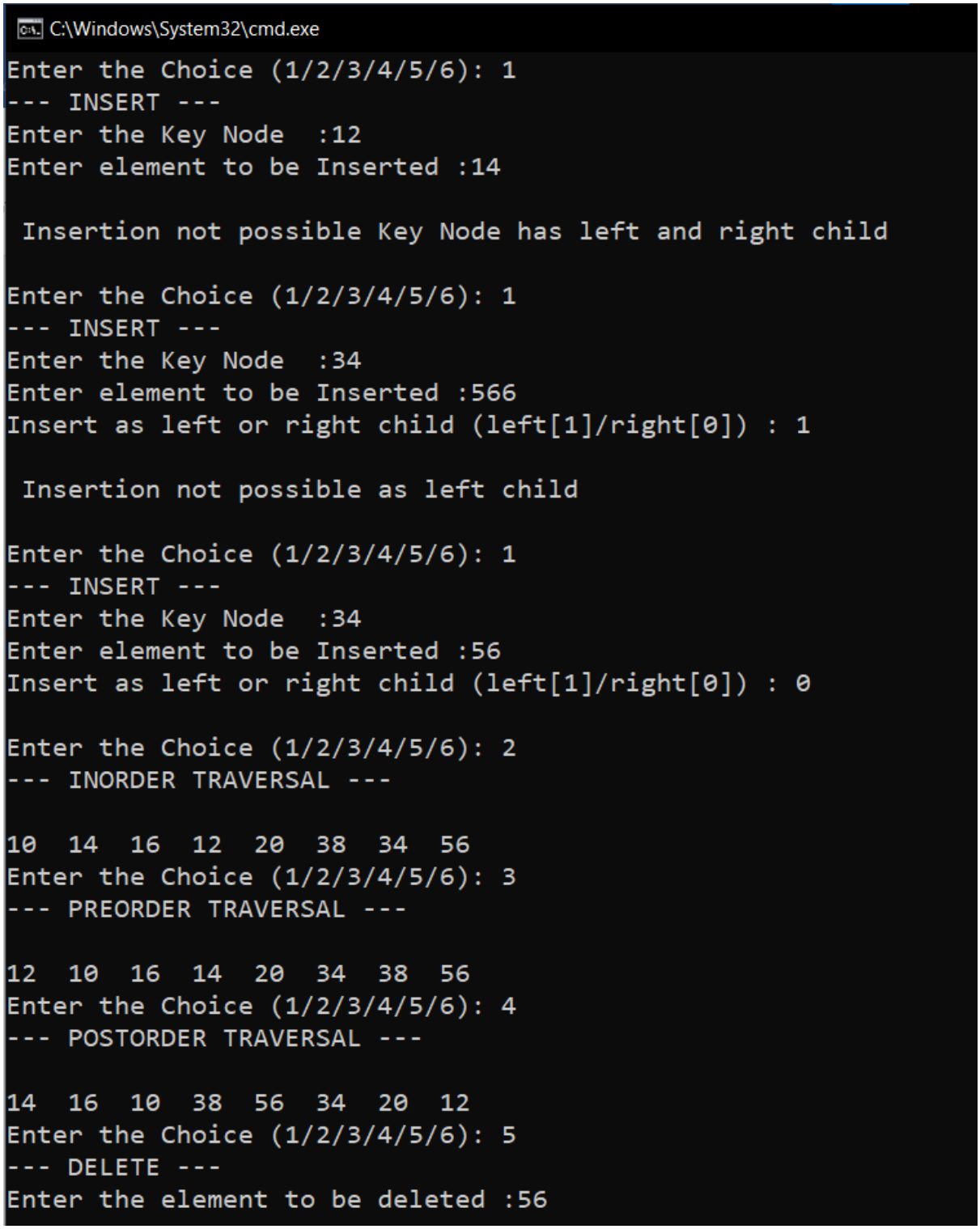
```
printf(" 1. INSERT \n");
printf(" 2. INORDER TRAVERSAL\n");
printf(" 3. PREORDER TRAVERSAL\n");
printf(" 4. POSTORDER TRAVERSAL\n");
printf(" 5. DELETE \n");
printf(" 6. EXIT \n");
while(ans=='y'){
   printf("\nEnter the Choice (1/2/3/4/5/6): ");
   scanf("%d",&n);
   switch(n){
      case 1:printf("--- INSERT ---\n");
           if(root == NULL){
               printf("\n Tree is empty \n\n");
               printf("Enter element to be Inserted :");
               scanf("%d", &item);
               root = (struct node*)malloc(sizeof(struct node));
               root->lchild=NULL;
               root->rchild=NULL;
               root->data=item;
           }else{
              printf("Enter the Key Node  :");
              scanf("%d", &key);
              insert_tree(root,key);
           }
           break;
      case 2:printf("--- INORDER TRAVERSAL ---\n\n");
           if(root!=NULL){
              inorder_traversal(root);
           }else{
              printf("\n Tree is empty \n");
           }
           break;
      case 3:printf("--- PREORDER TRAVERSAL ---\n\n");
           if(root!=NULL){
              preorder_traversal(root);
           }else{
              printf("\n Tree is empty \n");
           }
           break;
      case 4:printf("--- POSTORDER TRAVERSAL ---\n\n");
           if(root!=NULL){
              postorder_traversal(root);
           }else{
              printf("\n Tree is empty \n");
           }
           break;
      case 5:printf("--- DELETE ---\n");
```

```
            if(root!=NULL){
               printf("Enter the element to be deleted :");
               scanf("%d", &item);
               if(root->data==item && root->lchild==NULL && root->rchild == NULL){
                  root = NULL;
               }else if(root->data==item && root->lchild==NULL){
                  root=root->rchild;
               }else if(root->data==item && root->rchild==NULL){
                  root=root->lchild;
               }else if(root->data==item){
                  printf("\n Node is not a leaf Node\n");
               }else{
                  delete_tree(root,item);
               }
            }else{
               printf("\n Tree is empty \n");
            }
            break;
       case 6:ans='n';
            break;
      default:printf("Enter a Valid Input\n");
    }
  }
}
```

**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>BinaryTree
--- BUILD BINARY TREE ---
Enter the element :12
Whether Node{data = 12} has left Subtree (Yes[1]/No[0]) : 1
Enter the element :10
Whether Node{data = 10} has left Subtree (Yes[1]/No[0]) : 1
Enter the element :18
Whether Node{data = 18} has left Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 18} has right Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 10} has right Subtree (Yes[1]/No[0]) : 1
Enter the element :16
Whether Node{data = 16} has left Subtree (Yes[1]/No[0]) : 1
Enter the element :14
Whether Node{data = 14} has left Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 14} has right Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 16} has right Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 12} has right Subtree (Yes[1]/No[0]) : 1
Enter the element :20
Whether Node{data = 20} has left Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 20} has right Subtree (Yes[1]/No[0]) : 1
Enter the element :34
Whether Node{data = 34} has left Subtree (Yes[1]/No[0]) : 1
Enter the element :38
Whether Node{data = 38} has left Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 38} has right Subtree (Yes[1]/No[0]) : 0
Whether Node{data = 34} has right Subtree (Yes[1]/No[0]) : 0
--- OPERATION ON BINARY TREE ---
1. INSERT
2. INORDER TRAVERSAL
3. PREORDER TRAVERSAL
4. POSTORDER TRAVERSAL
5. DELETE
6. EXIT


C:\Windows\System32\cmd.exe
6. EXIT
Enter the Choice (1/2/3/4/5/6): 2
--- INORDER TRAVERSAL ---
18 10 14 16 12 20 38 34
Enter the Choice (1/2/3/4/5/6): 3
--- PREORDER TRAVERSAL ---
12 10 18 16 14 20 34 38
Enter the Choice (1/2/3/4/5/6): 4
--- POSTORDER TRAVERSAL ---
18 14 16 10 38 34 20 12
Enter the Choice (1/2/3/4/5/6): 5
--- DELETE ---
Enter the element to be deleted :10
Node is not a leaf Node
Enter the Choice (1/2/3/4/5/6): 5
--- DELETE ---
Enter the element to be deleted :18
Enter the Choice (1/2/3/4/5/6): 2
--- INORDER TRAVERSAL ---
10 14 16 12 20 38 34
Enter the Choice (1/2/3/4/5/6): 3
--- PREORDER TRAVERSAL ---
12 10 16 14 20 34 38
Enter the Choice (1/2/3/4/5/6): 4
--- POSTORDER TRAVERSAL ---
14 16 10 38 34 20 12




**RESULT:**

The given operations are performed on a binary tree.

04/01/2021

## Experiment No:19

# BINARY SEARCH TREE

### AIM:

Create a binary search tree with the following operations:

1. Insert a new node.
2. Inorder traversal.
3. Preorder traversal.
4. Postorder traversal.
5. Delete a node.
6. Count the number of leaf nodes

### DATA STRUCTURES USED:

Tree using Linked List

### ALGORITHM:

Algorithm Insert()

ptr=root flag = False

```
1. While ptr != NULL
2.     If ITEM <= ptr->DATA
3.         ptr1 = ptr
4.         ptr = ptr->LC
5.     Else if ITEM > ptr->DATA
6.         ptr1 = ptr
7.         ptr = ptr->RC
8.     Else
9.         Flag=True
10.        print “Item already exists”
11. Endwhile
12. If ptr = NULL
13.    new= GetNode(NODE)
14.    new->LC = NULL
15.    new->RC = NULL
16.    new->DATA = ITEM
17.    If ptr1->DATA < ITEM
18.        ptr1->RC = new
```

```
19.    if ptr1->DATA>ITEM
20.          ptr1->LC = new
21.    Endif
22. EndIf
```

Algorithm inorder_traversal(root)

```
1. ptr=root
2. If ptr!= NULL
3.     inorder_traversal(ptr->LC)
4.     print ptr->DATA
5.     inorder_traversal(ptr->RC)
6. Endif
```

Algorithm preorder_traversal(root)

```
1. ptr=root
2. If ptr!= NULL
3.     print ptr->DATA
4.     preorder_traversal(ptr->LC)
5.     preorder_traversal(ptr->RC)
6. Endif
```

Algorithm postorder_traversal(root)

```
1. ptr=root
2. If ptr!= NULL
3.     postorder_traversal(ptr->LC)
4.     postorder_traversal(ptr->RC)
5.     print ptr->DATA
6. Endif
```

Algorithm successor(ptr)

```
1. ptr1 = ptr->RC
2. If ptr1 != NULL
3.     While ptr1->LC != NULL
4.          ptr1 = ptr1->LC
5.     Endwhile
6. Endif
7. Return(ptr1)
```

Algorithm Delete()

```
1. ptr = ROOT
2. flag = false
3. While ptr != NULL and flag = false
```

```
4.      If ITEM < ptr->DATA
5.         parent = ptr
6.         ptr = ptr->LC
7.      Else if ITEM > ptr->DATA
8.          parent = ptr
9.          ptr = ptr->RC
10.     Else
11.         flag = true

12.     Endif
13. Endwhile
14. If flag = false
15.      print "ITEM doesn't exist"
16.      Exit
17. Endif
18. If ptr->LC = NULL and ptr->RC = NULL
19.      CASE = 1
20. Else If ptr->LC != NULL and ptr->RC != NULL
21.      CASE = 3
22. Else
23.      CASE = 2
24. Endif
25. Endif
26. If CASE = 1
27.    If parent->LC = ptr
28.         parent->LC = NULL
29.    Else
30.         parent->RC = NULL
31.    Endif
32. ReturnNode(ptr)
33.EndIf
34. if CASE = 2
35.      If parent->LC = ptr
36.          If ptr->LC = NULL
37.               parent->LC = ptr->RC
38.          Else
39.               parent->LC = ptr->LC
40.          Endif
41.      Else
42.         If ptr->LC = NULL
43.              parent->RC = ptr->RC

44.         Else
45.              parent->RC = ptr->LC
46.         Endif
47.      Endif
48. ReturnNode(ptr)
```

49. If CASE=3
50. ptr1 = successor(ptr)
51. ITEM1 = ptr1->DATA
52. DeleteBST(ITEM1)
53. ptr->DATA = ITEM1
54. Endif

Algorithm no_of_leaf_nodes(root)

1. ptr=root
2. if ptr =NULL
3. return 0;
4. else if ptr->lchild == NULL && ptr->rchild == NULL
5. return 1;
6. Else
7. return no_of_leaf_nodes(ptr->LC)+ no_of_leaf_nodes(ptr->RC)

**PROGRAM:**

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

struct node{
   int data;
   struct node *lchild;
   struct node *rchild;
};

void Insert(struct node* root,int item){
   struct node* ptr=root;
   struct node* ptr1;
   int flag=0;
   while(ptr!=NULL && flag == 0){
      if(item<ptr->data){
         ptr1=ptr;
         ptr=ptr->lchild;
      }else if(item>ptr->data){
         ptr1=ptr;
         ptr=ptr->rchild;
      }else{
         flag=1;
         printf("\n ITEM already exists \n ");
      }
   }
   if(ptr==NULL){
```

```
        struct node* new = (struct node*)malloc(sizeof(struct node));
        new->data=item;
        new->lchild=NULL;
        new->rchild=NULL;
        if(ptr1->data<item){
           ptr1->rchild=new;
        }
        if(ptr1->data>item){
           ptr1->lchild=new;
        }
    }
}
void inorder_traversal(struct node* root){
    struct node* ptr;
    ptr = root;
    if(ptr!=NULL){
        inorder_traversal(ptr->lchild);
        printf("%d  ",ptr->data);
        inorder_traversal(ptr->rchild);
    }
}
void preorder_traversal(struct node* root){
    struct node* ptr;
    ptr = root;
    if(ptr!=NULL){
        printf("%d  ",ptr->data);
        preorder_traversal(ptr->lchild);
        preorder_traversal(ptr->rchild);
    }
}
void postorder_traversal(struct node* root){
    struct node* ptr;
    ptr = root;
    if(ptr!=NULL){
        postorder_traversal(ptr->lchild);
        postorder_traversal(ptr->rchild);
        printf("%d  ",ptr->data);
    }
}
struct node* successor(struct node* ptr){
    struct node* ptr1;
    ptr1=ptr->rchild;
    if(ptr1!=NULL){
        while(ptr1->lchild!=NULL){
           ptr1=ptr1->lchild;
        }
    }
```

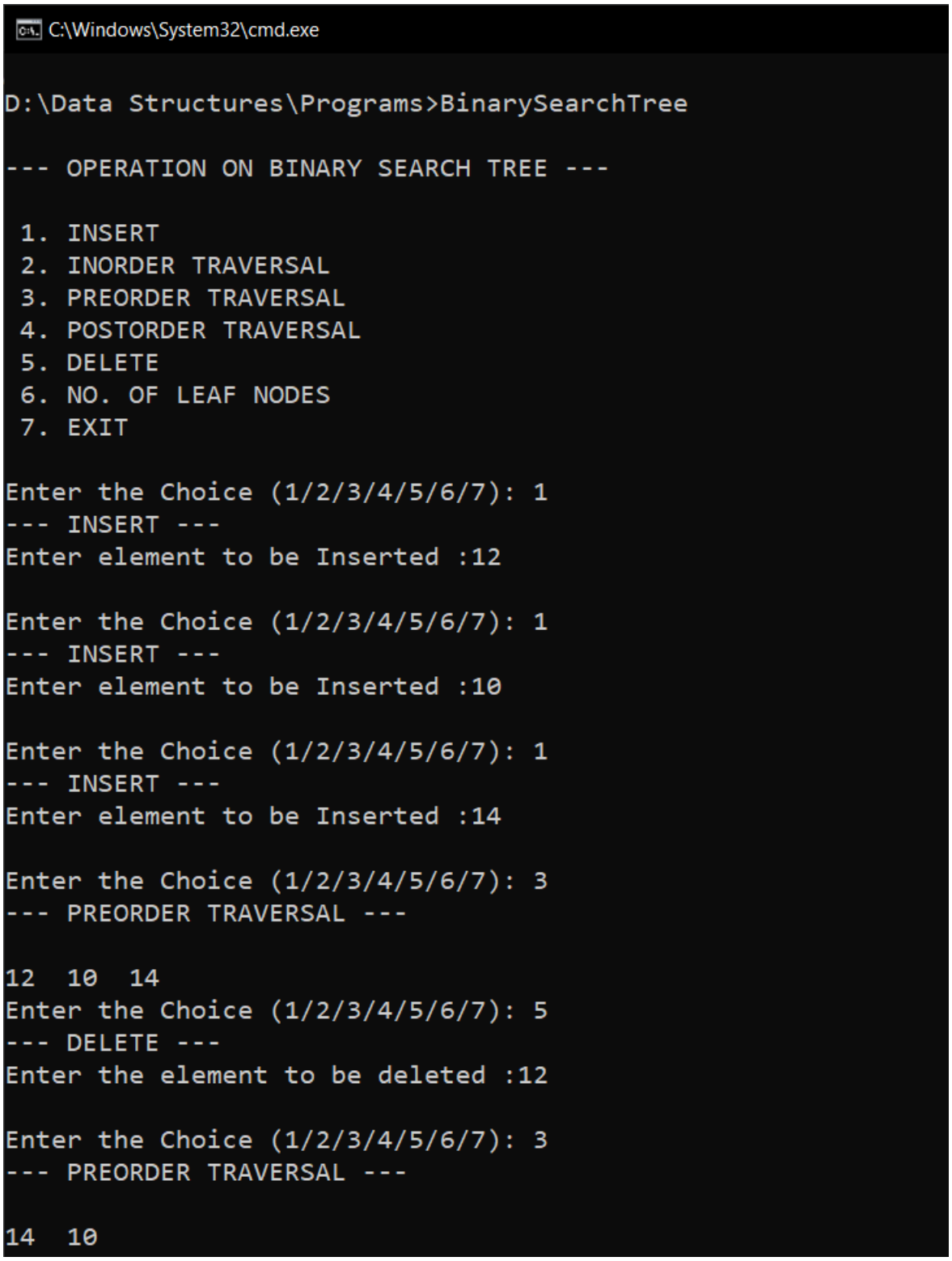
```
    return(ptr1);
}

void Delete(struct node* root,int item){
    struct node* ptr=root;
    struct node* ptr1;
    struct node* parent=NULL;
    int flag=0,temp;
    while(ptr!=NULL && flag == 0){
        if(item<ptr->data){
            parent=ptr;
            ptr=ptr->lchild;
        }else if(item>ptr->data){
            parent=ptr;
            ptr=ptr->rchild;
        }else{
            flag=1;
        }
    }
    if(flag==0){
         printf(" \nITEM doesn't exists\n");
    }else{
       if(ptr->lchild==NULL && ptr->rchild==NULL){
            if(parent->lchild==ptr){
                parent->lchild=NULL;
            }
            if(parent->rchild==ptr){
                parent->rchild=NULL;
            }
            free(ptr);
        }else if(ptr->lchild!=NULL && ptr->rchild!=NULL){
            ptr1 = successor(ptr);
            temp =ptr1->data;
            Delete(root,temp);
            ptr->data=temp;
            free(ptr1);
        }else{
            if(parent->lchild==ptr){
                if(ptr->lchild==NULL){
                    parent->lchild=ptr->rchild;
                }else{
                    parent->lchild=ptr->lchild;
                }
            }else if(parent->rchild==ptr){
                if(ptr->lchild==NULL){
                    parent->rchild=ptr->rchild;
                }else{
```

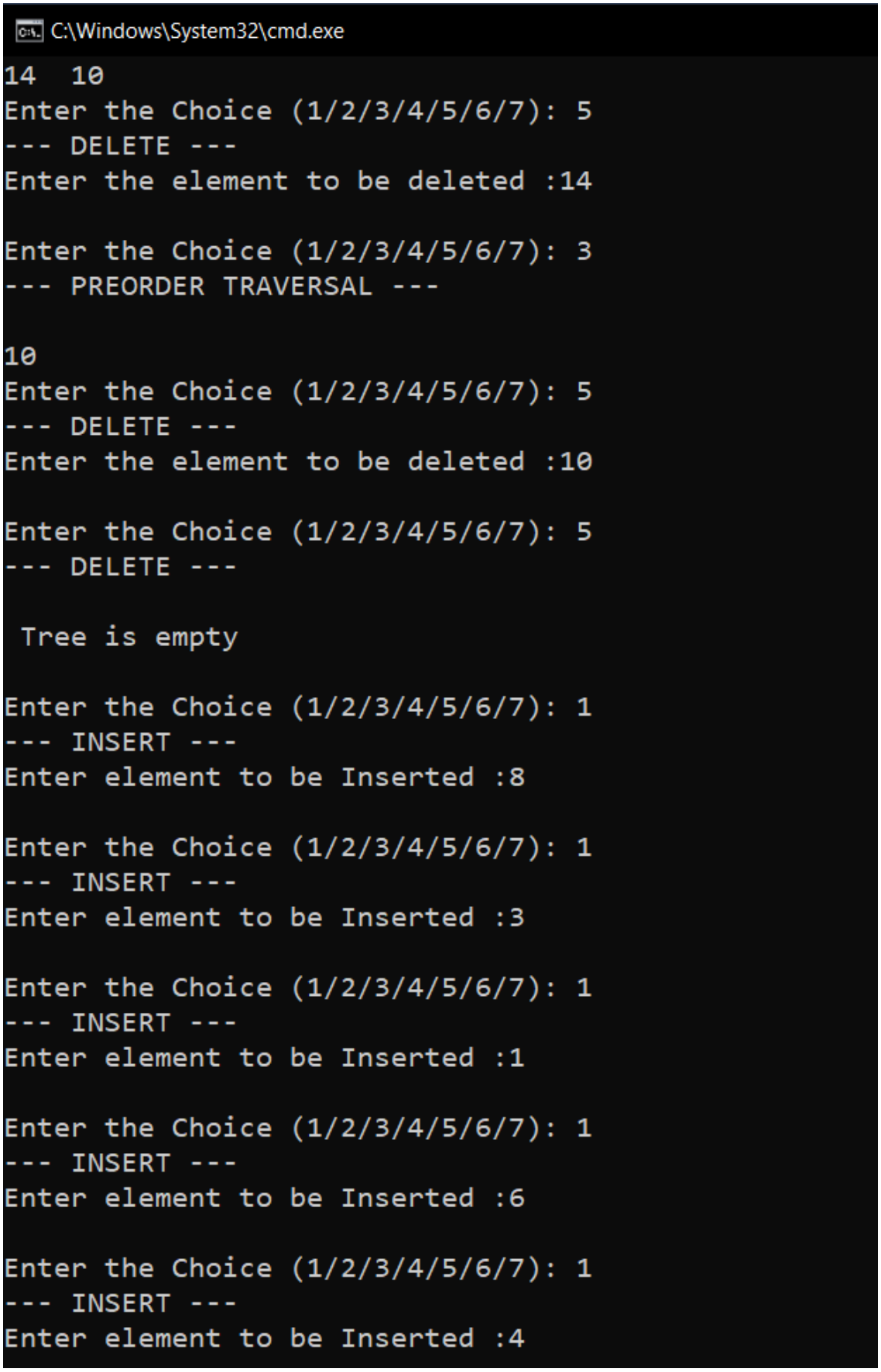
```
                parent->rchild=ptr->lchild;
            }
          }
          free(ptr);
       }
    }
}

int no_of_leaf_nodes(struct node* root){
   struct node* ptr;
   ptr = root;
   if(ptr == NULL){
      return 0;
   }else if(ptr->lchild == NULL && ptr->rchild == NULL){
      return 1;
   }else{
      return no_of_leaf_nodes(ptr->lchild)+no_of_leaf_nodes(ptr->rchild);
   }
}

void main(){
 int n,item,var=0;
 char ans='y';
 struct node* root = NULL;
 printf("\n--- OPERATION ON BINARY SEARCH TREE --- \n\n");
 printf(" 1. INSERT \n");
 printf(" 2. INORDER TRAVERSAL\n");
 printf(" 3. PREORDER TRAVERSAL\n");
 printf(" 4. POSTORDER TRAVERSAL\n");
 printf(" 5. DELETE \n");
 printf(" 6. NO. OF LEAF NODES \n");
 printf(" 7. EXIT \n");
 while(ans=='y'){
    printf("\nEnter the Choice (1/2/3/4/5/6/7): ");
    scanf("%d",&n);
    switch(n){
       case 1:printf("--- INSERT ---\n");
            printf("Enter element to be Inserted :");
            scanf("%d", &item);
            if(root==NULL){
               root = (struct node*)malloc(sizeof(struct node));
               root->lchild=NULL;
               root->rchild=NULL;
               root->data=item;
            }else{
               Insert(root,item);
            }
```

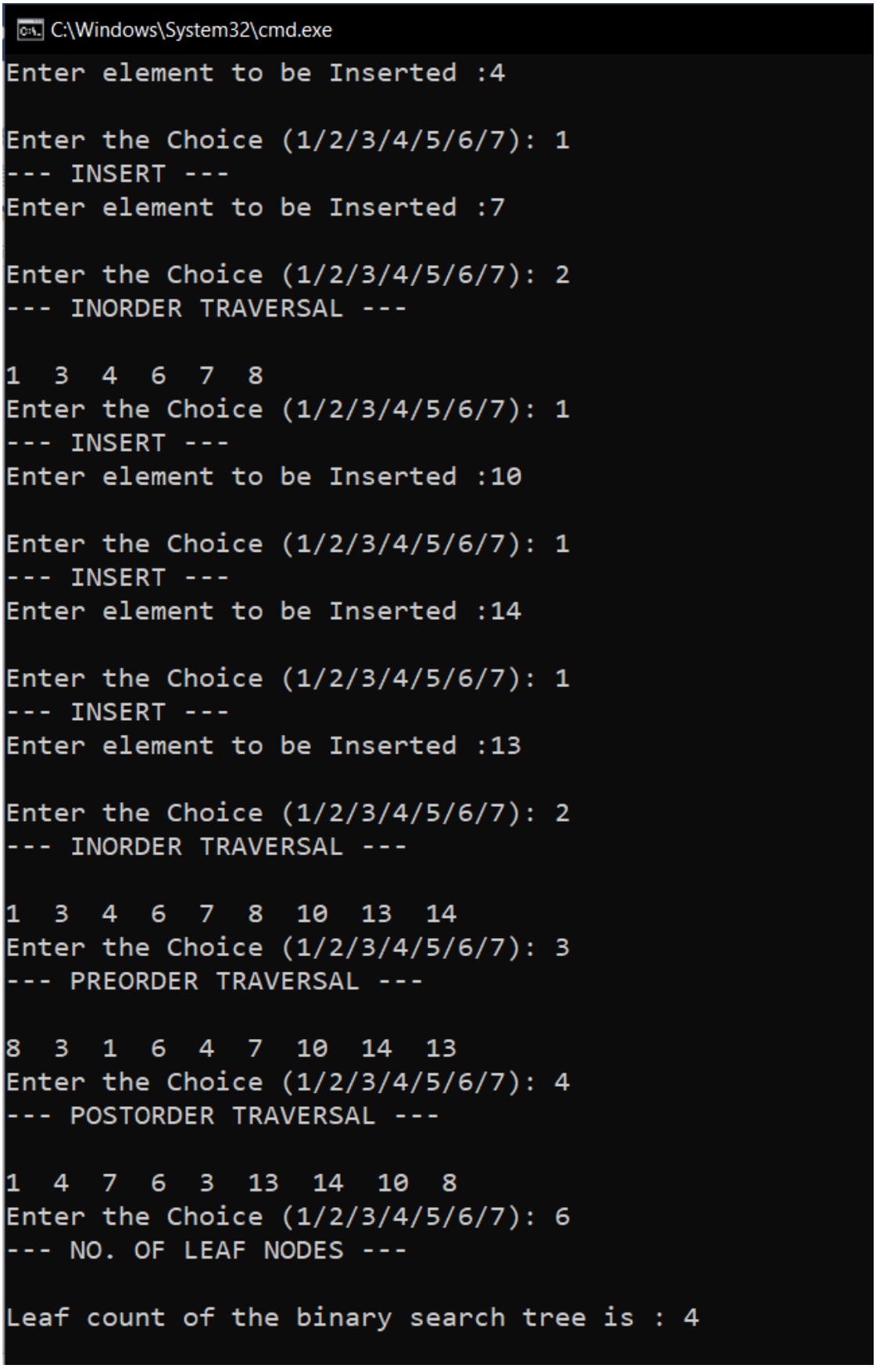
```
        var++;
        break;
    case 2:printf("--- INORDER TRAVERSAL ---\n\n");
        if(root!=NULL){
           inorder_traversal(root);
        }else{
           printf("\n Tree is empty \n");
        }
        break;
    case 3:printf("--- PREORDER TRAVERSAL ---\n\n");
        if(root!=NULL){
           preorder_traversal(root);
        }else{
           printf("\n Tree is empty \n");
        }
        break;
    case 4:printf("--- POSTORDER TRAVERSAL ---\n\n");
        if(root!=NULL){
           postorder_traversal(root);
        }else{
           printf("\n Tree is empty \n");
        }
        break;
    case 5:printf("--- DELETE ---\n");
        if(root!=NULL){
           printf("Enter the element to be deleted :");
           scanf("%d", &item);
           if(root->data==item && root->lchild==NULL && root->rchild == NULL){
              root = NULL;
           }else if(root->data==item && root->lchild==NULL){
              root=root->rchild;
           }else if(root->data==item && root->rchild==NULL){
              root=root->lchild;
           }else{
               Delete(root,item);
           }
        }else{
           printf("\n Tree is empty \n");
        }
        break;
    case 6:printf("--- NO. OF LEAF NODES ---\n");
        printf("\nLeaf count of the binary search tree is : %d\n",no_of_leaf_nodes(root));
        break;
    case 7:ans='n';
        break;
    default:printf("Enter a Valid Input\n");
}
```

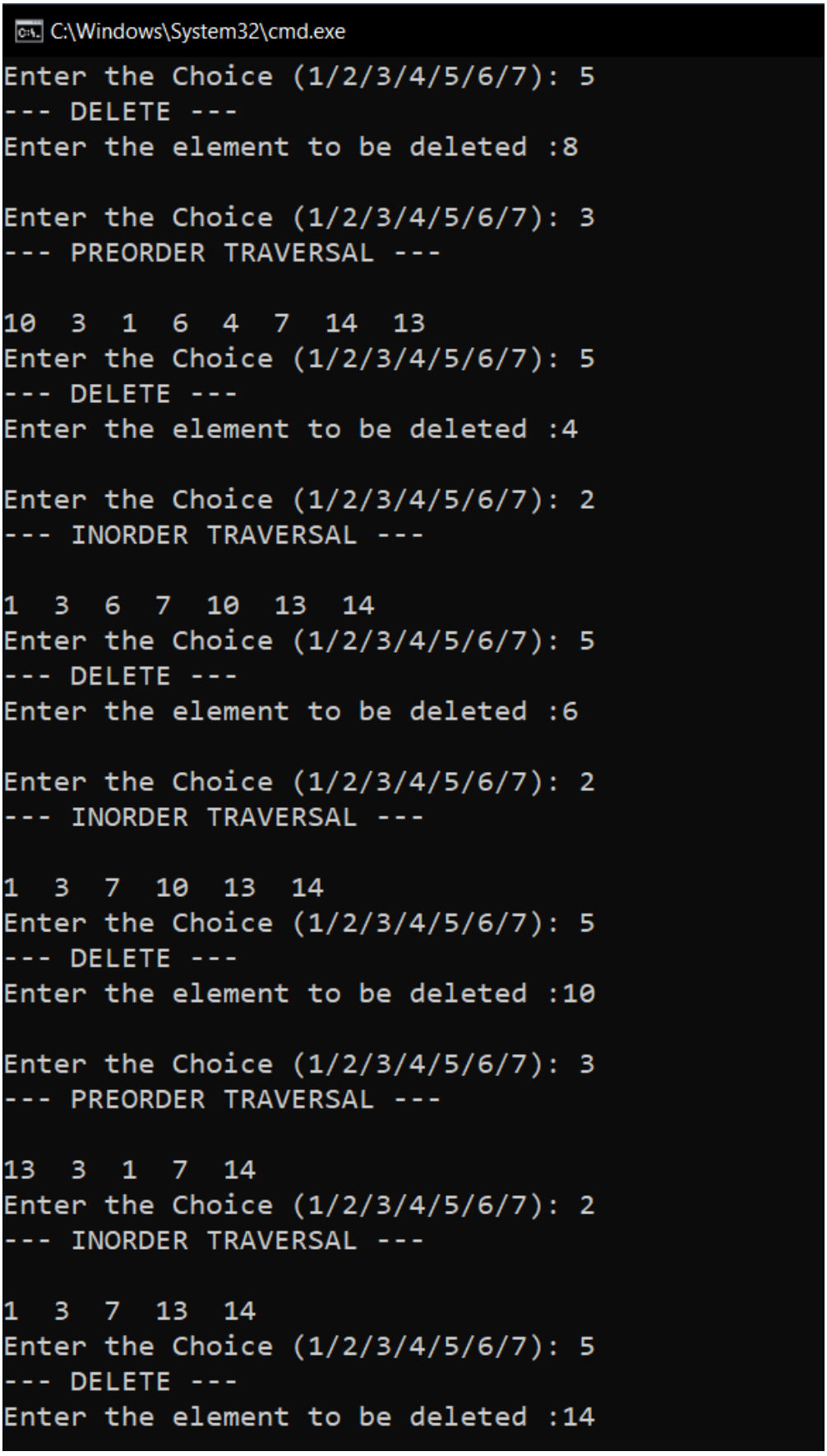
```
  }
}
```

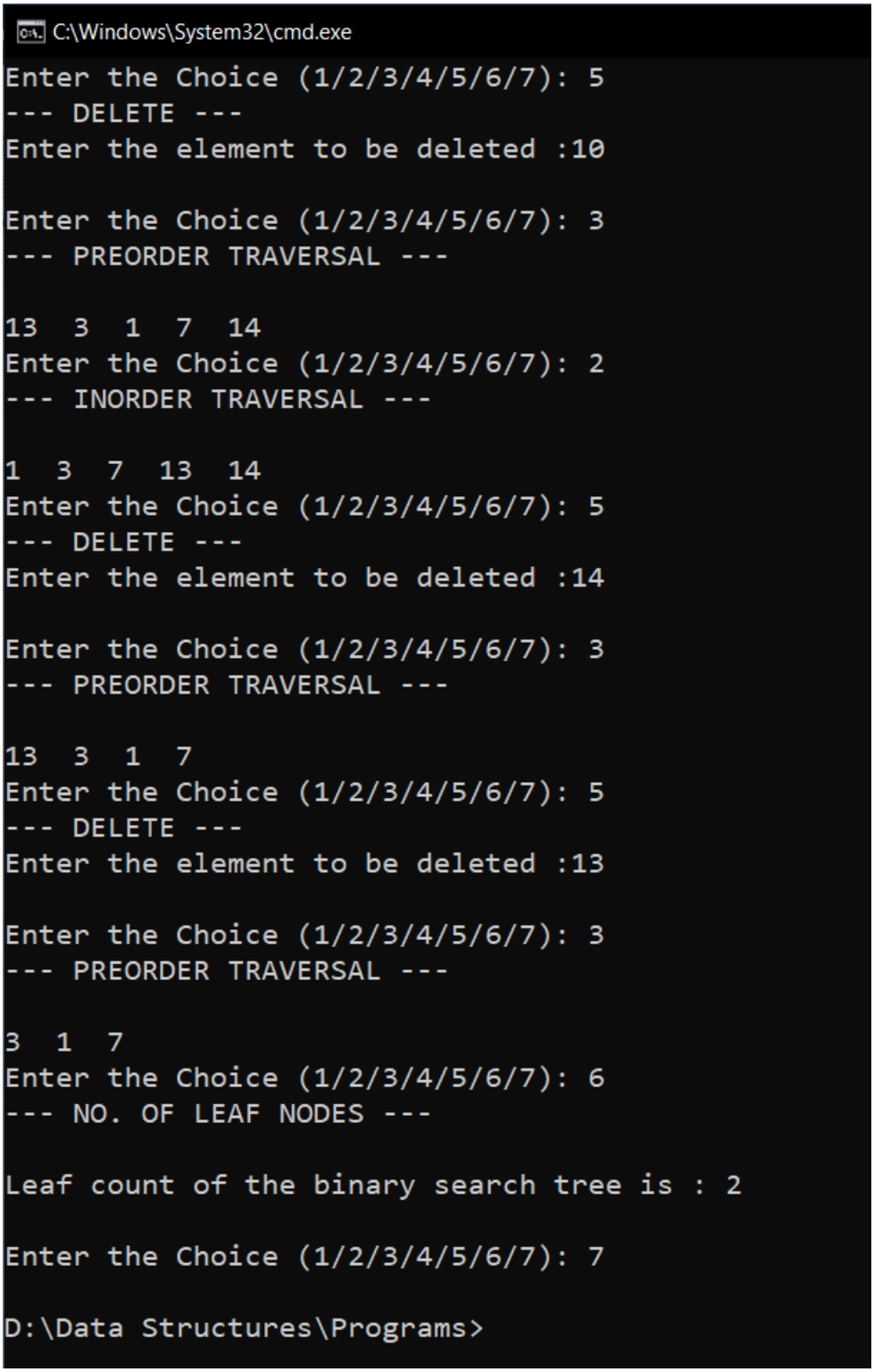
**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>BinarySearchTree
--- OPERATION ON BINARY SEARCH TREE ---
1. INSERT
2. INORDER TRAVERSAL
3. PREORDER TRAVERSAL
4. POSTORDER TRAVERSAL
5. DELETE
6. NO. OF LEAF NODES
7. EXIT
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :12
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :10
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :14
Enter the Choice (1/2/3/4/5/6/7): 3
--- PREORDER TRAVERSAL ---
12 10 14
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :12
Enter the Choice (1/2/3/4/5/6/7): 3
--- PREORDER TRAVERSAL ---
14 10


C:\Windows\System32\cmd.exe
14  10
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :14
Enter the Choice (1/2/3/4/5/6/7): 3
--- PREORDER TRAVERSAL ---
10
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :10
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Tree is empty
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :8
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :3
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :1
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :6
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :4


C:\Windows\System32\cmd.exe
Enter element to be Inserted :4
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :7
Enter the Choice (1/2/3/4/5/6/7): 2
--- INORDER TRAVERSAL ---
1 3 4 6 7 8
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :10
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :14
Enter the Choice (1/2/3/4/5/6/7): 1
--- INSERT ---
Enter element to be Inserted :13
Enter the Choice (1/2/3/4/5/6/7): 2
--- INORDER TRAVERSAL ---
1 3 4 6 7 8 10 13 14
Enter the Choice (1/2/3/4/5/6/7): 3
--- PREORDER TRAVERSAL ---
8 3 1 6 4 7 10 14 13
Enter the Choice (1/2/3/4/5/6/7): 4
--- POSTORDER TRAVERSAL ---
1 4 7 6 3 13 14 10 8
Enter the Choice (1/2/3/4/5/6/7): 6
--- NO. OF LEAF NODES ---
Leaf count of the binary search tree is : 4


C:\Windows\System32\cmd.exe
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :8
Enter the Choice (1/2/3/4/5/6/7): 3
--- PREORDER TRAVERSAL ---
10 3 1 6 4 7 14 13
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :4
Enter the Choice (1/2/3/4/5/6/7): 2
--- INORDER TRAVERSAL ---
1 3 6 7 10 13 14
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :6
Enter the Choice (1/2/3/4/5/6/7): 2
--- INORDER TRAVERSAL ---
1 3 7 10 13 14
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :10
Enter the Choice (1/2/3/4/5/6/7): 3
--- PREORDER TRAVERSAL ---
13 3 1 7 14
Enter the Choice (1/2/3/4/5/6/7): 2
--- INORDER TRAVERSAL ---
1 3 7 13 14
Enter the Choice (1/2/3/4/5/6/7): 5
--- DELETE ---
Enter the element to be deleted :14




**RESULT:**

The given operations are performed on a binary search tree.

04/01/2021

## Experiment No: 20

# SORT USING BINARY SEARCH TREE

### AIM:

Write a program to sort a set of numbers using a binary search tree.

### DATA STRUCTURES USED:

Tree using Linked List

### ALGORITHM:

Algorithm Insert()

ptr=root flag = False

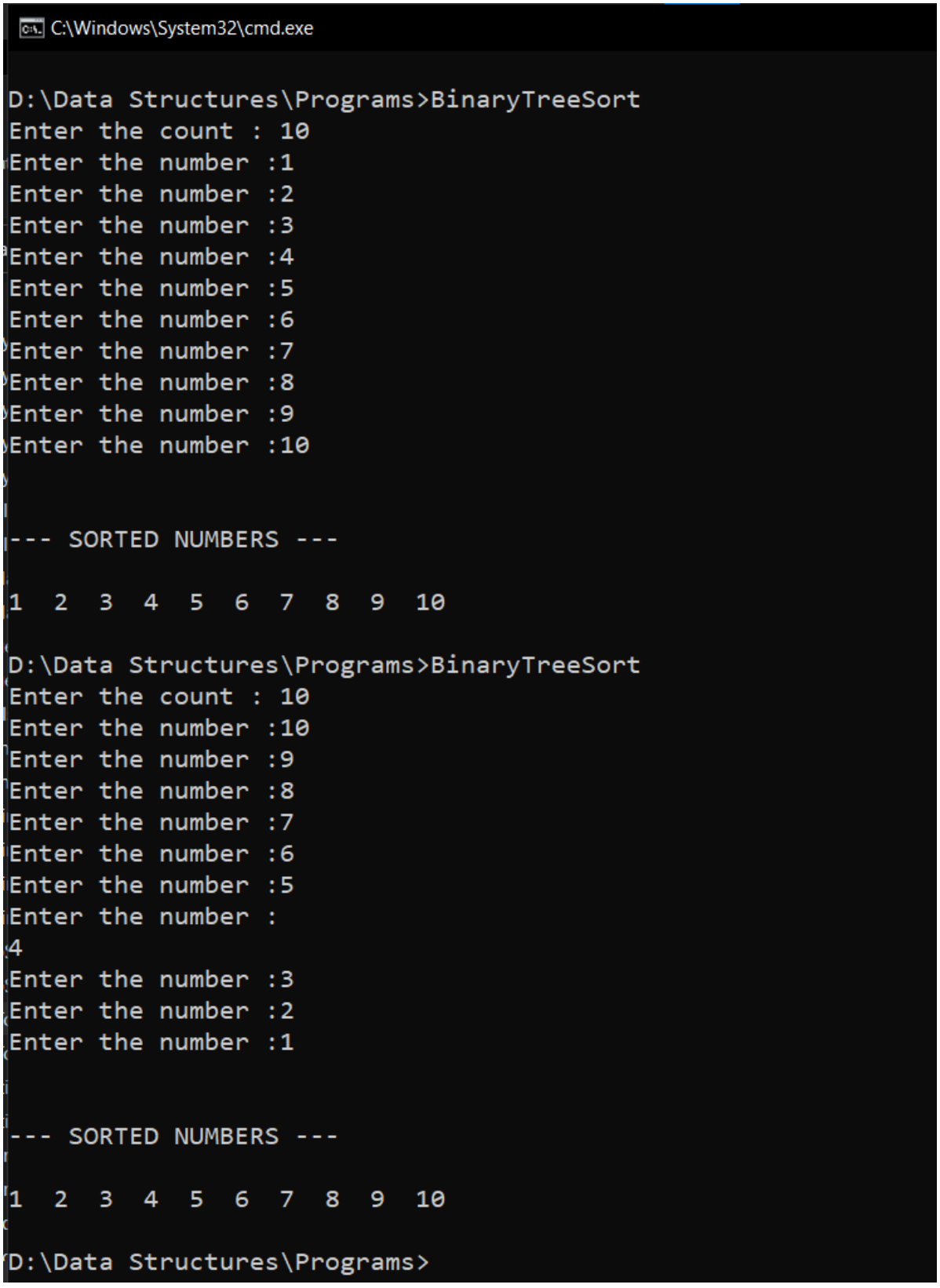
```
1. While ptr != NULL
2.     If ITEM <= ptr->DATA
3.         ptr1 = ptr
4.         ptr = ptr->LC
5.     Else if ITEM > ptr->DATA
6.         ptr1 = ptr
7.         ptr = ptr->RC
8.     Else
9.         Flag=True
10.        print “Item already exists”
11. Endwhile
12. If ptr = NULL
13.    new= GetNode(NODE)
14.    new->LC = NULL
15.    new->RC = NULL
16.    new->DATA = ITEM
17.    If ptr1->DATA < ITEM
18.        ptr1->RC = new
19.    if ptr1->DATA>ITEM
20.        ptr1->LC = new
21.    Endif
22. EndIf
```

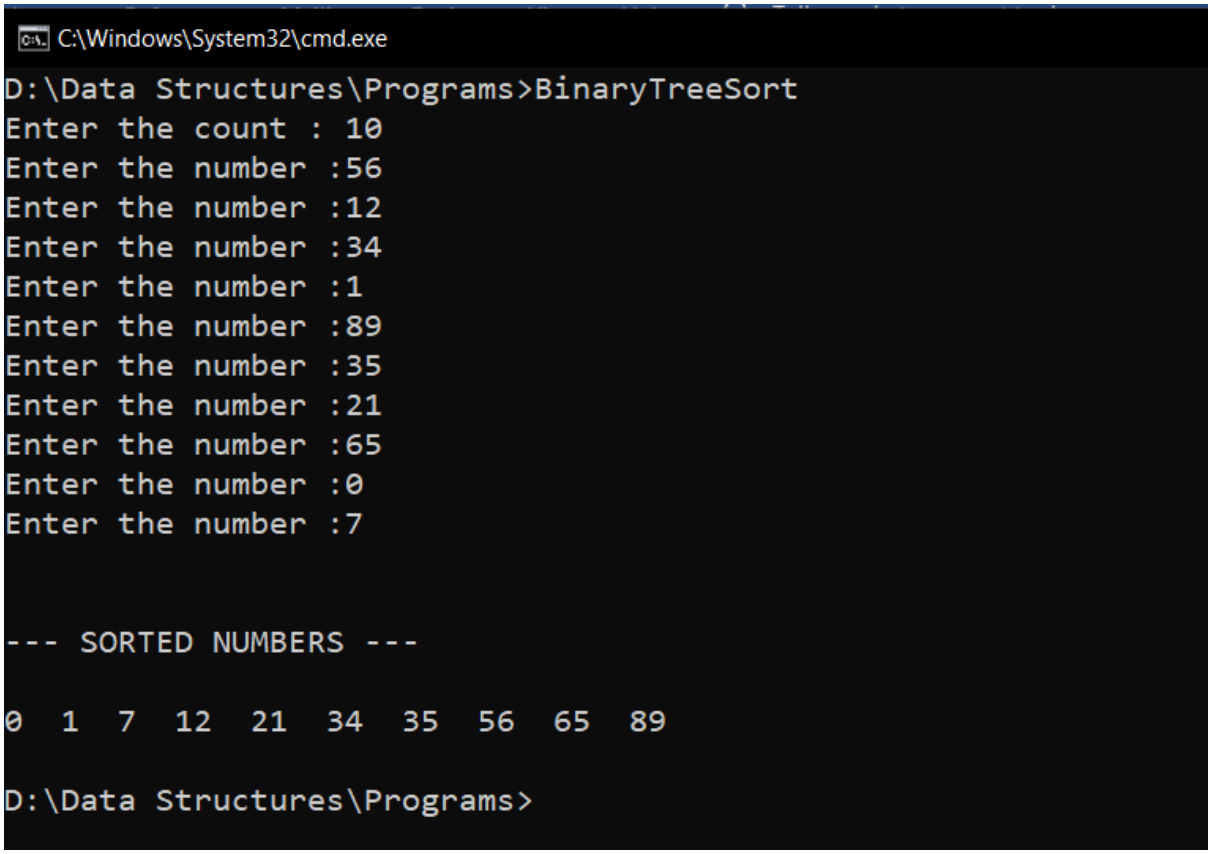
**PROGRAM:**

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

struct node{
   int data;
   struct node *lchild;
   struct node *rchild;
};


void Insert(struct node* root,int item){
   struct node* ptr=root;
   struct node* ptr1;
   int flag=0;
   while(ptr!=NULL && flag == 0){
      if(item<ptr->data){
         ptr1=ptr;
         ptr=ptr->lchild;
      }else if(item>ptr->data){
         ptr1=ptr;
         ptr=ptr->rchild;
      }else{
         flag=1;
         printf("\n ITEM already exists \n ");
      }
   }
   if(ptr==NULL){
      struct node* new = (struct node*)malloc(sizeof(struct node));
      new->data=item;
      new->lchild=NULL;
      new->rchild=NULL;
      if(ptr1->data<item){
         ptr1->rchild=new;
      }
      if(ptr1->data>item){
         ptr1->lchild=new;
      }
   }
}

void inorder_traversal(struct node* root){
   struct node* ptr;
   ptr = root;
   if(ptr!=NULL){
      inorder_traversal(ptr->lchild);
      printf("%d  ",ptr->data);
```

```
        inorder_traversal(ptr->rchild);
    }
}


void main(){
 int n,i;
 struct node* root = (struct node*)malloc(sizeof(struct node));
 root->lchild=NULL;
 root->rchild=NULL;
 printf("Enter the count : ");
 scanf("%d", &n);
 if(n>0){
     int* arr = (int*)malloc(sizeof(int)*n);
     for(i=0;i<n;i++){
         printf("Enter the number :");
         scanf("%d",&arr[i]);
     }
     root->data=arr[0];
     for(i=1;i<n;i++){
         Insert(root,arr[i]);
     }
     printf("\n\n--- SORTED NUMBERS ---\n\n");
     inorder_traversal(root);
     printf("\n");
 }else{
     printf("\n Please Enter valid count ");
  }
}
```

**OUTPUT:**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>BinaryTreeSort
Enter the count : 10
Enter the number :1
Enter the number :2
Enter the number :3
Enter the number :4
Enter the number :5
Enter the number :6
Enter the number :7
Enter the number :8
Enter the number :9
Enter the number :10
--- SORTED NUMBERS ---
1 2 3 4 5 6 7 8 9 10
D:\Data Structures\Programs>BinaryTreeSort
Enter the count : 10
Enter the number :10
Enter the number :9
Enter the number :8
Enter the number :7
Enter the number :6
Enter the number :5
Enter the number :
4
Enter the number :3
Enter the number :2
Enter the number :1
--- SORTED NUMBERS ---
1 2 3 4 5 6 7 8 9 10
D:\Data Structures\Programs>




**RESULT:**

The given set of numbers are sorted using a binary search tree.

11/01/2021

## Experiment No:21

# GRAPH TRAVERSAL

### AIM:

Write a program to create a graph using arrays and perform the following operations:

1. DFS Traversal
2. BFS Traversal

### DATA STRUCTURES USED:

Graph using Arrays,Stack,Queue.

### ALGORITHM:

Algorithm DFS
START
1. Push the starting vertex into the stack
2. While stack not empty
3. Pop a vertex v
4. If v is not in VISIT
5. Visit the vertex x
6. Store v in VISIT
7. Push all the adjacent vertices of v into stack
8. EndIf
9. EndWhile
STOP

Algorithm BFS
START
1. Enqueue starting vertex
2. Visit the vertex
3. Store the vertex in VISIT
4. While queue not empty
5. Dequeue a vertex v
6. For all the adjacent vertices w of v
7. If w is not in VISIT
8. Enqueue w
9. Visit w
10. Store w in VISIT
11. EndIf
12. EndFor
13. EndWhile

STOP

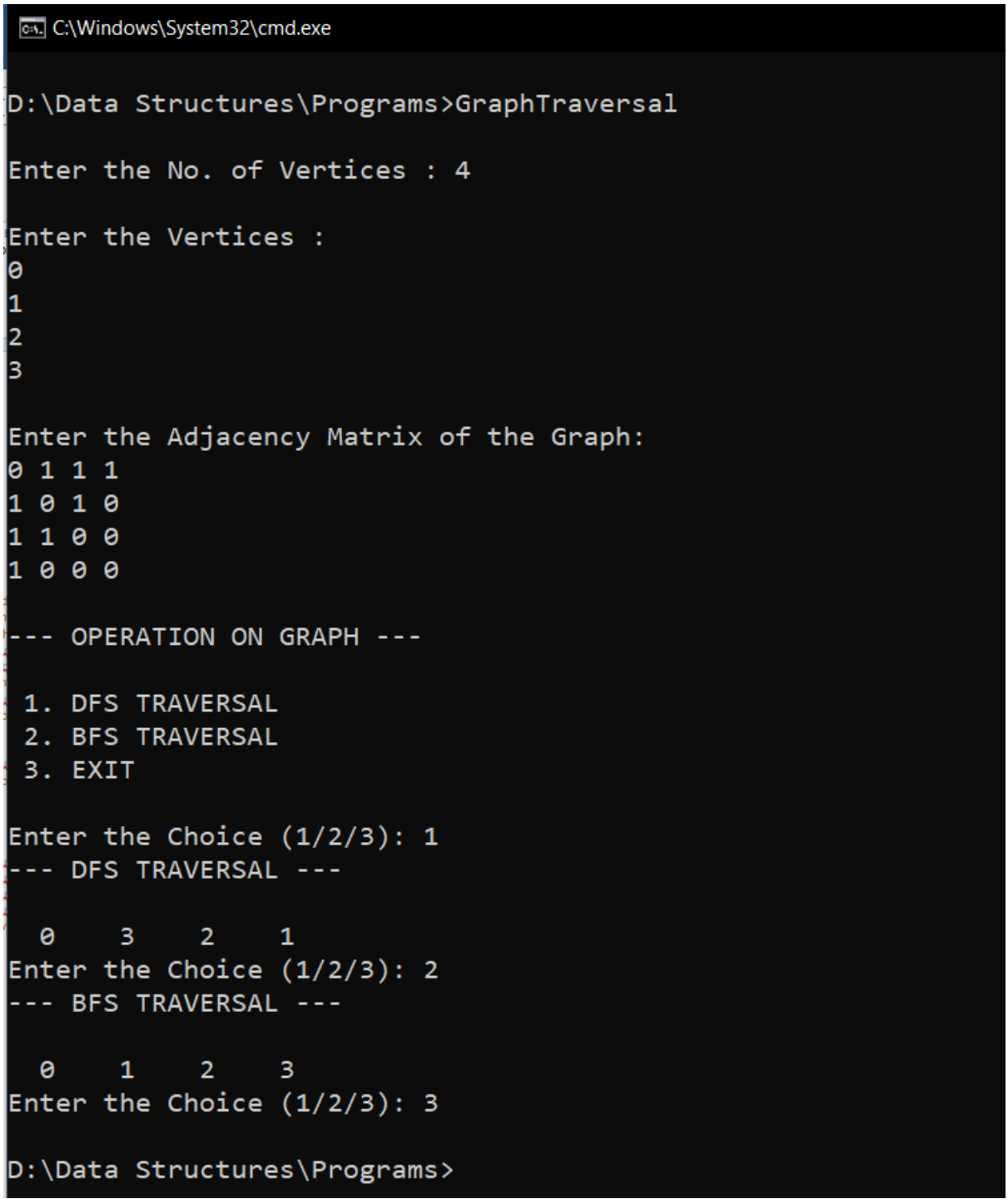
**PROGRAM:**

```
#include<stdio.h>
#include<stdlib.h>
int stack[100];
int queue[100];
int top = -1;
int front = -1,rear=-1;
void push(int x){
   stack[++top] = x;
}

int pop(){
   if(top!=-1){
      int x = stack[top];
      top--;
      return x;
   }
}
void enqueue(int x){
   if(front == -1){
      front = 0;
      rear = 0;
      queue[rear]=x;
   }else{
      queue[++rear]=x;
   }
}
int dequeue(){
   if(front != -1){
      int x = queue[front];
      if(front == rear){
         front = -1;
         rear = -1;
      }else{
         front = front + 1;
      }
      return x;
   }
}
void dfs_traversal(int n ,int value[], int adj[][n]){
   int flag = 0;
   int index=0,j,k;
   int vertex;
   int visit[n];
```

```
    push(value[0]);
    while(top!=-1){
        vertex = pop();
        for(j=0; j<n; j++){
            if(visit[j] == vertex){
                flag =1;
            }
        }
        if(flag == 0){
            visit[index] = vertex;
            printf("  %d  ",vertex);
            for(j=0; j<n; j++){
                if(value[j] == vertex){
                    for(k=0; k<n; k++){
                        if(adj[j][k] == 1 ){
                            push(value[k]);
                        }
                    }
                    break;
                }
            }
            index++;
        }
        flag = 0;
    }
}
void bfs_traversal(int n ,int value[], int adj[][n]){
    int index = 0;
    int flag = 0,vertex,j,k,i;
    int visit[n];
    enqueue(value[0]);
    printf("  %d  ", value[0]);
    visit[index++] = value[0];
    while(front!= -1){
        vertex = dequeue();
        for( j=0; j<n; j++){
            if(value[j] == vertex){
                for(k=0; k<n; k++){
                    if(adj[j][k] == 1){
                        for( i=0; i<n; i++){
                            if(visit[i] == value[k]){
                                flag = 1;
                            }
                        }
                        if(flag == 0){
                            enqueue(value[k]);
                            printf("  %d  ", value[k]);
```

```
                    visit[index] = value[k];
                    index++;
                }
                flag = 0;
            }
        }
        break;
    }
  }
 }
void main(){
  int n,i,j,op;
  char ans='y';
  printf("\nEnter the No. of Vertices : ");
  scanf("%d", &n);
  int adj[n][n],value[n];
  printf("\nEnter the Vertices : \n");
  for(i=0; i<n; i++){
    scanf("%d", &value[i]);
  }
  printf("\nEnter the Adjacency Matrix of the Graph:\n");
  for(i=0; i<n; i++){
    for(j=0; j<n; j++){
      scanf("%d", &adj[i][j]);
    }
  }
  printf("\n--- OPERATION ON GRAPH --- \n\n");
  printf(" 1. DFS TRAVERSAL\n");
  printf(" 2. BFS TRAVERSAL\n");
  printf(" 3. EXIT \n");
  while(ans=='y'){
    printf("\nEnter the Choice (1/2/3): ");
    scanf("%d",&op);
    switch(op){
        case 1:printf("--- DFS TRAVERSAL ---\n\n");
            dfs_traversal(n,value,adj);
            break;
        case 2:printf("--- BFS TRAVERSAL ---\n\n");
            bfs_traversal(n,value,adj);
            break;
        case 3:ans='n';
            break;
        default:printf("Enter a Valid Input\n");
    }
  }
}
```

**OUTPUT:**




**RESULT:**

The given operations are performed on a graph using arrays.

10/02/2021

## Experiment No:22

# QUICK SORT AND MERGE SORT

### AIM:

Create a text file containing the name, height, weight of the students in a class. Perform Quick sort and Merge sort on this data and store the resultant data in two separate files. Also write the time taken by the two sorting methods into the respective files. Eg: Sony Mathew 5.5 60 Arun Sajeev 5.7 58 Rajesh Kumar 6.1 70

### DATA STRUCTURES USED:

Arrays

### ALGORITHM:

```
Algorithm Partition(A, p, r)
START
1. x = A[r]
2. i = p-1
3. for j = p to r
4.     if (A[j] <= x)
5.         i = i+1
6.         if (i != j)
7.             swap A[i] and A[j]
8.         endif
9.     endif
10. endfor
11. if (r != i+1)
12.     swap A[i+1] and A[r]
13. endif
14. return i+1
STOP
```

```
Algorithm QuickSort(A, p, r)
START
1. if (p < r)
2.     q = Partition(A, p ,r)
3.     QuickSort(A, p, q-1)
4.     QuickSort(A, q+1, r)
5. endif
STOP
```

Algorithm Merge(A, p, q, r)
START
1. n1 = q - p + 1
2. n2 = r - q
3. Declare L[n1], R[n2]
4. for i = 0 till n1
5.  L[i] = A[p+i]
6. endfor
7. for j = 0 till n2
8.  R[j] = A[q+j+1]
9. endfor
10. i = 0, j = 0,L[n1+1]=R[n2+1]=∞
11. for k = p to r
12.  if (L[i] <= R[j])
13.  A[k] = L[i]
14.  i = i+1
15.  else
20.  A[k] = R[j]
21.  j = j+1
25.  endif
27. endfor
STOP

Algorithm MergeSort(A, p, r)
START
1. if (p < r)
2.  q = floor((p+r)/2)
3.  MergeSort(A, p, q)
4.  MergeSort(A, q+1, r)
5.  Merge(A, p, q, r)
6. endif
STOP

**PROGRAM:**

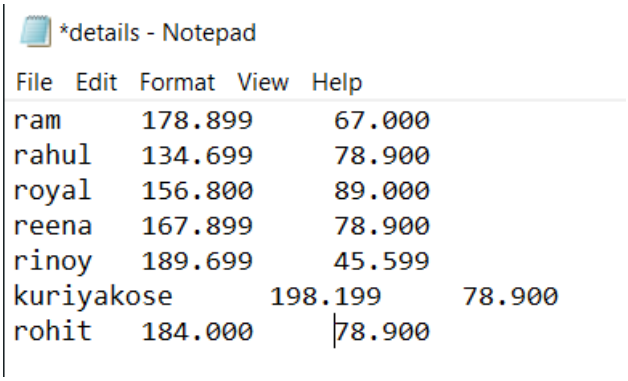
```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include<time.h>
#include<math.h>

struct student
{
  char name[20];
```

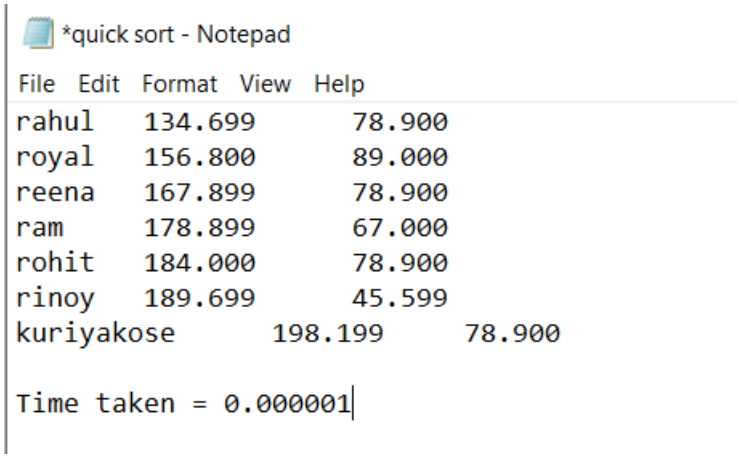
```
  float height;
  float weight;
};
int partition(struct student s[], int p, int r){
   struct student temp;
  float x = s[r].height;
  int i = p-1;
  for(int j = p; j < r; j++){
    if(s[j].height <= x){
      i=i+1;
      temp = s[i];
      s[i] = s[j];
      s[j] = temp;
    }
  }
  temp = s[i+1];
  s[i+1] = s[r];
  s[r] = temp;
  return i+1;
}
void quick_sort(struct student s[], int p, int r)
{
  if(p < r)
  {
    int q = partition(s, p ,r);
    quick_sort(s, p, q-1);
    quick_sort(s, q+1, r);
  }
}
void merge(struct student s[], int p, int q, int r){
  int n1 = q - p + 1;
  int n2 = r - q;
  int i,j;
  struct student L[n1], R[n2];
  for( i = 0; i <n1; i++){
    L[i] = s[p+i];
  }
  for(j = 0; j <n2;j++){
    R[j] = s[q+j+1];
  }
  i = 0, j = 0;
  int k;
  for(k = p; k <= r; k++){
    if(L[i].height <= R[j].height){
      s[k] = L[i];
      i=i+1;
      if(i == n1){
```

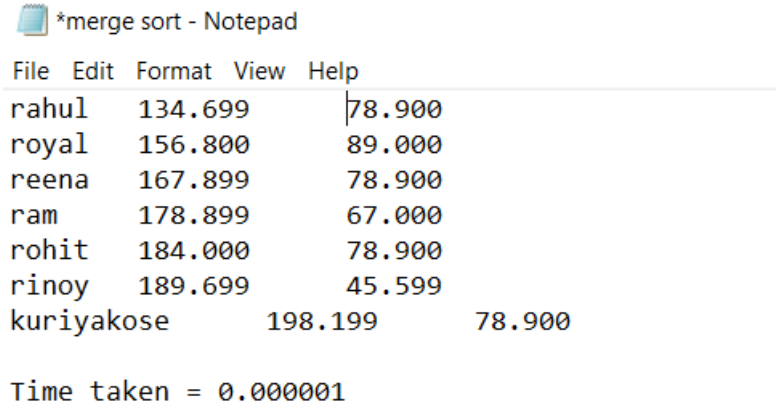
```
            k++;
            break;
          }
        }
        else{
          s[k] = R[j];
          j=j+1;
          if(j == n2){
            k++;
            break;
          }

        }
      }
      while(i < n1)
      {
        s[k] = L[i];
        i++;
        k++;
      }
      while(j < n2)
      {
        s[k] = R[j];
        j++;
        k++;
      }
}

void merge_sort(struct student s[], int p, int r)
{
  if(p < r)
  {
    int q = floor((p+r)/2);
    merge_sort(s, p, q);
    merge_sort(s, q+1, r);
    merge(s, p, q, r);
  }
}
void main()
{
  int n,i;
  char c,name[50];
  float height, weight;

  printf("Enter the Number of Students : ");
  scanf("%d", &n);
```

```
  FILE *fp1 = fopen("details.txt", "w");
  FILE *fp2 = fopen("details.txt", "r");
  FILE *fp3 = fopen("quick sort.txt", "w");
  FILE *fp4 = fopen("merge sort.txt", "w");
  struct student s1[50],s2[50];
  for( i=0; i<n; i++){
    printf("\nEnter the Details :\n");
    printf("  Name : ");
    scanf("%c", &c);
    gets(name);
    printf("  Height :");
    scanf("%f", &height);
    printf("  Weight : ");
    scanf("%f", &weight);
    fprintf(fp1,"%s\t%.3f\t%.3f\n",name,height,weight);
  }
  fclose(fp1);

  for( i = 0; i <n; i++){
    fscanf(fp2,"%s\t%f\t%f\n",s1[i].name, &s1[i].height, &s1[i].weight);
    strcpy(s2[i].name,s1[i].name);
    s2[i].height = s1[i].height;
    s2[i].weight = s1[i].weight;
  }
  fclose(fp2);


  clock_t start ,stop;
  start = clock();
  quick_sort(s1, 0, n-1);
  stop= clock() ;
  for(i = 0; i < n; i++){
    fprintf(fp3,"%s\t%.3f\t%.3f\n",, s1[i].name, s1[i].height, s1[i].weight);
  }
  fprintf(fp3, "\nTime taken = %f", (double) (start-stop) / CLOCKS_PER_SEC);
  fclose(fp3);

  start = clock();
  merge_sort(s2, 0, n-1);
  stop= clock();
  for(i = 0; i < n; i++){
    fprintf(fp4,"%s\t%.3f\t%.3f\n",, s2[i].name, s2[i].height, s2[i].weight);
  }
  fprintf(fp4, "\nTime taken = %f", (double) (start-stop) / CLOCKS_PER_SEC);
  fclose(fp4);

}
```

**OUTPUT:**




**RESULT:**

Quick sort and Merge sort were done on file containing data.

10/02/2021

## Experiment No:23

# HEAP SORT

### AIM:

Write a program to sort a set of numbers using Heap sort and find a particular number from the sorted set using Binary Search.

### DATA STRUCTURES USED:

Arrays

### ALGORITHM:

```
Algorithm CreateHeap(A, n)
START
1. i = 0
2. while (i < n)
3.     j = i
4.     while (j > 1)
5.         if (A[j] > A[(j-1)/2])
6.             swap A[j] and A[(j-1)/2]
7.             j = j/2
8.         else
9.             j=1
10.        endif
11     endwhile
12.. i = i+1
13. endwhile
STOP

Algorithm RemoveMax(A, i)
START
1. swap A[i] and A[1]
STOP

Algorithm RebuildHeap(A, i)
START
1. if (i =1)
2.     exit
3. endif
4. j = 1,flag=TRUE
5. while(flag = TRUE)
6.     leftchild = 2 * j
```

```
7.    rightchild = 2 *j + 1
8.    if (rightchild <= i)
9.          if(A[j] <= A[leftchild] && A[leftchild] >= A[rc])
10.               swap A[j] and A[leftchild]
11.               j = leftchild
12.       else if (A[j] <= A[rightchild] && A[rightchild] >= A[leftchild])
13.               swap A[j] and A[rightchild]
14.               j = rightchild
15.       else
16.              flag = FALSE
17.   else if (leftchild <= i)
18.        if (A[j] <= A[leftchild])
19.               swap A[j] and A[leftchild]
20.               j=leftchild
21.         else
22.              break
23.   else
24.        flag = FALSE
25. endif
26. endwhile
STOP

Algorithm HeapSort(A, n)
START
1. CreateHeap(A, n)
2.  for i = n-1 down till 2
3.        RemoveMax(A, i)
4.        RebuildHeap(A, i-1)
5. endfor
STOP

Algorithm BinarySearch(A, num, l, r)
START
1. while (first <= last)
2.       middle = (first+last) / 2
3.       if (A[middle] == num)
4.              return middle
5.      else if (A[middle] < num)
6.             first = middle+1
7.      else
8.             last = middle - 1
9. endif
STOP
```

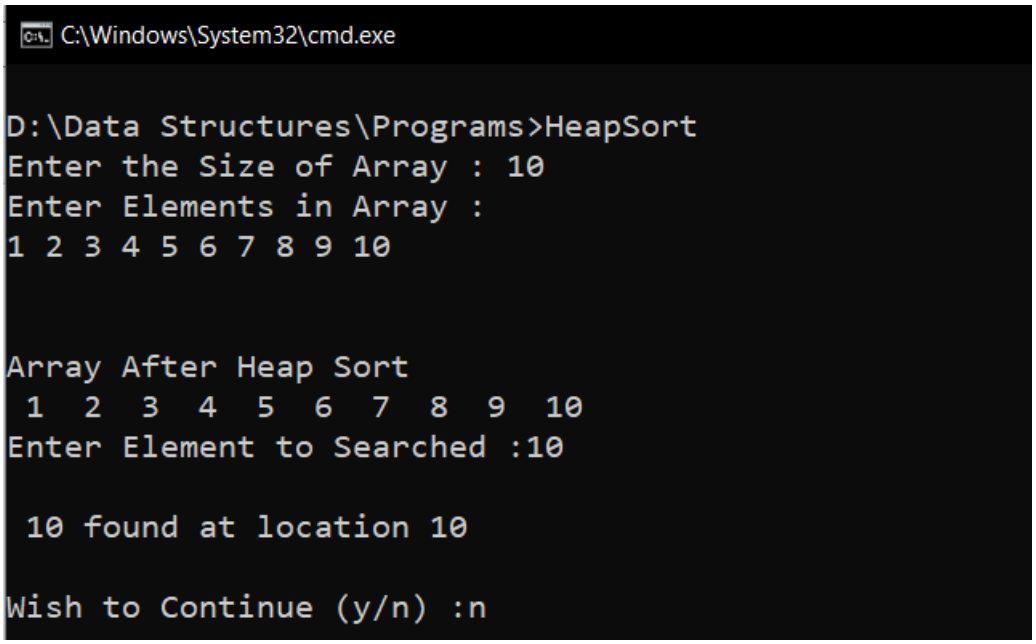
**PROGRAM:**

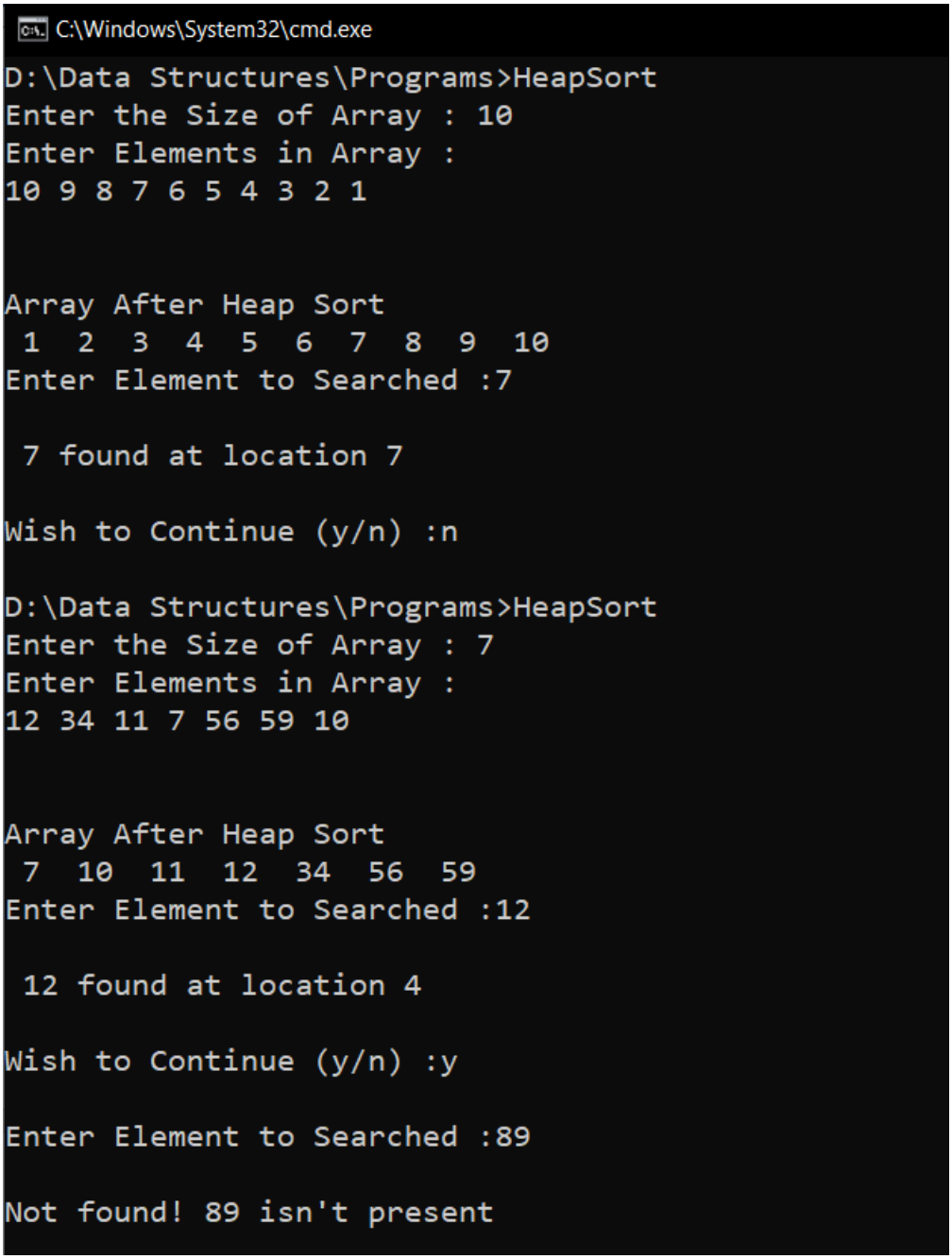
```
#include<stdio.h>
void create_heap(int A[],int B[],int n){
   int i=1;
   while(i<=n){
      int x = A[i];
      B[i] = x;
      int j = i;
      while(j>1){
         if(B[j]>B[j/2]){
            int temp = B[j];
            B[j] = B[j/2];
            B[j/2] = temp;
            j = j/2;
         }else{
            j = 1;
         }
      }
      i++;
   }
}

void remove_max(int B[],int i){
   int temp = B[i];
   B[i] = B[1];
   B[1] = temp;
}

void rebuild_heap(int B[],int i){
  if(i!=1){
     int j=1;
     int flag = 1;
     int temp;
     while(flag==1){
        int leftchild = 2*j;
        int rightchild = 2*j+1;
        if(rightchild<=i){
           if((B[j]<=B[leftchild])&&(B[rightchild]<=B[leftchild])){
              temp = B[j];
              B[j] = B[leftchild];
              B[leftchild] = temp;
              j = leftchild;
           }else if((B[j]<=B[rightchild])&&(B[rightchild]>=B[leftchild])){
              temp = B[j];
              B[j] = B[rightchild];
              B[rightchild] = temp;
```

```
            j = rightchild;
          }else{
            flag = 0;
          }
        }else if(leftchild<=i){
          if(B[j]<=B[leftchild]){
            temp = B[j];
            B[j] = B[leftchild];
            B[leftchild] = temp;
            j = leftchild;
          }else{
            flag = 0;
          }
        }else{
          flag=0;
        }
      }
    }
}

void binary_search(int B[],int n,int item){


  int first = 1;
  int last = n;
  int middle = (first+last)/2;
  while(first<=last) {
    if(B[middle]<item){
      first = middle + 1;
    }
    else if(B[middle] == item) {
      printf("\n %d found at location %d \n", item, middle);
      break;
    }
    else{
      last = middle - 1;
    }
    middle = (first + last)/2;
  }
  if(first>last){
    printf("\nNot found! %d isn't present \n", item);
  }
}

void main(){
    int A[100],B[100],n,i,item;
    char ans;
```

```
    printf("Enter the Size of Array : ");
    scanf("%d",&n);
    printf("Enter Elements in Array :\n");
    for(i=1;i<=n;i++){
        scanf("%d",&A[i]);
    }
    create_heap(A,B,n);
    for(i=n;i>1;i--){
        remove_max(B,i);
        rebuild_heap(B,i-1);
    }
    printf("\n\nArray After Heap Sort\n");
    for(i=1;i<=n;i++){
        printf(" %d ",B[i]);
    }
    do{
        printf("\nEnter Element to Searched :");
        scanf("%d", &item);
        binary_search(B,n,item);
        printf("\nWish to Continue (y/n) :");
        scanf("%c",&ans);
        scanf("%c",&ans);
    }while(ans=='y');
}
```

**OUTPUT:**






**RESULT:**

Heap Sort was carried out in a set of data.

12/02/2021

## Experiment No:24

# HASHING

### AIM:

1. Implement a Hash table using Chaining method. Let the size of hash table be 10 so that the index varies from 0 to 9.
2. Implement a Hash table that uses Linear Probing for collision resolution

### DATA STRUCTURES USED:

Arrays

### ALGORITHM:

Algorithm Hashing(using Chaining)
START
1. index = value % 10
2. ptr = hash_table[index]
3. while (ptr->LINK != NULL)
4. ptr = ptr->LINK
5. endwhile
6. new = GetNode(NODE)
7. new->value = value
8. new->link=NULL
9. ptr->link=new
STOP

Algorithm Hashing(using Linear Probing)
START
1. index = value % size
2. if (hash_table[index] == ∞)
3. hash_table[index] = key
4. else
5. for i = index+1 till size
6. if (hash[i] == ∞)
7. hash[i] = key
8. return
9. endfor
10. for i = 0 till index-1
11. if (hash[i] == ∞)
12. hash[i] = key
13. return
14. endfor

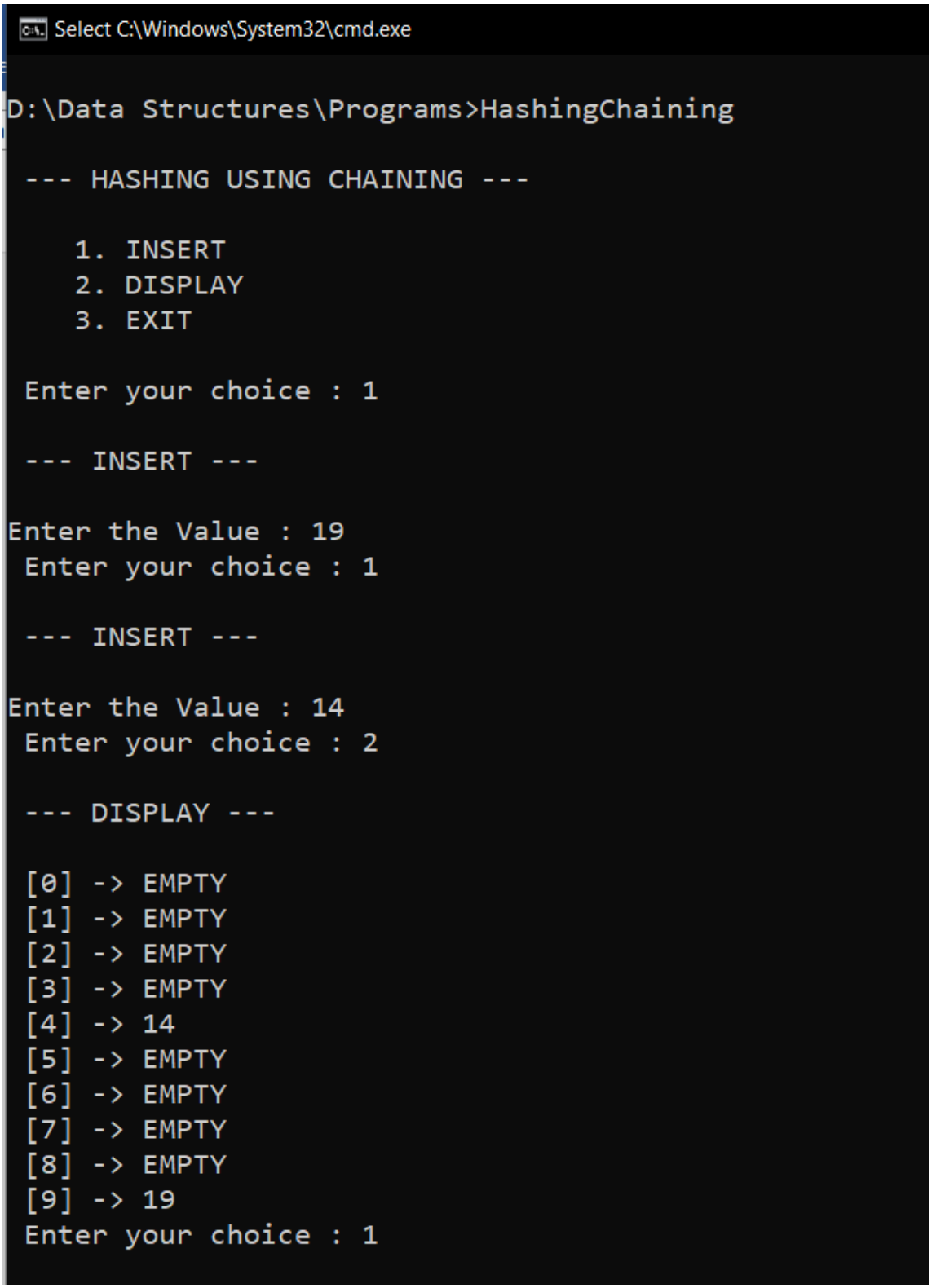
15 print "Hash table is full!"
16. endif
STOP

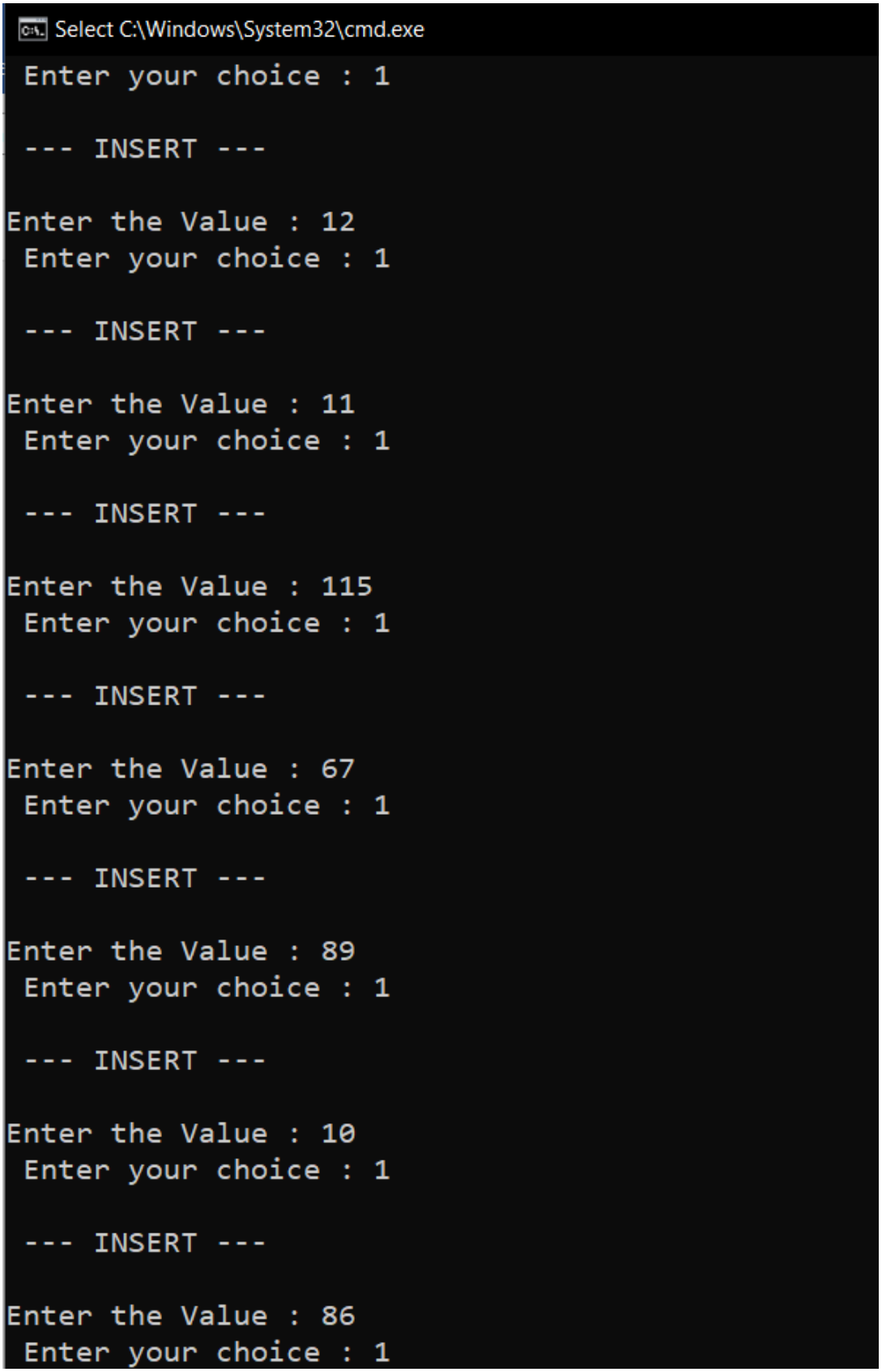
**PROGRAM(1):**

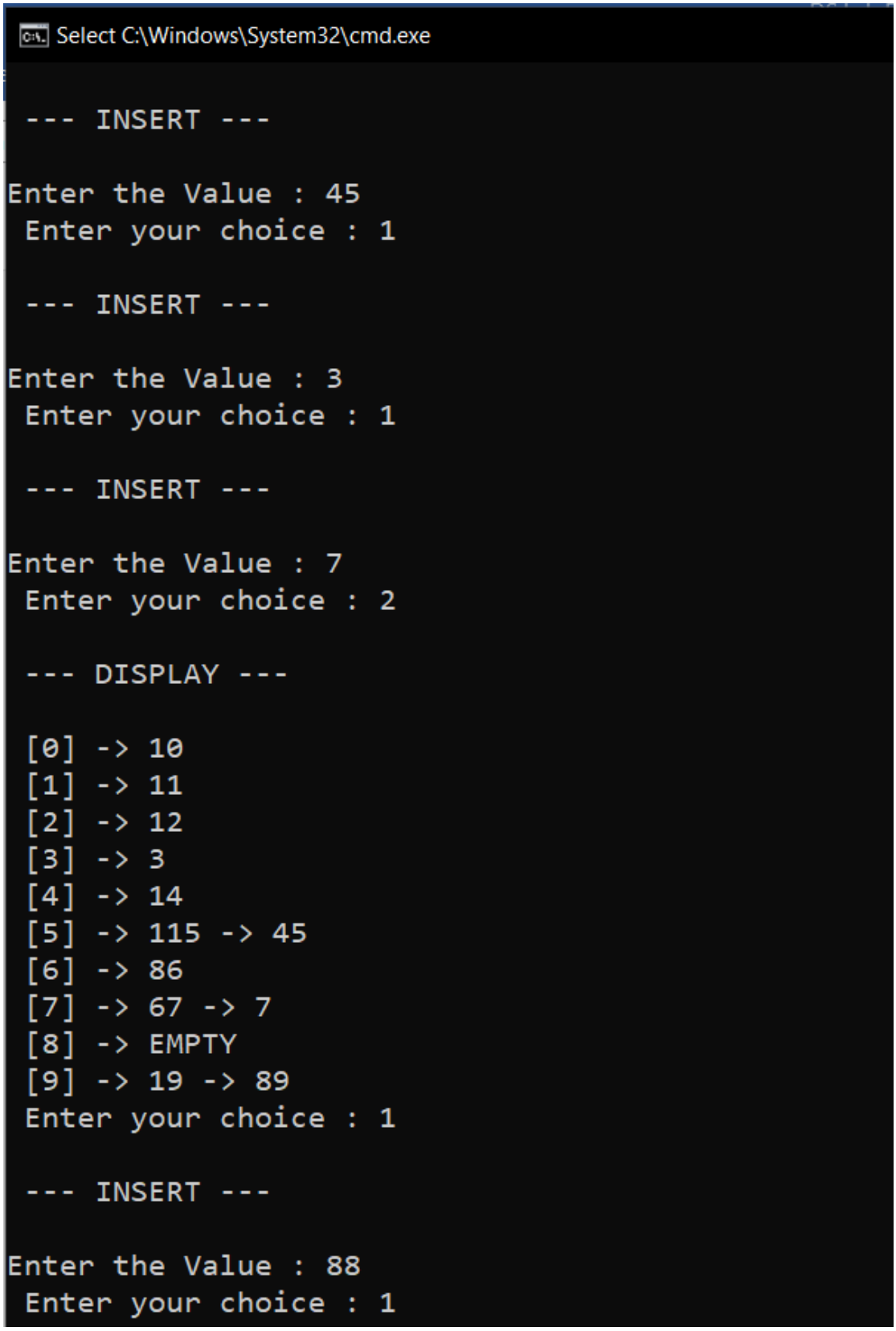
```
#include<stdio.h>
#include<stdlib.h>
struct node {
   int value;
   struct node *link;
};
void insert(struct node hash_table[],int value){
   int index = value%10;
   struct node *ptr = hash_table;
   struct node *new = (struct node*)malloc(sizeof(struct node));
   new->link=NULL;
   new->value = value;
   ptr=ptr+index;
   if(ptr->link==NULL){
      ptr->link=new;
   }else{
      while(ptr->link != NULL){
         ptr=ptr->link;
      }
      ptr->link=new;
   }
}
void display(struct node hash_table[]){
   struct node *ptr = hash_table;
   for(int i=0;i<10;i++){
      if(ptr->link==NULL){
         printf(" [%d] -> EMPTY ",i);
      }else{
         printf(" [%d] ",i);
         struct node *ptr1=ptr;
         while(ptr1->link!=NULL){
            ptr1=ptr1->link;
            printf("-> %d ",ptr1->value);
         }
      }
      printf("\n");
      ptr++;
   }

}
void main(){
   int ans=1,op,value,i;
```

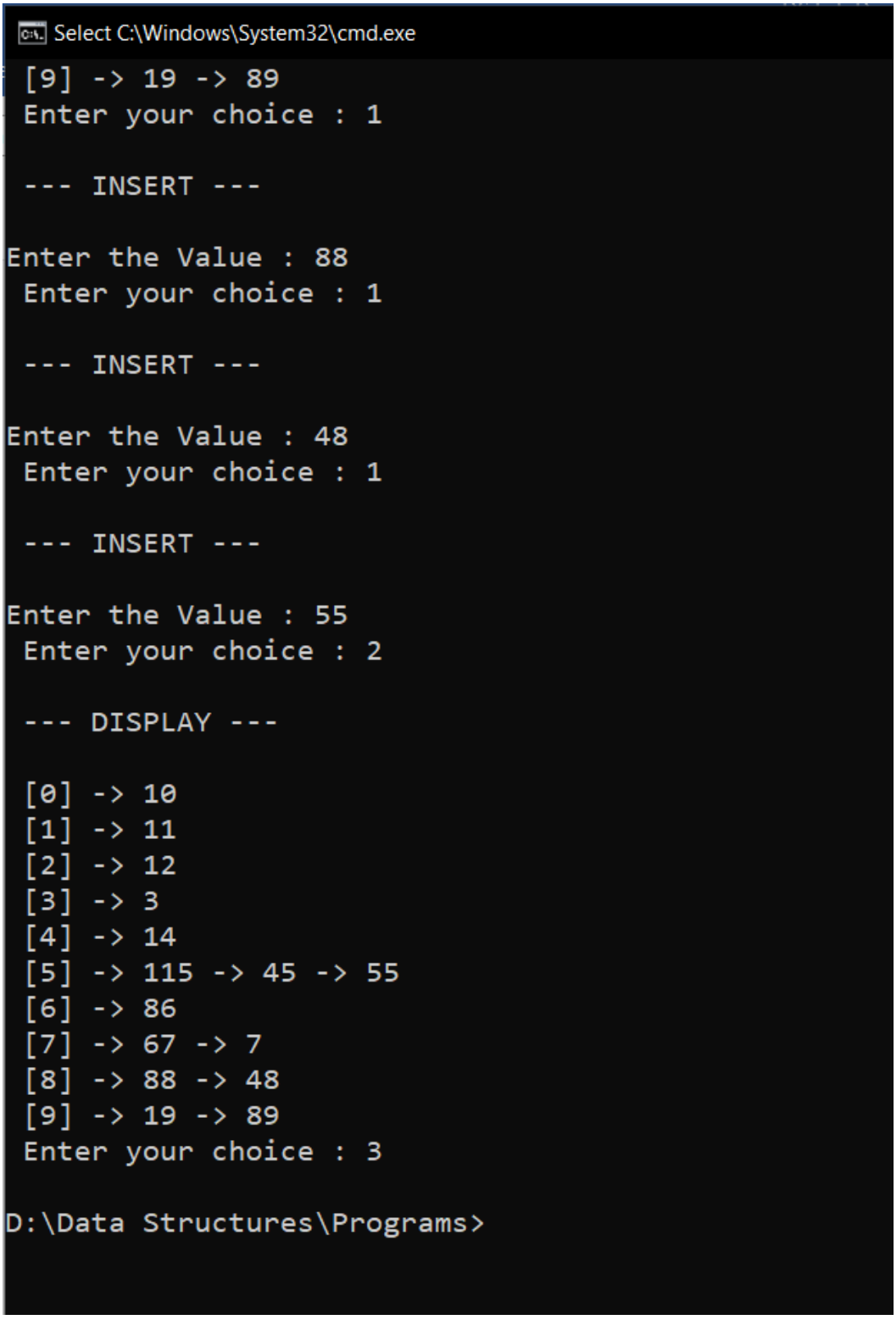
```
    struct node hash_table[10];
    for(i=0;i<10;i++){
      hash_table[i].link=NULL;
    }
    printf("\n --- HASHING USING CHAINING --- \n\n");
    printf("    1. INSERT \n");
    printf("    2. DISPLAY \n");
    printf("    3. EXIT \n\n");
    while(ans==1){
       printf(" Enter your choice : ");
       scanf("%d",&op);
       switch(op){
          case 1 : printf("\n --- INSERT ---\n\n");
                   printf("Enter the Value : ");
                   scanf("%d",&value);
                   insert(hash_table,value);
                   break;
          case 2 : printf("\n --- DISPLAY ---\n\n");
                   display(hash_table);
                   break;
          case 3 : ans=0;
                   break;
          default : printf("\n Enter a Valid Input \n");
       }
    }
}
```

**OUTPUT(1):**


Select C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>HashingChaining
--- HASHING USING CHAINING ---
1. INSERT
2. DISPLAY
3. EXIT
Enter your choice : 1
--- INSERT ---
Enter the Value : 19
Enter your choice : 1
--- INSERT ---
Enter the Value : 14
Enter your choice : 2
--- DISPLAY ---
[0] -> EMPTY
[1] -> EMPTY
[2] -> EMPTY
[3] -> EMPTY
[4] -> 14
[5] -> EMPTY
[6] -> EMPTY
[7] -> EMPTY
[8] -> EMPTY
[9] -> 19
Enter your choice : 1


Select C:\Windows\System32\cmd.exe
Enter your choice : 1
--- INSERT ---
Enter the Value : 12
Enter your choice : 1
--- INSERT ---
Enter the Value : 11
Enter your choice : 1
--- INSERT ---
Enter the Value : 115
Enter your choice : 1
--- INSERT ---
Enter the Value : 67
Enter your choice : 1
--- INSERT ---
Enter the Value : 89
Enter your choice : 1
--- INSERT ---
Enter the Value : 10
Enter your choice : 1
--- INSERT ---
Enter the Value : 86
Enter your choice : 1


Select C:\Windows\System32\cmd.exe
--- INSERT ---
Enter the Value : 45
Enter your choice : 1
--- INSERT ---
Enter the Value : 3
Enter your choice : 1
--- INSERT ---
Enter the Value : 7
Enter your choice : 2
--- DISPLAY ---
[0] -> 10
[1] -> 11
[2] -> 12
[3] -> 3
[4] -> 14
[5] -> 115 -> 45
[6] -> 86
[7] -> 67 -> 7
[8] -> EMPTY
[9] -> 19 -> 89
Enter your choice : 1
--- INSERT ---
Enter the Value : 88
Enter your choice : 1

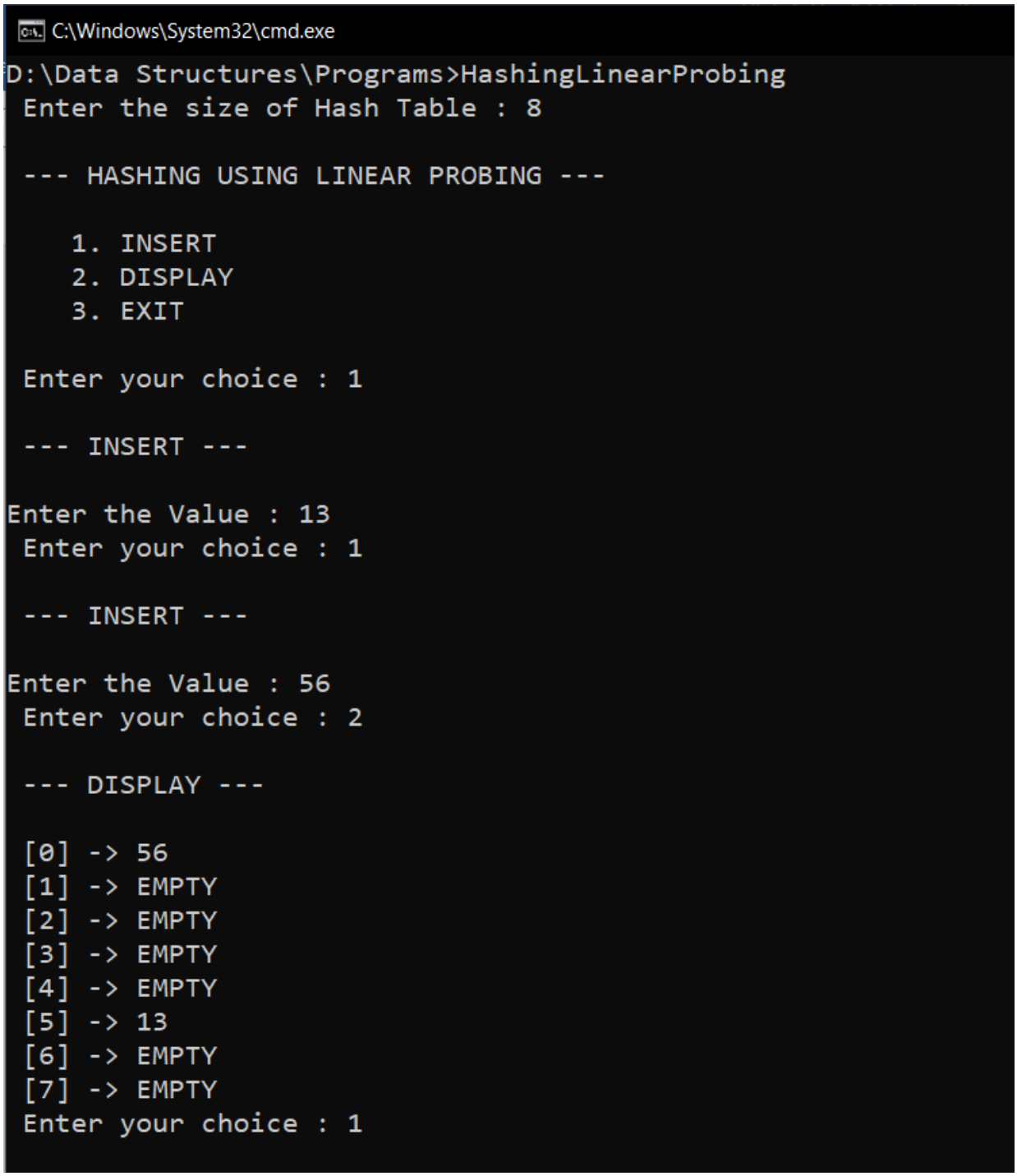

Select C:\Windows\System32\cmd.exe
[9] -> 19 -> 89
Enter your choice : 1
--- INSERT ---
Enter the Value : 88
Enter your choice : 1
--- INSERT ---
Enter the Value : 48
Enter your choice : 1
--- INSERT ---
Enter the Value : 55
Enter your choice : 2
--- DISPLAY ---
[0] -> 10
[1] -> 11
[2] -> 12
[3] -> 3
[4] -> 14
[5] -> 115 -> 45 -> 55
[6] -> 86
[7] -> 67 -> 7
[8] -> 88 -> 48
[9] -> 19 -> 89
Enter your choice : 3
D:\Data Structures\Programs>

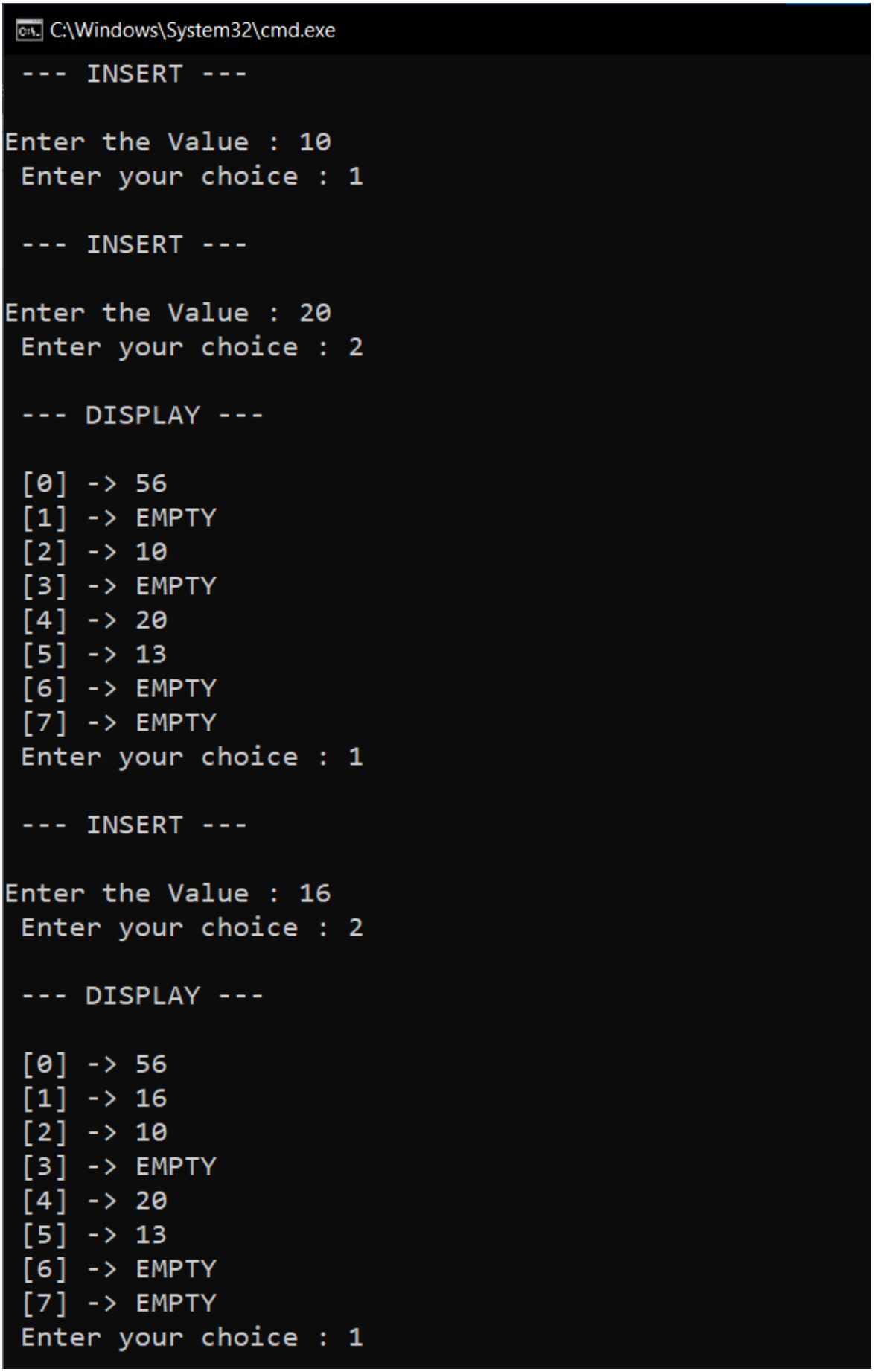
**PROGRAM(2):**

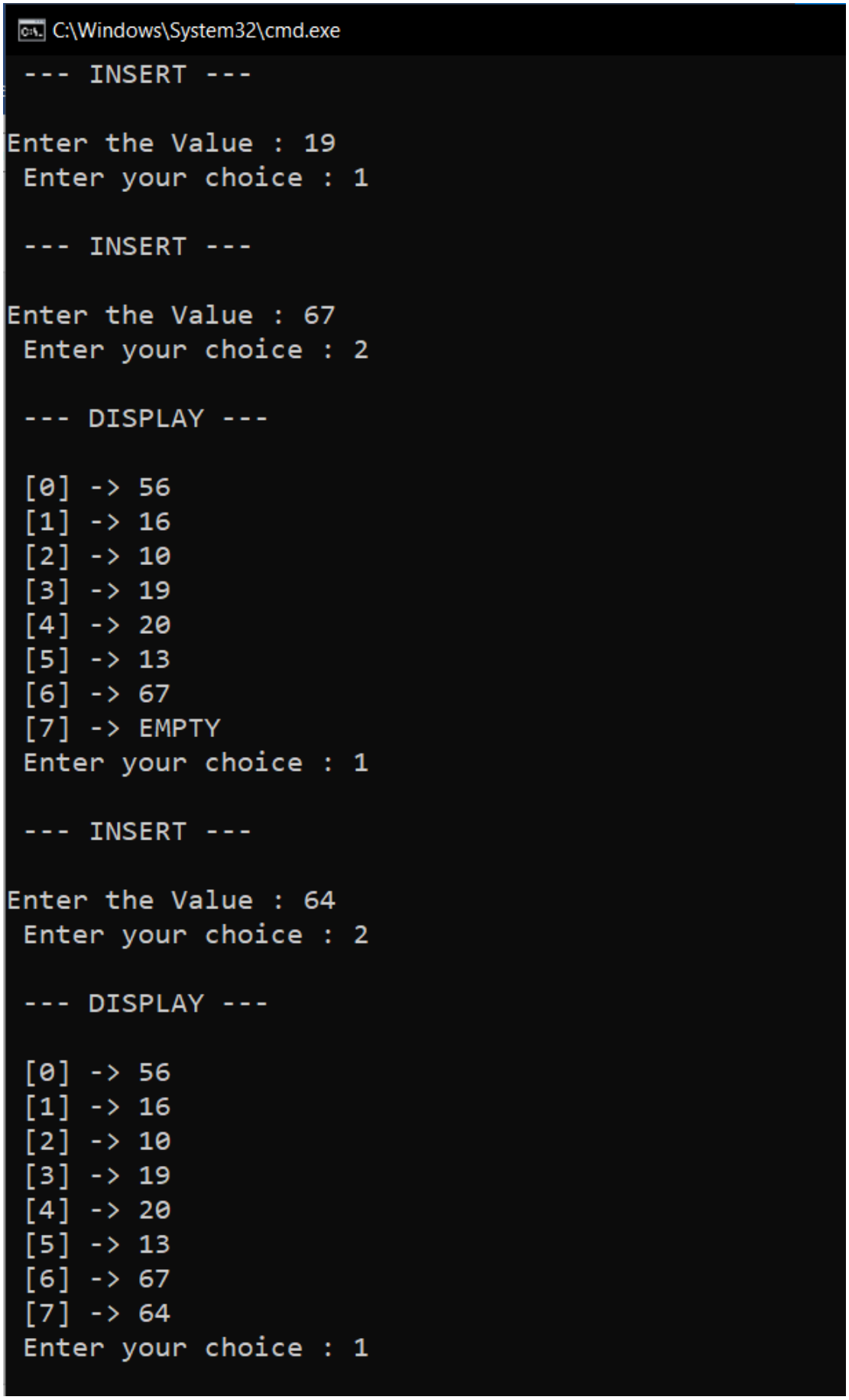
```
#include<stdio.h>
#include<stdlib.h>
#include<math.h>
void insert(int hash_table[],int value,int size){
   int index = value%size;
   if(hash_table[index]==(int)INFINITY){
      hash_table[index]=value;
   }else{
      for(int i= index+1;i<size;i++){
         if(hash_table[i]==(int)INFINITY){
            hash_table[i]=value;
            return;
         }
      }
      for(int i=0;i<index;i++){
         if(hash_table[i]==(int)INFINITY){
            hash_table[i]=value;
            return;
         }
      }
      printf("\n Hash Table is FULL \n");
   }
}
void display(int hash_table[],int size){

   for(int i=0;i<size;i++){
      if(hash_table[i]==(int)INFINITY){
         printf(" [%d] -> EMPTY ",i);
      }else{
         printf(" [%d] -> %d ",i,hash_table[i]);
      }
      printf("\n");
   }

}
void main(){
   int ans=1,op,value,i,size;
   printf(" Enter the size of Hash Table : ");
   scanf("%d",&size);
   int hash_table[size];
   for(i=0;i<size;i++){
      hash_table[i]=(int)INFINITY;
   }
   printf("\n --- HASHING USING LINEAR PROBING --- \n\n");
   printf("    1. INSERT \n");
```

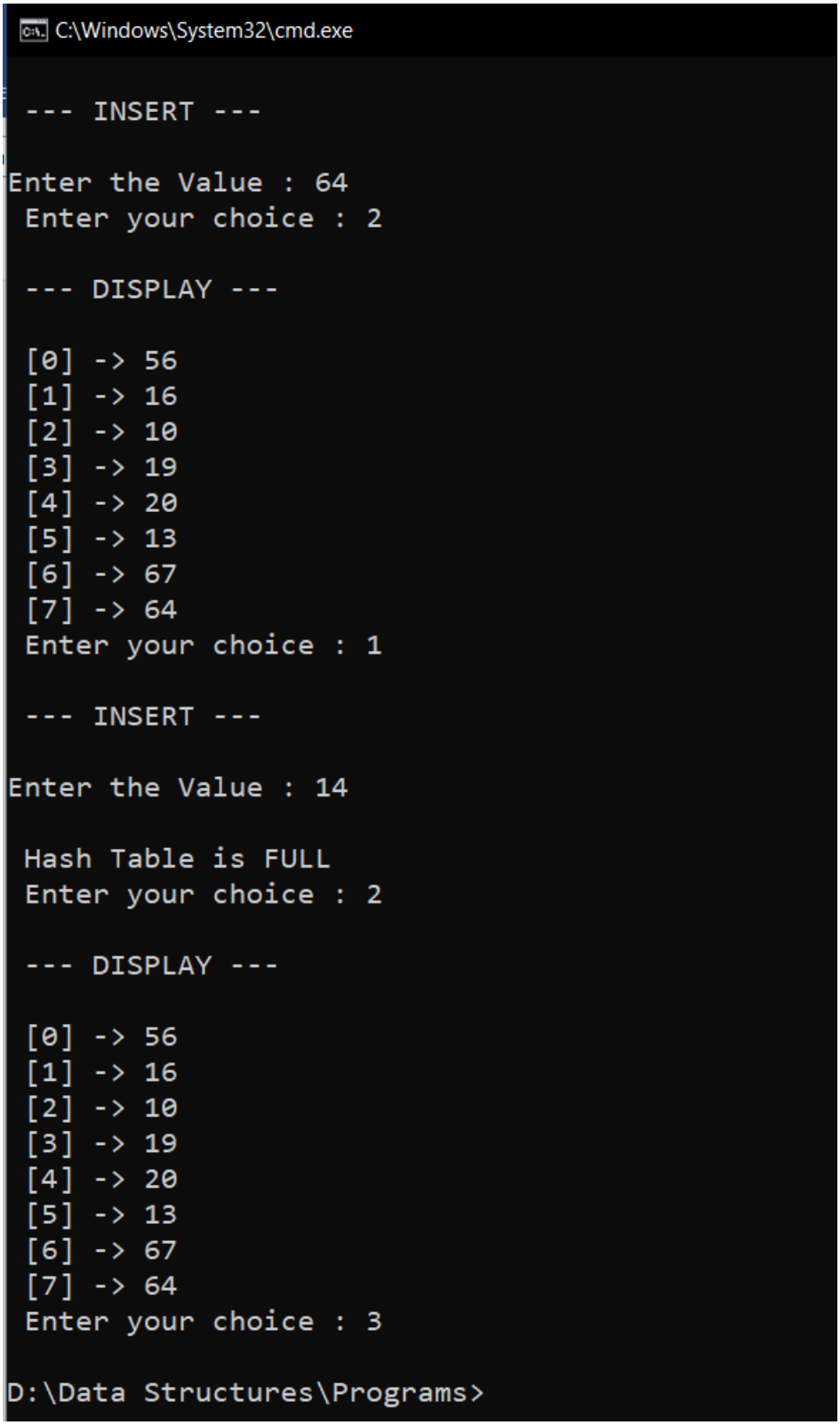
```
    printf("    2. DISPLAY \n");
    printf("    3. EXIT \n\n");
    while(ans==1){
        printf(" Enter your choice : ");
        scanf("%d",&op);
        switch(op){
            case 1 : printf("\n --- INSERT ---\n\n");
                     printf("Enter the Value : ");
                     scanf("%d",&value);
                     insert(hash_table,value,size);
                     break;
            case 2 : printf("\n --- DISPLAY ---\n\n");
                     display(hash_table,size);
                     break;
            case 3 : ans=0;
                     break;
            default : printf("\n Enter a Valid Input \n");
        }
    }
}
```

**OUTPUT(2):**


C:\Windows\System32\cmd.exe
D:\Data Structures\Programs>HashingLinearProbing
Enter the size of Hash Table : 8
--- HASHING USING LINEAR PROBING ---
1. INSERT
2. DISPLAY
3. EXIT
Enter your choice : 1
--- INSERT ---
Enter the Value : 13
Enter your choice : 1
--- INSERT ---
Enter the Value : 56
Enter your choice : 2
--- DISPLAY ---
[0] -> 56
[1] -> EMPTY
[2] -> EMPTY
[3] -> EMPTY
[4] -> EMPTY
[5] -> 13
[6] -> EMPTY
[7] -> EMPTY
Enter your choice : 1


C:\Windows\System32\cmd.exe
--- INSERT ---
Enter the Value : 10
Enter your choice : 1
--- INSERT ---
Enter the Value : 20
Enter your choice : 2
--- DISPLAY ---
[0] -> 56
[1] -> EMPTY
[2] -> 10
[3] -> EMPTY
[4] -> 20
[5] -> 13
[6] -> EMPTY
[7] -> EMPTY
Enter your choice : 1
--- INSERT ---
Enter the Value : 16
Enter your choice : 2
--- DISPLAY ---
[0] -> 56
[1] -> 16
[2] -> 10
[3] -> EMPTY
[4] -> 20
[5] -> 13
[6] -> EMPTY
[7] -> EMPTY
Enter your choice : 1


C:\Windows\System32\cmd.exe
--- INSERT ---
Enter the Value : 19
Enter your choice : 1
--- INSERT ---
Enter the Value : 67
Enter your choice : 2
--- DISPLAY ---
[0] -> 56
[1] -> 16
[2] -> 10
[3] -> 19
[4] -> 20
[5] -> 13
[6] -> 67
[7] -> EMPTY
Enter your choice : 1
--- INSERT ---
Enter the Value : 64
Enter your choice : 2
--- DISPLAY ---
[0] -> 56
[1] -> 16
[2] -> 10
[3] -> 19
[4] -> 20
[5] -> 13
[6] -> 67
[7] -> 64
Enter your choice : 1




**RESULT:**

Hash tables are implemented using open hashing (chaining) and closed hashing (linear probing).