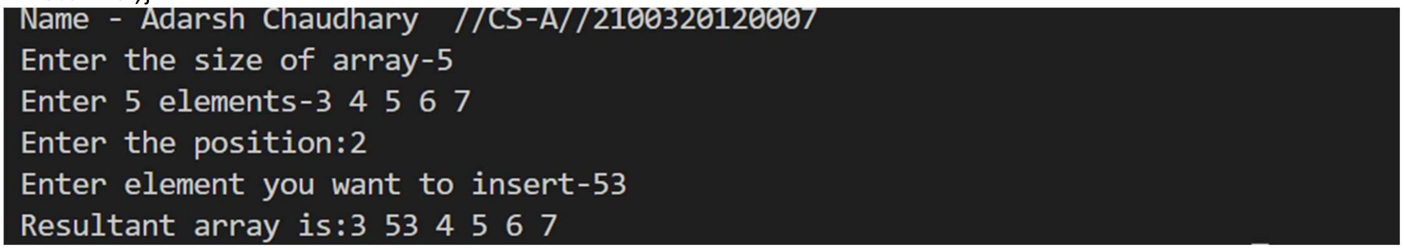
PROGRAM 1A - Program for Insertion in any array

ALGORITHM Insertion(A[], N, i, key)

```
BEGIN:
        FOR j=N TO i STEP-1 DO
             A[j+1]=A[j]
             A[i]=key
             N=N+1
END;
```

Time Complexity:Ɵ(N)
Space Complexity:Ɵ(1)

```
#include<stdio.h>
int main()

{
  printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
  int arr[100];
  int n;
  printf("Enter the size of array\n");
  scanf("%d",&n);
  printf("Enter %d elements\n",n);
  for(int i=0;i<n;i++)
  scanf("%d",&arr[i]);
  int posi;
  printf("position:");
  scanf("%d",&posi);
  int ele;
  printf("Enter element\n");
  scanf("%d",&ele);
  for(int i=n;i>=posi;i--)
    arr[i]=arr[i-1];

    arr[posi-1]=ele;
    n++;
  for(int i=0;i<n;i++)
    printf("%d",arr[i]);

  return 0 ;}
```



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array-5
Enter 5 elements-3 4 5 6 7
Enter the position:2
Enter element you want to insert-53
Resultant array is:3 53 4 5 6 7
```

PROGRAM 22 - Transpose without using second matrix

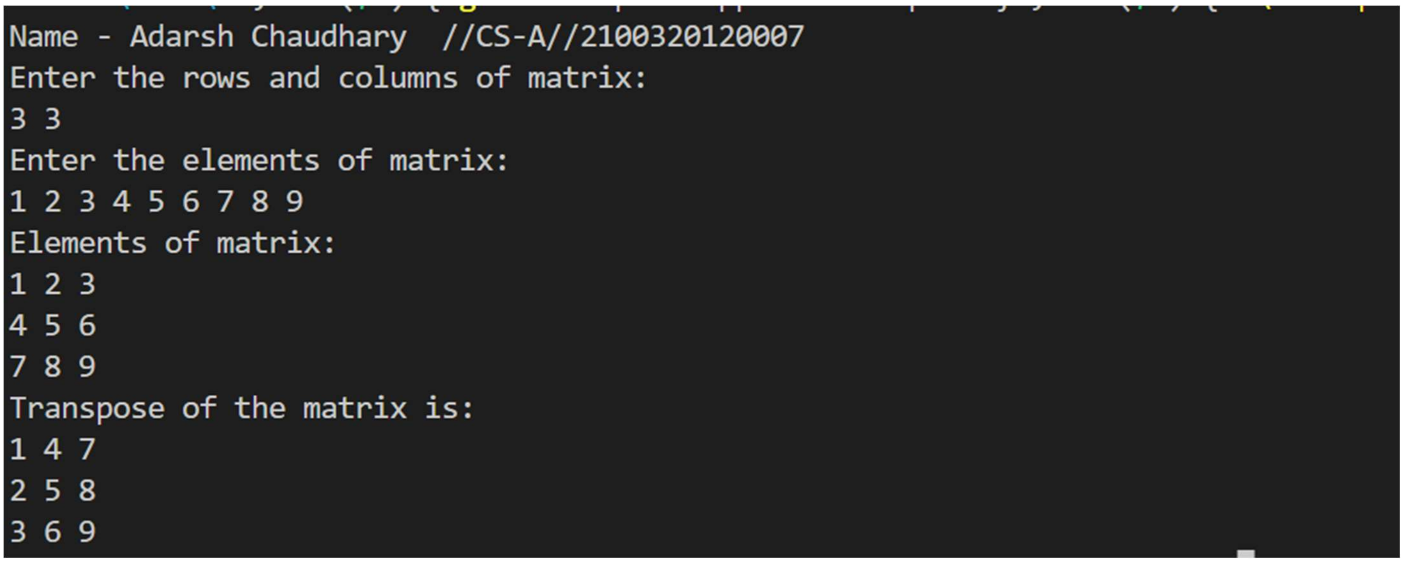
ALGORITHM: Matrixtranspose(A[][], M,N)

```
BEGIN:
        FOR i=1 TO M DO
                FOR j=1 TO i DO
                        temp=A[i][j]
                        A[i][j]=A[j][i]
                        A[j][i]=temp
        RETURN A
END;
```

Time Complexity: ϴ(N^2)
Space Complexity:ϴ(1)

```
#include<stdio.h>
int main()
{
   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n,m;
   printf("Enter the rows and columns of matrix:\n");
   scanf("%d%d",&n,&m);
   int arr[n][m];
   printf("Enter the elements of matrix:\n");
    for(int i=0;i<n;i++)
    {
      for(int j=0;j<m;j++)
         scanf("%d",&arr[i][j]);
    }
   for(int i=0;i<n;i++)
   {
      for(int j=i;j<m;j++)
      {
         int temp=arr[i][j];
         arr[i][j]=arr[j][i];
         arr[j][i]=temp;
      }
   }
   printf("Transpose of the matrix is:\n");
    for(int i=0;i<m;i++)
    {
      for(int j=0;j<n;j++)
      printf("%d",arr[i][j]);
      printf("\n");
    }
    return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the rows and columns of matrix:
3 3
Enter the elements of matrix:
1 2 3 4 5 6 7 8 9
Elements of matrix:
1 2 3
4 5 6
7 8 9
Transpose of the matrix is:
1 4 7
2 5 8
3 6 9
```

PROGRAM 1C - Program for Traversing of array

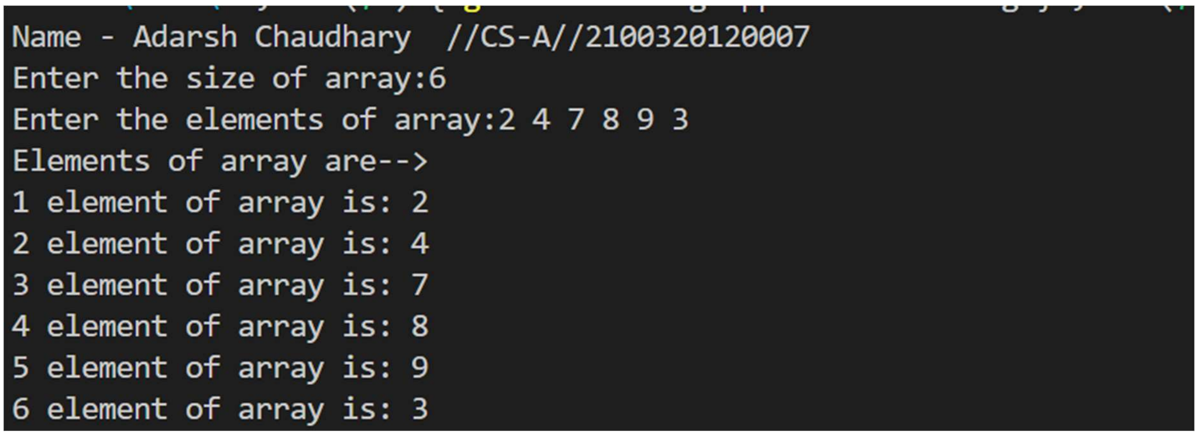
ALGORITHM Traverse(A[], N)

```
BEGIN:
        FOR i=1 TO N DO
              WRITE(A[i])
END;
```

Time Complexity:Ɵ(N)
Space Complexity:Ɵ(1)

```
#include<stdio.h>

int main()

{
  printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
  int n;
  printf("Enter the size of array:");
  scanf("%d",&n);
  int arr[n];
  printf("Enter the elements of array:");
  for(int i=0;i<n;i++)
  scanf("%d",&arr[i]);

  printf("Elements of array are-->\n");
  for(int i=0;i<n;i++)
  printf("%d element of array is: %d\n",i+1,arr[i]);
  return 0 ;
}
```

OUTPUT:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array:6
Enter the elements of array:2 4 7 8 9 3
Elements of array are-->
1 element of array is: 2
2 element of array is: 4
3 element of array is: 7
4 element of array is: 8
5 element of array is: 9
6 element of array is: 3
```

PROGRAM 1B - Program for Deletion of elements in array

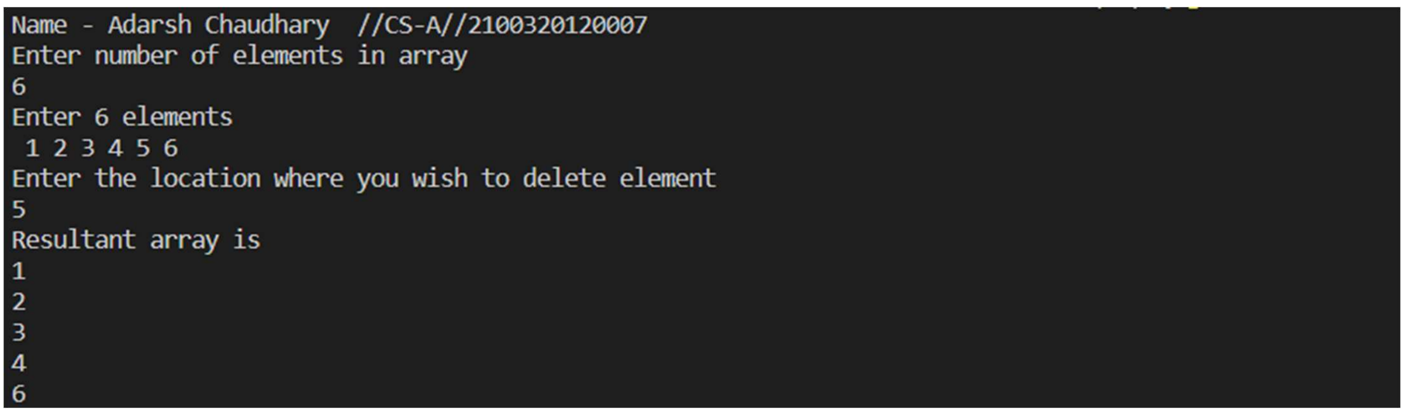
ALGORITHM Deletion(A[], N, i)

```
BEGIN:
        X=A[i]
          FOR j=i+1 TO N DO
                A[j-1]=A[i]
                N=N-1
        RETURN x
END;
```

Time Complexity:ϴ(N)
Space Complexity:ϴ(1)

```
#include <stdio.h>


int main()
{    printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int array[100], position, c, n;

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

   printf("Enter %d elements\n", n);

   for ( c = 0 ; c < n ; c++ )
   scanf("%d", &array[c]);

   printf("Enter the location where you wish to delete element\n");
   scanf("%d", &position);

   if ( position >= n+1 )
   printf("Deletion not possible.\n");

   else
   {
      for ( c = position - 1 ; c < n - 1 ; c++ )
      array[c] = array[c+1];
      printf("Resultant array is\n");

      for( c = 0 ; c < n - 1 ; c++ )
      printf("%d\n", array[c]);
   }
   return 0; }
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter number of elements in array
6
Enter 6 elements
 1 2 3 4 5 6
Enter the location where you wish to delete element
5
Resultant array is
1
2
3
4
6
```

PROGRAM 3 - Program to Find the number, which is not repeated in Array of integers, others are present for two times

ALGORITHM: Arr_func(A[], N)

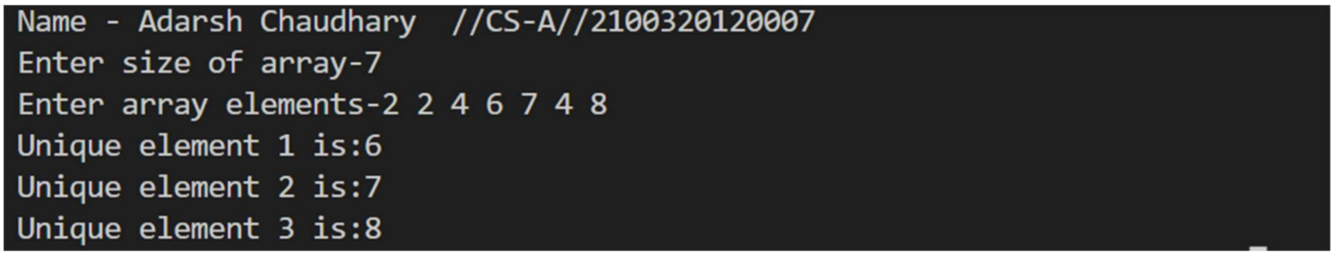
```
BEGIN:
        K=0,c,B[20]
        FOR i=0 TO N DO
                c=0
                FOR j=0 TO N DO
                        IF A[j]==A[i] THEN
                                c=c+1
                        IF c==1 THEN
                                B[k++]=A[i]
        FOR i=0 TO k DO
                WRITE(B[i])
END;
```

Time Complexity:Θ(N^2)
Space Complexity:Θ(1)

```
#include<stdio.h>
void unique(int arr[],int n)
{
   int count=1,i,j;
   for( i=0;i<n;i++)
   {
      for( j=0;j<n;j++)
      {
         if(arr[i]==arr[j]&& i!=j)
         break;
      }
         if(j==n)
         {
            printf("Unique element %d is:%d\n",count,arr[i]);
            count++;
          }
   }

}


int main()
{  printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n;
   printf("Enter size of array:\n");
   scanf("%d",&n);
   int arr[n];
```

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

    unique(arr,n);
    return 0 ;
}
```

OUTPUT:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter size of array-7
Enter array elements-2 2 4 6 7 4 8
Unique element 1 is:6
Unique element 2 is:7
Unique element 3 is:8
```

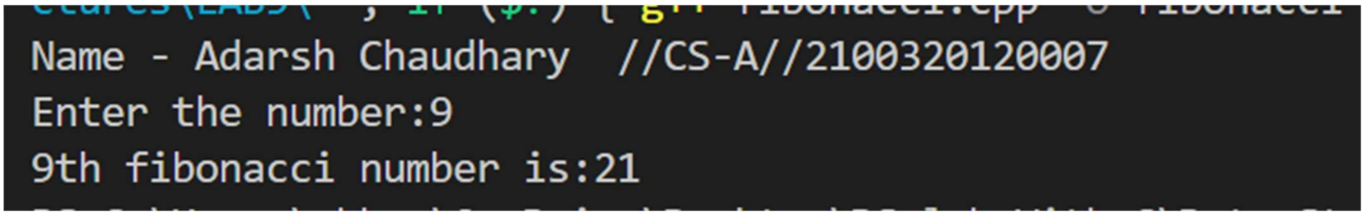
PROGRAM 63 - Program for finding nth Fibonacci number using Recursion and improving its run time to save stack operations

```
ALGORITHM  Fibo(a)
BEGIN:
        IF a==1 THEN
                RETURN 0
        ELSE
                IF a==2 THEN
                        RETURN 1
                ELSE
                        RETURN Fibo(a-1)+Fibo(a-2)
END;
```

Time Complexity: $\Theta(2^N)$
Space Complexity: $\Theta(N)$

```
#include<stdio.h>

int fibo(int n){
   if(n<=1)
   return n;

   return fibo(n-1)+fibo(n-2);
}
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n;
   printf("Enter the number:");
   scanf("%d",&n);

   printf("%dth fibonacci number is:%d",n,fibo(n-1));
   return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the number:9
9th fibonacci number is:21
```

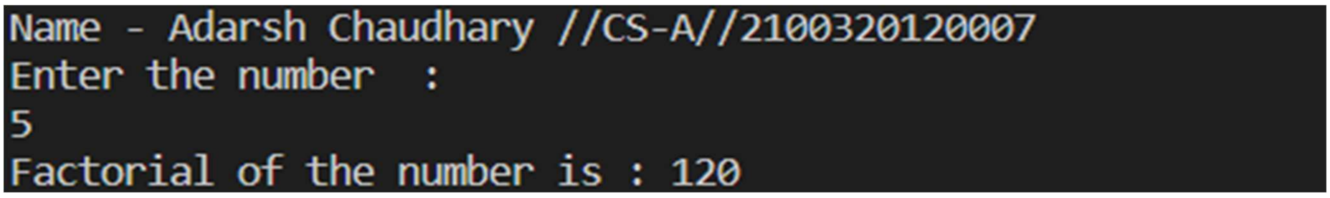
PROGRAM 59 - Program for factorial of a given number using recursion

```
ALGORITHM FACTORIAL(a)
BEGIN :
IF a==0
        RETURN(1)
ELSE
        IF(a>0)
                RETURN(a*FACTORIAL(a-1))
END;
```

Time Complexity: ϴ(n)
Space Complexity: ϴ(n)

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


int fact(int n){
   if (n==0)
   {
      return 1;
   }
   else
   {
      return n * fact(n-1);
   }


}
int main(){
   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n;
   printf("Enter the number  : \n");
   scanf("%d",&n);

   printf("Factorial of the number is : ");
   printf("%d",fact(n));
   return 0;
}
```

Output:



```
Name - Adarsh Chaudhary //CS-A//2100320120007
Enter the number  :
5
Factorial of the number is : 120
```

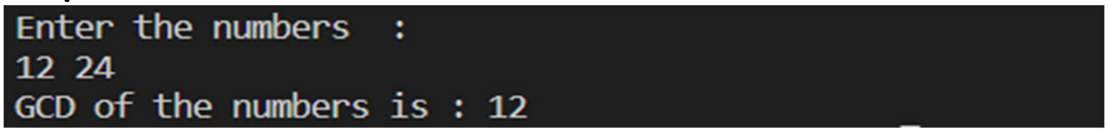
PROGRAM 64 - Program for finding the GCD of two numbers using Recursion

```
ALGORITHM HCF(a,b)
BEGIN:
    IF a==b THEN
        RETURN a
    ELSE IF a>b THEN
        RETURN HCF(a-b,b)
    ELSE
        RETURN HCF (a,b-a)
END;
```

Time Complexity: O(log n)
Space Complexity: ϴ(1)

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

int gcd(int a, int b)
{
   if (a == b)
   {
      return a;
   }
   else
   {
      if (a > b)
      {
         return gcd(a - b, b);
      }
      else
      {
         return gcd(a, b - a);
      }
   }
}
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int a, b;
   printf("Enter the numbers  : \n");
   scanf("%d %d", &a, &b);
      printf("GCD of the numbers is : ");
   printf("%d", gcd(a, b));
return 0;
}
```

Output:



```
Enter the numbers   :
12 24
GCD of the numbers is : 12
```

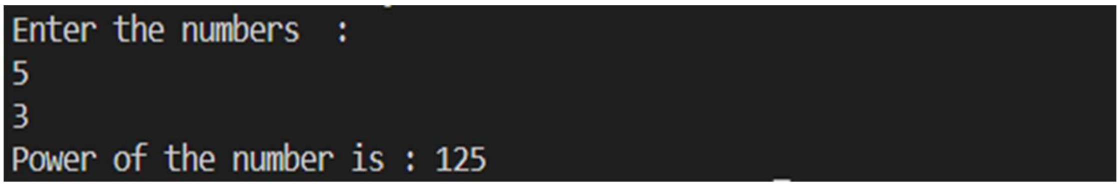
EXPERIMENT 61 - Program for Computing A raised to power n using Recursion

```
ALGORITHM POWER(a,b)
BEGIN:
        IF b == 0 THEN
                RETURN 1
         ELSE
                IF b%2 == 0 THEN
                        RETURN  POWER(a,b/2) * POWER(a,b/2)
                ELSE
                        RETURN  a+ POWER(a,b/2) * POWER(a,b/2)

END;
```

Time Complexity: O(log b)
Space Complexity: ϴ(log b)

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

int power(int a, int b)
{
   if (b == 0)
   {
      return 1;
   }
   else
   {
      return a * power(a, b - 1);
   }
}
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int a, b;
   printf("Enter the numbers  : \n");
   scanf("%d %d", &a, &b);

   printf("Power of the number is : ");
   printf("%d", power(a, b));
   return 0;
}
```

Output:



```
Enter the numbers  :
5
3
Power of the number is : 125
```

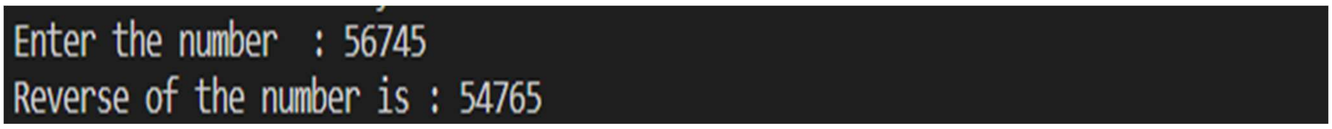
PROGRAM 65 - Program to reverse the given number using Recursion

```
ALGORITHM REV (a,len)
BEGIN:
        IF len ==1
                RETURN a
        ELSE
                RETURN((a%10)*pow(10,len-1))+REV(a/10,len-1)
END;
```

Time Complexity: Θ (log n)
Space Complexity: Θ (log n)

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


int reverse(int n,int temp,int sum)
{
   if (n > 0)
   {
      temp = n % 10;
      sum = sum * 10 + temp;
      reverse(n / 10 , temp,sum);
   }
   else
   {
      return sum;
   }
}
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n;
   int temp = 0, sum = 0;
   printf("Enter the number  : ");
   scanf("%d",&n);
   printf("Reverse of the number is : ");
   printf("%d", reverse(n,temp,sum));
   return 0;
}
```

Output:



```
Enter the number  : 56745
Reverse of the number is : 54765
```

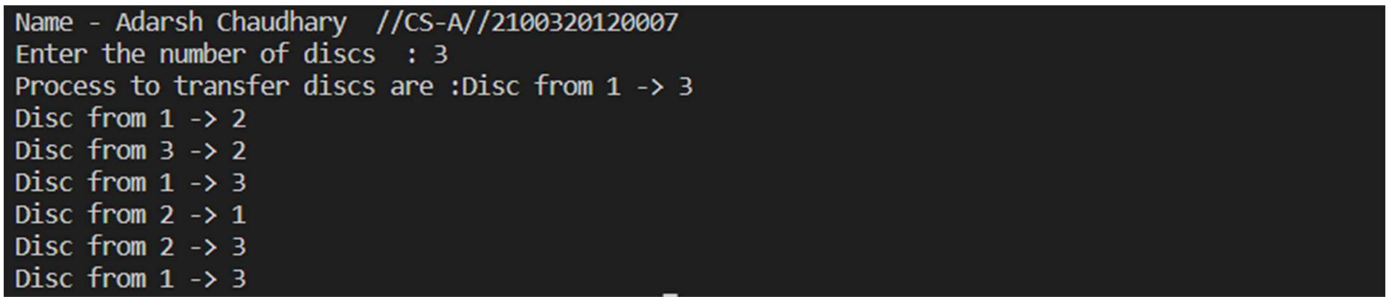
PROGRAM 60 - Program for Towers of Hanoi for n disk (user defined)

```
ALGORITHM TOH(N,S,M,D)

BEGIN:
IF N==1 THEN
        Transfer disk from S to D
ELSE
        TOH(N-1,S,M,D)
        Transfer Disk From S to D
        TOH(N-1M,S,D)
End;
```

Time Complexity: ϴ (2^n)
Space Complexity: ϴ (n)

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

void tower_of_hanoi(int n,int s,int m,int d){
 if (n>0)
    {
       tower_of_hanoi(n-1,s,d,m);
       printf("Move from %d -> %d \n",s,d);
       tower_of_hanoi(n-1,m,s,d);
    }
}
int main(){
     printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
    int n;
    printf("Enter the number of discs  : ");
    scanf("%d",&n);
 printf("Process to transfer discs are :");
    tower_of_hanoi(n,1,2,3);

    return 0;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the number of discs  : 3
Process to transfer discs are :Disc from 1 -> 3
Disc from 1 -> 2
Disc from 3 -> 2
Disc from 1 -> 3
Disc from 2 -> 1
Disc from 2 -> 3
Disc from 1 -> 3
```

PROGRAM 2 - Program for Insertion in sorted array

```
ALGORITHM  Sorted(A[], N, key)
BEGIN:
            i=0
           WHILE A[i]<key DO
                       i=i+1
                      RETURN i
END;
```

Time Complexity:ϴ(N)
Space Complexity:ϴ(1)

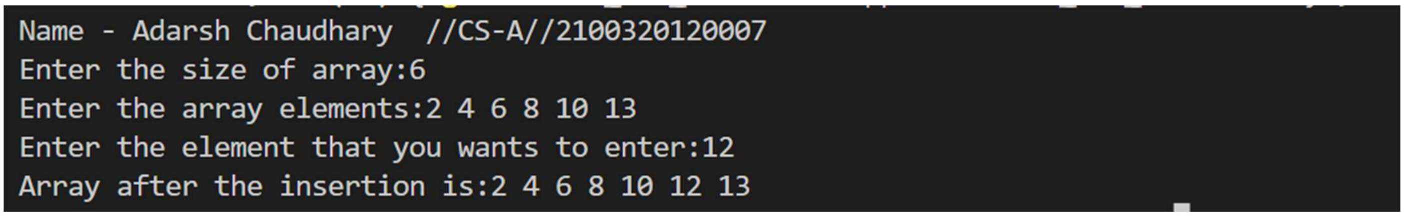
```
ALGORITHM: INS_sorted(A[], N ,i, key)
BEGIN:
           FOR j=N-1 TO i STEP-1 DO
                      A[j+1]=A[j]
           A[i]=key
           N=N+1
END;
```

Time Complexity:ϴ(N)
Space Complexity:ϴ(1)

```
#include<stdio.h>
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
    int n;
    printf("Enter the size of array:\n");
    scanf("%d",&n);
    int arr[n];
    printf("Enter the array elements:");
       for(int i=0;i<n;i++)
       {
       scanf("%d",&arr[i]);
    }
   int ele;
   printf("Enter the element that you wants to enter:");
   scanf("%d",&ele);

   int pos=0;
   for(int i=0;i<n;i++)
   {
    if(arr[i]<ele)
       pos++;
    else
```

```
        break;
    }

  for(int i=n;i>=pos;i--)
        arr[i]=arr[i-1];

        arr[pos]=ele;
        n++;

   printf("Array after the insertion is:\n");
   for(int i=0;i<n;i++){
        printf("%d",arr[i]);
   }
   return 0;

}
```

OUTPUT:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array:6
Enter the array elements:2 4 6 8 10 13
Enter the element that you wants to enter:12
Array after the insertion is:2 4 6 8 10 12 13
```

PROGRAM 15 - Program for Intersection of two Sets

ALGORITHM: SetIntersection(A[],m,B[],n)

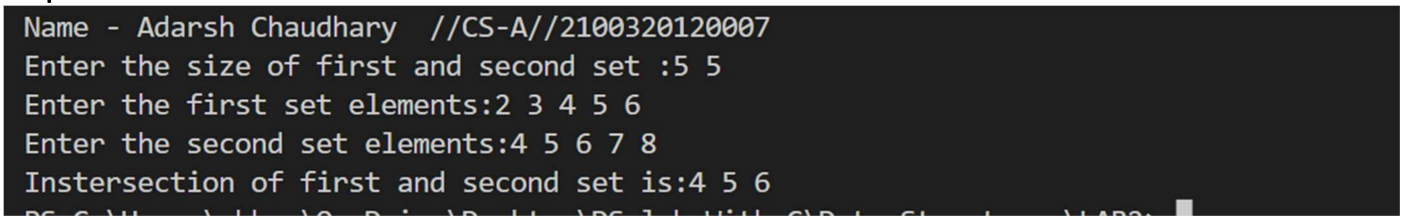
```
BEGIN:
    C[m+n]
    i=1, j=1, k=1
    WHILE i<=m AND j<=n DO
        IF A[i]<B[j] THEN
            i=i+1
        ELSE
            IF A[i]==B[j] THEN
                C[k]=B[j]
            i=i+1
            j=j+1
            k=k+1
            ELSE
                j=j+1
    RETURN C
END;
```

Time Complexity:ϴ(N)
Space Complexity:ϴ(N)

```
#include<stdio.h>

void intersection(int arr[],int brr[],int n,int m)
{
   int i=0,j=0;
   printf("Instersection of first and second set is:");
   while(i<n and j<m)
   {
      if(arr[i]<brr[j])
         i++;

      else if(arr[i]>brr[j])
         j++;

      else
      {
         printf("%d ",arr[i]);
         i++;
         j++;
      }
   }
}

int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
```

```c
    int n,m;
    printf("Enter the size of first and second set :");
    scanf("%d%d",&n,&m);

    int arr[n],brr[m];

    printf("Enter the first set elements:");
    for(int i=0;i<n;i++)
    scanf("%d",&arr[i]);

    printf("Enter the second set elements:");
    for(int j=0;j<m;j++)
    scanf("%d",&brr[j]);

    // sort(arr,arr+n);
    // sort(brr,brr+m);
    intersection(arr,brr,n,m);
    return 0 ;
}
```

output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of first and second set :5 5
Enter the first set elements:2 3 4 5 6
Enter the second set elements:4 5 6 7 8
Instersection of first and second set is:4 5 6
```

PROGRAM 11 - Program for Merging of two Sorted arrays

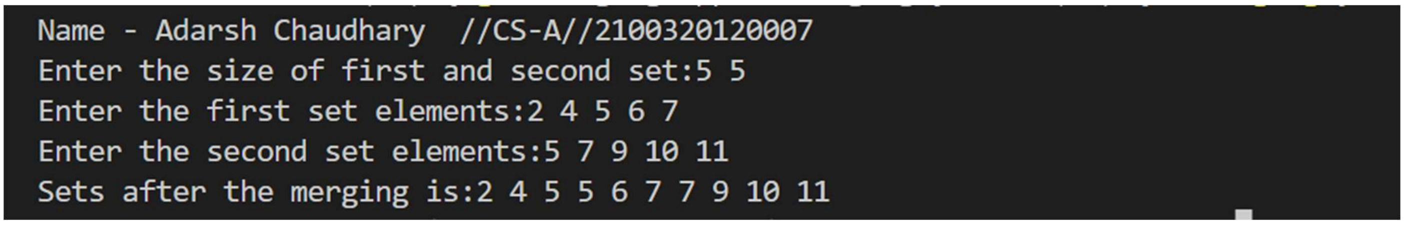
```
ALGORITHM: MergeArr(A[],m,B[],n)
BEGIN:
        C[m+n]
        i=1, j=1, k=1
        WHILE i<=m AND j<=n DO
                IF A[i]<B[j] THEN
                        C[k]=A[i]
                        i=i+1
                        k=k+1
                ELSE
                        C[k]=B[j]
                        J=j+1
                        k=k+1
        WHILE i<=m DO
                C[k]=A[i]
                i=i+1
                k=k+1
        WHILE j<=n DO
                C[k]=B[j]
                J=j+1
                k=k+1
        RETURN C
END;
```

Time Complexity: ϴ(N)
Space Complexity: ϴ(N)

```c
#include<stdio.h>

void merge(int arr[],int brr[],int n,int m,int ans[])

{
  int i=0,j=0,k=0;
  printf("Sets after the merging is:");
  while(i<n&&j<m)
  {
   if(arr[i]<brr[j])
   ans[k++]=arr[i++];

   else
   ans[k++]=brr[j++];
  }
   while(i<n)
   ans[k++]=arr[i++];

   while(j<m)
```

```
    ans[k++]=brr[j++];

    for(int i=0;i<n+m;i++)
            printf("%d ",ans[i]);
  }

int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
    int n,m;
    printf("Enter the size of first and second set:");
    scanf("%d%d",&n,&m);

    int arr[n],brr[m];

    printf("Enter the first set elements:");
    for(int i=0;i<n;i++)
    scanf("%d",&arr[i]);

    printf("Enter the second set elements:");
    for(int j=0;j<m;j++)
    scanf("%d",&brr[j]);

    int ans[n+m];

    merge(arr,brr,n,m,ans);
    return 0 ;
}
```

OUTPUT:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of first and second set:5 5
Enter the first set elements:2 4 5 6 7
Enter the second set elements:5 7 9 10 11
Sets after the merging is:2 4 5 5 6 7 7 9 10 11
```

PROGRAM 16 - Program for Set Difference

```
ALGORITHM: SetDIFference(A[],m,B[],n)
BEGIN:
        C[m+n]
        i=1, j=1, k=1
        WHILE i<=m AND j<=n DO
                IF A[i]<B[j] THEN
                        i=i+1
                ELSE
                         IF A[i]==B[j] THEN
                        i=i+1
                        j=j+1
                ELSE
                        C[k]=B[j]
                        j=j+1
                        k=k+1
        WHILE j<=n DO
                C[k]=B[j]
                J=j+1
                k=k+1
        RETURN C
END;
```

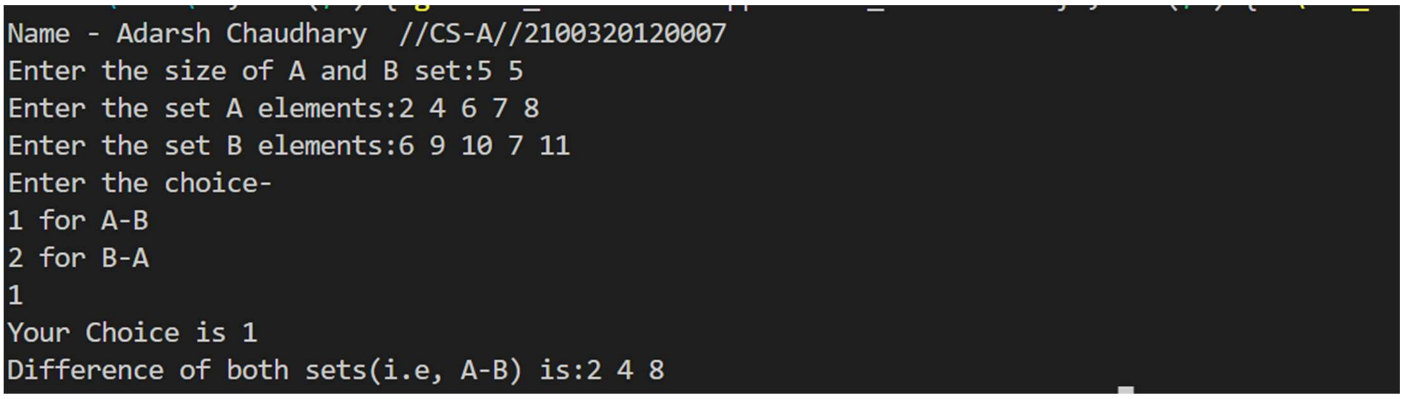
Time Complexity:Ɵ(N)
Space Complexity:Ɵ(N)

```
#include<stdio.h>

void AminusB(int arr[],int brr[],int n,int m){
   int k=0;
   int ans[100];
   int i,j;
   printf("Difference of both sets(i.e, A-B) is:");
   for(i=0;i<n;i++)
   {
      for(j=0;j<m;j++)
      {
         if(arr[i]==brr[j])
         break;
      }
         if(j==m)
         ans[k++]=arr[i];
   }

   for(int i=0;i<k;i++)
   printf("%d ",ans[i]);
}
```

```c
void BminusA(int arr[],int brr[],int n,int m){
   int k=0;
   int ans[100];
   int i,j;
   printf("Difference of both sets(i.e, B-A) is:");
   for(i=0;i<m;i++){
      for(j=0;j<n;j++)
      {
         if(brr[i]==arr[j])
         break;
      }

      if(j==n)
       ans[k++]=brr[i];
   }

   for(int i=0;i<k;i++)
   printf("%d ",ans[i]);
}

int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n,m;
   printf("Enter the size of A and B set:");
   scanf("%d%d",&n,&m);

   int arr[n],brr[m];

   printf("Enter the set A elements:");
   for(int i=0;i<n;i++)
   scanf("%d",&arr[i]);

   printf("Enter the set B elements:");
   for(int j=0;j<m;j++)
   scanf("%d",&brr[j]);

   int i=0;
   int j=0;

   int c;
   printf("Enter the choice-\n1 for A-B\n2 for B-A\n");
   scanf("%d",&c);

   if(c==1)
   AminusB(arr,brr,n,m);

   if(c==2)
   BminusA(arr,brr,n,m);
   return 0 ;
```

}

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of A and B set:5 5
Enter the set A elements:2 4 6 7 8
Enter the set B elements:6 9 10 7 11
Enter the choice-
1 for A-B
2 for B-A
1
Your Choice is 1
Difference of both sets(i.e, A-B) is:2 4 8
```

PROGRAM 14 - Program for Union of two sets

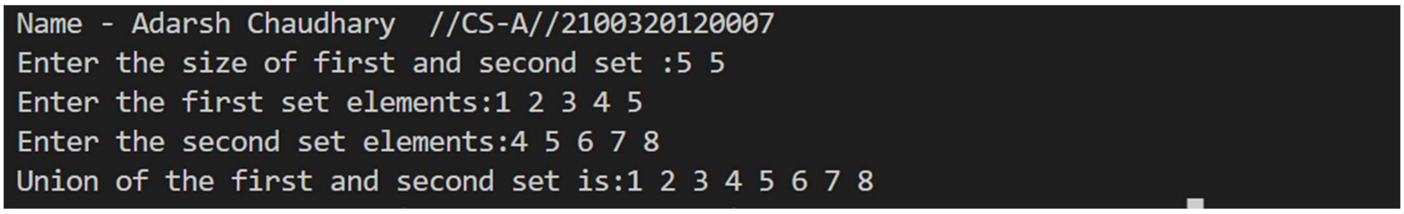
ALGORITHM: SetUnion(A[],m,B[],n)

```
BEGIN:
        C[m+n]
        i=1, j=1, k=1
        WHILE i<=m AND j<=n DO
                IF A[i]<B[j] THEN
                        C[k]=A[i]
                        i=i+1
                        k=k+1
                 ELSE
                        IF A[i]==B[j] THEN
                                C[k]=B[j]
                                i=i+1
                                j=j+1
                                k=k+1
                         ELSE
                                C[k]=B[j]
                                j=j+1
                                k=k+1
        WHILE i<=m DO
                C[k]=A[i]
                i=i+1
                k=k+1
        WHILE j<=n DO
                C[k]=B[j]
                J=j+1
                k=k+1
RETURN C
END;
```

Time Complexity:Ɵ(N)
Space Complexity:Ɵ(N)

```
#include<stdio.h>

void unionArr(int arr[],int brr[],int n,int m,int ans[])
{
  int i=0,j=0,k=0;

  while(i<n&&j<m)
  {

   if(arr[i]<brr[j])
   ans[k++]=arr[i++];
```

```
    else if(arr[i]=brr[j])
    {
       ans[k++]=arr[i++];
       j++;
            }
    else
    ans[k++]=brr[j++];

   }
    while(i<n)
    ans[k++]=arr[i++];

    while(j<m)
    ans[k++]=brr[j++];

    printf("Union of the first and second set is:");
    for(int i=0;i<k;i++)
    printf("%d ",ans[i]);

}
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
    int n,m;
    printf("Enter the size of first and second set :");
    scanf("%d%d",&n,&m);

    int arr[n],brr[m];

    printf("Enter the first set elements:");
    for(int i=0;i<n;i++)
    scanf("%d",&arr[i]);

    printf("Enter the second set elements:");
    for(int j=0;j<m;j++)
    scanf("%d",&brr[j]);

    int ans[n+m];

    unionArr(arr,brr,n,m,ans);
    return 0 ;
}
```
Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of first and second set :5 5
Enter the first set elements:1 2 3 4 5
Enter the second set elements:4 5 6 7 8
Union of the first and second set is:1 2 3 4 5 6 7 8
```

PROGRAM 5 - Program for Binary Search in an array

ALGORITHM Binary_search(A[], N, key)

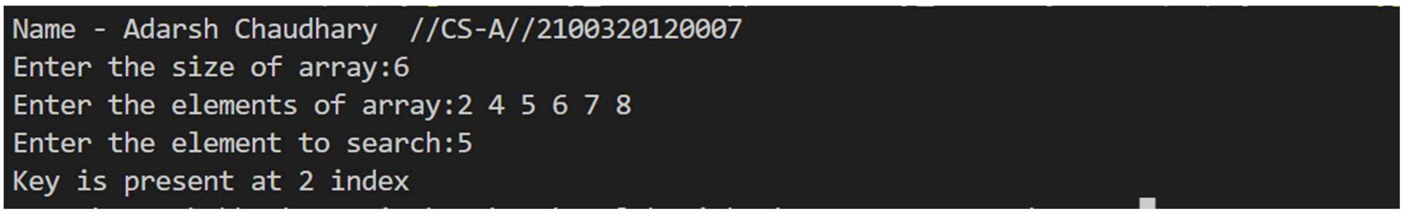
```
BEGIN:
        HIGH=N-1
        LOW=0
        WHILE LOW<=HIGH DO
                MID=(LOW+HIGH)/2
                IF A[MID]==key THEN
                        RETURN MID
                ELSE
                        IF key<A[MID] THEN
                                HIGH=MID-1
                        ELSE
                                LOW=MID+1
        RETURN -1
END;
```

Worst Case Time Complexity: O(logN)
Best Case Time Complexity: *Ω*(1)
Space Complexity: Θ(1)

```
#include<stdio.h>

int binarySearch(int arr[],int n,int key){
   int s=0;
   int l=n;

    while(s<=l)
    {
      int mid=(s+l)/2;
      if(arr[mid]>key)
      l=mid-1;

      else if(arr[mid]<key)
      s=mid+1;

      else
      return mid;
   }
   return -1;

}

int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n;
```

```
    printf("Enter the size of array:");
    scanf("%d",&n);
    int arr[n];
    printf("Enter the elements of array:");
    for(int i=0;i<n;i++)
    scanf("%d",&arr[i]);
    int key;
    printf("Enter the element to search:");
    scanf("%d",&key);
    printf("Key is present at %d index",binarySearch(arr,n,key));

    return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array:6
Enter the elements of array:2 4 5 6 7 8
Enter the element to search:5
Key is present at 2 index
```

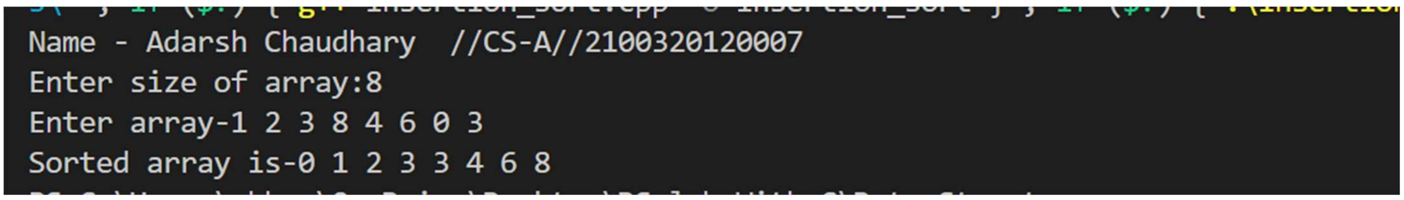
PROGRAM 4 - Program for Linear Search

```
ALGORITHM Linear_search(A[], N, key)
BEGIN:
        FOR i=1 TO N DO
                IF A[i]==key THEN
                        RETURN i
        RETURN -1
END;
```

Worst Case Time Complexity: O(N)
Best Case Time Complexity: *Ω*(1)
Space Complexity: ϴ(1)

```c
#include<stdio.h>

int main()

 {  printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n;
   printf("Enter the size of array: ");
   scanf("%d",&n);
    int arr[n];
    printf("Enter the elements of array :");
    for(int i=0;i<n;i++)
    scanf("%d",&arr[i]);
    int key;
   printf("Enter the element to be search:");
   scanf("%d",&key);
   int flag=0;
   for(int i=0;i<n;i++)
   {
      if (arr[i]==key)
      {
         printf("Elements is present at %d place.",i+1);
         flag=1;
         break;
      }
   }
    if(flag==0)
    printf("Element is not present in array !!!");
    return 0 ;
 }
```

OUTPUT:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter size of array:8
Enter array-1 2 3 8 4 6 0 3
Sorted array is-0 1 2 3 3 4 6 8
```

PROGRAM 19 - Program for Matrix Addition

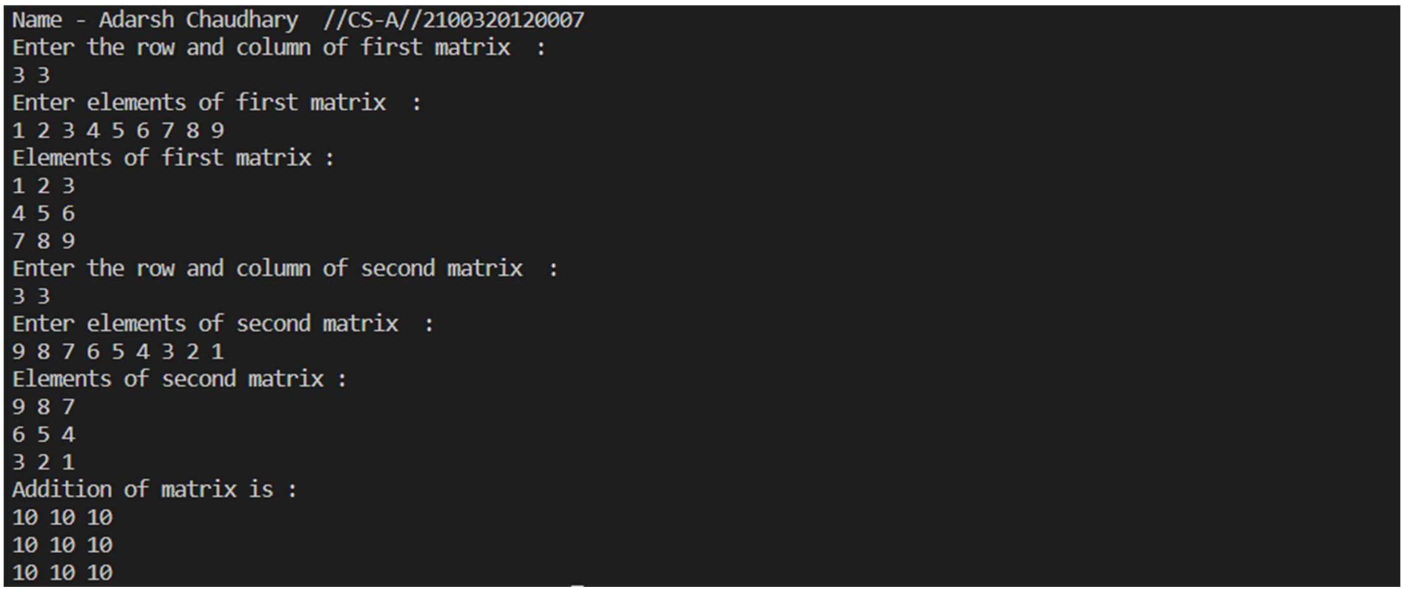
ALGORITHM: Matrixadd(A[][], B[][], M,N)

```
BEGIN:C[M][N]
        FOR i=1 TO M DO
                FOR j=1 TO N DO
                        C[i][j]=A[i][j]+B[i][j]
        RETURN C
END;
```

Time Complexity: ϴ(N^2)
Space Complexity:ϴ(N^2)
Source Code :

```c
#include <stdio.h>
#include <math.h>
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
    int m, n, o, p;
    printf("Enter the row and column of first matrix  : \n");
    scanf("%d %d", &m, &n);
    int a[m][n];
    printf("Enter elements of first matrix  : \n");
    for (int i = 0; i < m; i++)
    {
        for (int j = 0; j < n; j++)
        {
            scanf("%d", &a[i][j]);
        }
    }
    printf("Enter the row and column of second matrix  : \n");
    scanf("%d %d", &o, &p);
    int b[o][p];
    printf("Enter elements of second matrix  : \n");
    for (int i = 0; i < o; i++)
    {
        for (int j = 0; j < p; j++)
        {
            scanf("%d", &b[i][j]);
        }
    }
    if (n == o)
    {
        printf("Addition of matrix is : \n");
        for (int i = 0; i < m; i++)
        {
            for (int j = 0; j < n; j++)
            {
                printf("%d ", (a[i][j] + b[i][j]));
            }
            printf("\n");
        }
    }

    return 0;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the row and column of first matrix  :
3 3
Enter elements of first matrix  :
1 2 3 4 5 6 7 8 9
Elements of first matrix :
1 2 3
4 5 6
7 8 9
Enter the row and column of second matrix  :
3 3
Enter elements of second matrix  :
9 8 7 6 5 4 3 2 1
Elements of second matrix :
9 8 7
6 5 4
3 2 1
Addition of matrix is :
10 10 10
10 10 10
10 10 10
```

PROGRAM 20 - Program for Matrix Multiplication

ALGORITHM: Matrixmultiply(A[][], M,N, B[][], P,Q)
BEGIN:

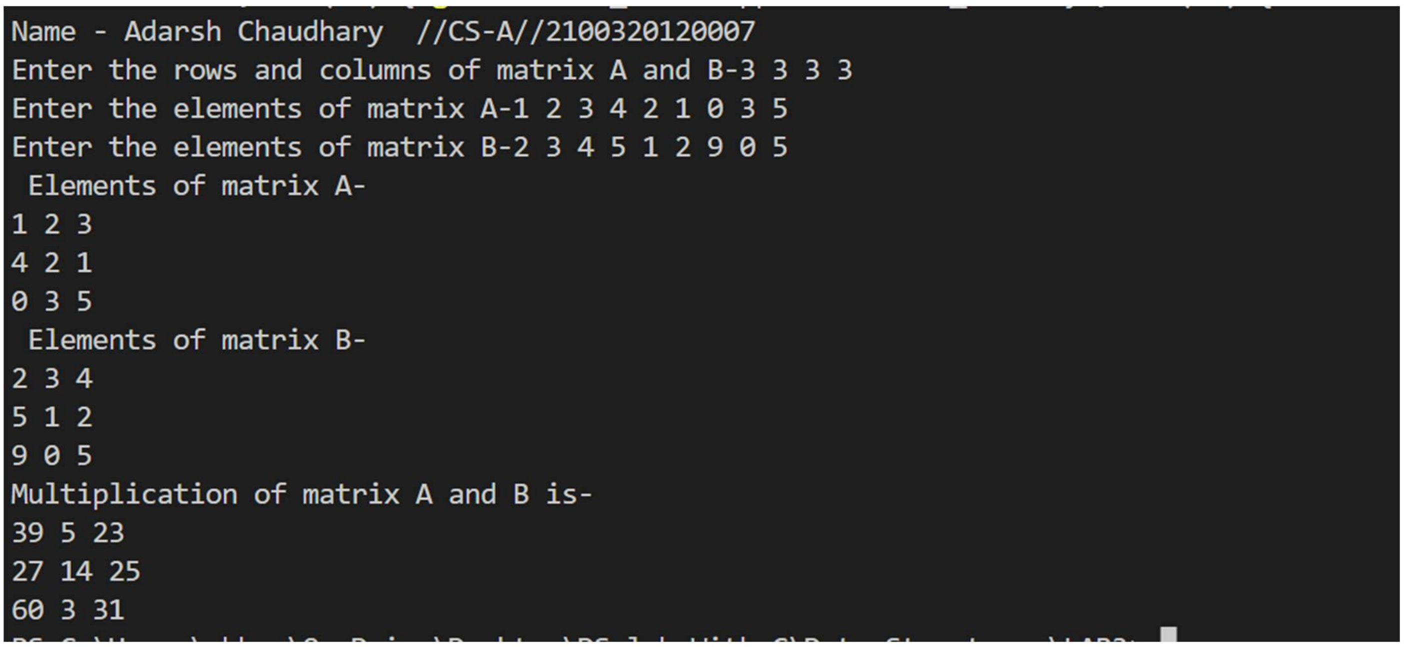
```
    C[M][Q]
     IF N!=P THEN
     FOR i=1 TO M DO
         FOR j=1 T0 Q DO
             C[i][j]=0
             FOR k=1 TO N DO
                 C[i][j]=C[i][j]+A[i][k]*B[k][j]
    RETURN C
```

END;

Time Complexity: ϴ(N^3)
Space Complexity:ϴ(N^2)

```
#include<stdio.h>

int main()

{

   int n,m,p,q;

   printf("Enter the rows and columns of matrix A and B-");

   scanf("%d%d%d%d",&n,&m,&p,&q);

   if(m==p){

   int arr[n][m];

   int brr[m][q];

   int ans[n][q];

   printf("Enter the elements of matrix A-");

    for(int i=0;i<n;i++){

      for(int j=0;j<m;j++)

         scanf("%d",&arr[i][j]);

    }

    printf("Enter the elements of matrix B-");

     for(int i=0;i<m;i++){

      for(int j=0;j<q;j++)

         scanf("%d",&brr[i][j]);

    }
    for(int i=0;i<n;i++){
      for(int j=0;j<q;j++)
          ans[i][j]=0;
    }

    for(int i=0;i<n;i++){
      for(int j=0;j<q;j++){
          for(int k=0;k<m;k++)
           ans[i][j]+=arr[i][k]*brr[k][j];
      }
   }
   printf("Multiplication of matrix A and B is-");
    for(int i=0;i<n;i++){
      for(int j=0;j<q;j++)
          printf("%d ",ans[i][j]);
         printf("\n");
    }}
   return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the rows and columns of matrix A and B-3 3 3 3
Enter the elements of matrix A-1 2 3 4 2 1 0 3 5
Enter the elements of matrix B-2 3 4 5 1 2 9 0 5
 Elements of matrix A-
1 2 3
4 2 1
0 3 5
 Elements of matrix B-
2 3 4
5 1 2
9 0 5
Multiplication of matrix A and B is-
39 5 23
27 14 25
60 3 31
```

PROGRAM 21 - Program for Transpose of matrix using second matrix

ALGORITHM: Matrix_transpose (A[][], M,N)
BEGIN:

```
        B[N][M]
        FOR I =1 TO M DO
                FOR j=1 TO N DO
                        B[j][i]=A[i][j]
        RETURN B
```

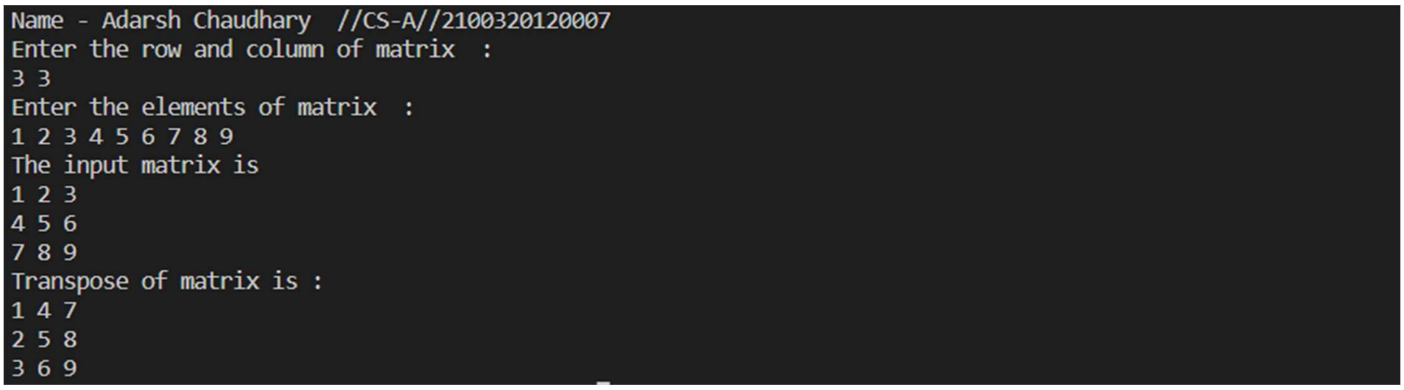
END;

Time Complexity: Ɵ(N^2)
Space Complexity:Ɵ(N^2

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

int main()
{  printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n, m;
    printf("Enter the row and column of matrix  : \n");
   scanf("%d %d", &m, &n);
   int a[n][m];
   int t[m][n];
   printf("Enter the elements of matrix  : \n");
   for (int i = 0; i < n; i++)
   {
      for (int j = 0; j < m; j++)
      {
         scanf("%d", &a[i][j]);
      }
   }

   printf("The input matrix is  \n");
   for (int i = 0; i < n; i++)
   {
      for (int j = 0; j < m; j++)
      {
         printf("%d ", a[i][j]);
      }
      printf("\n");
   }

   for (int i = 0; i < n; i++)
   {
      for (int j = 0; j < m; j++)
      {
         t[i][j] = a[j][i];
      }
   }
```

```
    printf("Transpose of matrix is : \n");
    for (int i = 0; i < m; i++)
    {
        for (int j = 0; j < n; j++)
        {
            printf("%d ", t[i][j]);
        }
        printf("\n");
    }
    return 0;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the row and column of matrix  :
3 3
Enter the elements of matrix  :
1 2 3 4 5 6 7 8 9
The input matrix is
1 2 3
4 5 6
7 8 9
Transpose of matrix is :
1 4 7
2 5 8
3 6 9
```

PROGRAM 6 - Program for Index Sequential Search

ALGORITHM: INDsearch(data[N],KEY,index[M][2])
BEGIN:

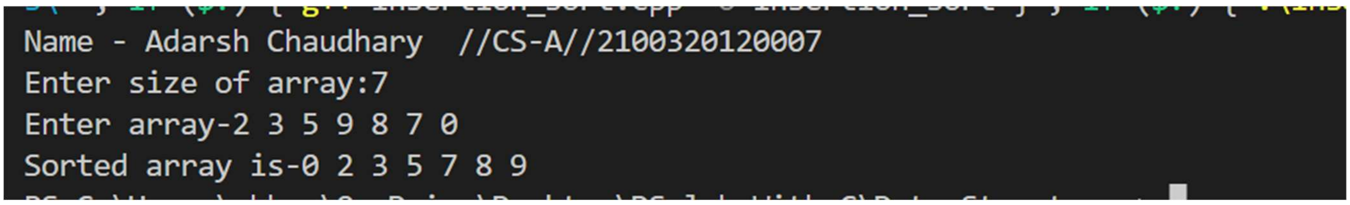
```
                FOR i=0 TO M-1 DO
                   IF KEY==index[i][1] THEN
                    RETURN index[i][0]
                 ELSE
                    IF KEY <index[i][1] THEN
                        high=index[i][0]-1
                        Low =index[i-1][0]+1
                         BREAK
                 FOR i=low TO high DO
                       IF KEY ==data[i] THEN
                         RETURN i
                 RETURN -1
```

END;

Worst Case Time Complexity: O(N/K+K)
Best Case Time Complexity: *Ω*(1)
Space Complexity: Θ(1)

```
#include<stdio.h>

int index_search(int arr[],int n,int key)
{
   int m=0,start,end,flag=0;
   int index[n/3],indexEle[n/3];

   for(int i=0;i<n;i+3)
  {
      indexEle[m]=arr[i];
      index[m]=i;
      m++;
   }

   if(key<indexEle[0])
      return -1;

   else
  {
      for(int i=1;i<m;i++)
       {
         if(key<indexEle[i])
        {
            start=index[i=1];
            end=index[i];
            flag=1;
            break;
         }

         if(flag==0)
         {
            start=index[i-1];
            end=n-1;
         }
       }
   }

   for(int i=start;i<end;i++)
  {
      if(arr[i]==key)
      return i;
   }

   return -1;
}
int main()
{   printf("Name - Adarsh Chaudhary  //CS-A//2100320120007 \n");
   int n;
   printf("Enter the size of array:");
   scanf("%d",&n);
   int arr[n];
   printf("Enter the elements of array:");
   for(int i=0;i<n;i++)
   scanf("%d",&arr[i]);
   int key;
   printf("Enter the element to search:");
   scanf("%d",&key);

   int ans=index_search(arr,n,key);
   if(ans==-1)
   printf("Element not found!!");
   else
   printf("Element is present at %d position!!", ans+1);
   return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter size of array:7
Enter array-2 3 5 9 8 7 0
Sorted array is-0 2 3 5 7 8 9
```

PROGRAM 18 - Program for Radix Sort

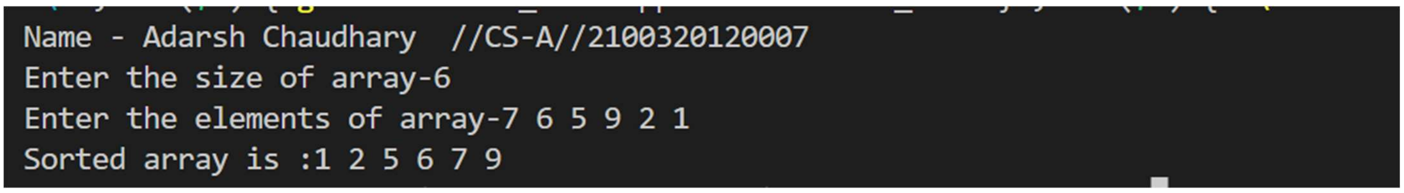
```
ALGORITHM: RadixSort(A[],N,d)
BEGIN:
        FOR i=1 TO d DO
                Apply counting Sort on A[] at radix i
END;
```

Time Complexity: ϴ(N)
Space Complexity:ϴ(N)

```
#include <stdio.h>

int getMax(int a[], int n) {
  int max = a[0];
  for(int i = 1; i<n; i++) {
    if(a[i] > max)
      max = a[i];
  }
  return max;
}

void countingSort(int a[], int n, int place)
{
 int output[n + 1];
 int count[10] = {0};

 for (int i = 0; i < n; i++)
   count[(a[i] / place) % 10]++;

 for (int i = 1; i < 10; i++)
   count[i] += count[i - 1];
   for (int i = n - 1; i >= 0; i--) {

   count[(a[i] / place) % 10]--;
 }

 for (int i = 0; i < n; i++)
```

```
    a[i] = output[i];
}
void radixsort(int a[], int n) {

  int max = getMax(a, n);

  for (int place = 1; max / place > 0; place *= 10)
    countingSort(a, n, place);
}

void printArray(int a[], int n) {
  for (int i = 0; i < n; ++i) {
    printf("%d  ", a[i]);
  }
  printf("\n");
}

int main() {
  int a[] = {181, 289, 390, 121, 145, 736, 514, 888, 122};
  int n = sizeof(a) / sizeof(a[0]);
  printf("Before sorting array elements are - \n");
  printArray(a,n);
  radixsort(a, n);
  printf("After applying Radix sort, the array elements are - \n");
  printArray(a, n);
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array-6
Enter the elements of array-7 6 5 9 2 1
Sorted array is :1 2 5 6 7 9
```

PROGRAM 17 - Program for Counting Sort

ALGORITHM: CountingSort(A[],k,n)

BEGIN:

```
    FOR i = 0 TO k DO
        c[i] = 0
    FOR j = 0 TO n DO
        c[A[j]] = c[A[j]] + 1
    FOR i = 1 TO k DO
        c[i] = c[i] + c[i-1]
    FOR j = n-1 TO 0 STEP-1 DO
        B[ c[A[j]]-1 ] = A[j]
        c[A[j]] = c[A[j]] - 1
    RETURN B
```

END;

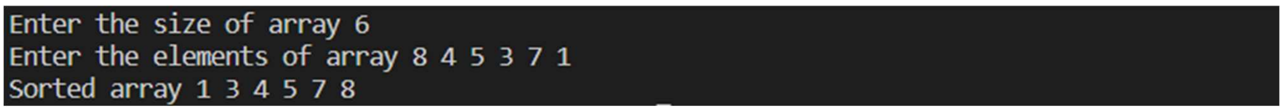
Time Complexity: Omega(N)

Space Complexity:ϴ(N)

```
#include <stdio.h>

void countingSort(int array[], int size) {
  int output[10];

  int max = array[0];
  for (int i = 1; i < size; i++) {
    if (array[i] > max)
      max = array[i];
  }
  int count[10];

  for (int i = 0; i <= max; ++i) {
    count[i] = 0;
  }

  for (int i = 0; i < size; i++) {
    count[array[i]]++;
  }

  for (int i = 1; i <= max; i++) {
    count[i] += count[i - 1];
  }

  for (int i = size - 1; i >= 0; i--) {
    output[count[array[i]] - 1] = array[i];
    count[array[i]]--;
  }

  for (int i = 0; i < size; i++) {
    array[i] = output[i];
  }
}

void printArray(int array[], int size) {
printf("Sorted array ");
  for (int i = 0; i < size; ++i) {
    printf("%d  ", array[i]);
  }
  printf("\n");
}
int main() {
int n;
  printf("Enter the size of array ");
  scanf("%d",&n);
  int array[n];
  printf("Enter the elements of array ");
  for (int i = 0; i < n; i++)
  {
    scanf("%d",&array[i]);
  }
countingSort(array, n);
  printArray(array, n);
}
```

OUTPUT:

Output:



```
Enter the size of array 6
Enter the elements of array 8 4 5 3 7 1
Sorted array 1 3 4 5 7 8
```

PROGRAM 7B - Program For Selection sort

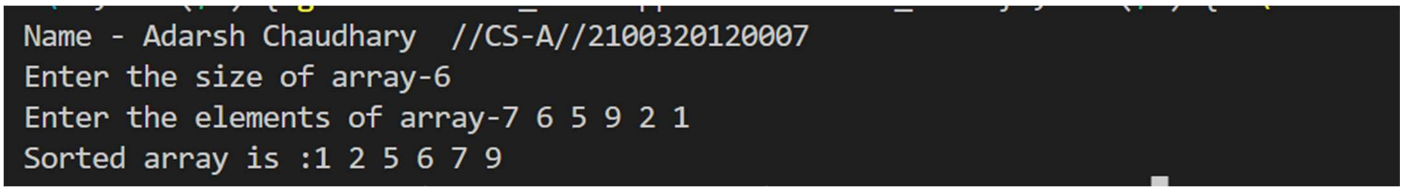
ALGORITHM: SelectionSort(A[], N)
BEGIN:

```
        FOR i=1 TO N-1 DO
                min=i
                FOR  j=i+1 TO N DO
                        IF A[j]<A[min] THEN
                        min=j
                Exchange(A[min], A[i])
```

END;
Time Complexity: Ɵ(N^2)
Space Complexity:Ɵ(1)

```
#include<stdio.h>
int main()

{
   int n;
   printf("Enter the size of array-");
   scanf("%d",&n);
   int arr[n];
   printf("Enter the elements of array-");
   for (int i=0;i<n;i++){
      scanf("%d",&arr[i]);
   }

   for (int i=0;i<n-1;i++)
   {
      for(int j=i+1;j<n;j++)
    {  if(arr[j]<arr[i])
      {
         int temp=arr[j];
         arr[j]=arr[i];
         arr[i]=temp;
      }
    }
   }
   printf("Sorted array is :");
   for(int i=0;i<n;i++)
   {
      printf("%d ",arr[i]);
   }
```

```
    return 0 ;
}
```
Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array-6
Enter the elements of array-7 6 5 9 2 1
Sorted array is :1 2 5 6 7 9
```

PROGRAM 9 - Program for Quick sort

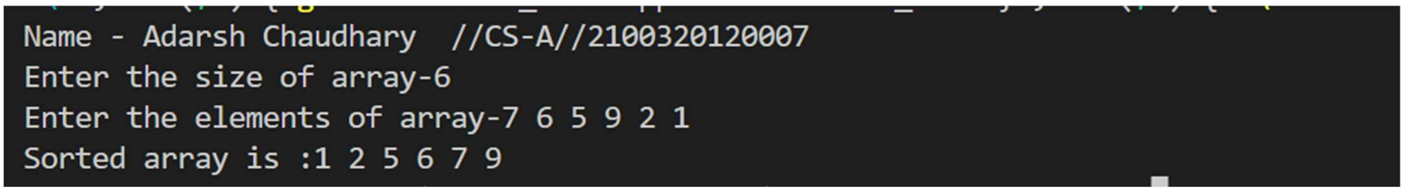
```
ALGORITHM: QuickSort(A[],low,high)
BEGIN:
        IF low<high THEN
                j=Partition(A[],low,high)
                QuickSort(A[],low,j-1)
                QuickSort(A[],j+1,high)
END;
```

```
ALGORITHM: Partition(A[],low,high)
BEGIN:
        i=low, j=high+1,pivot=A[low]
        DO
                DO
                        i=i+1
                WHILE(A[i]<pivot)
                DO
                        J=j-1
                WHILE(A[j]>pivot)

                IF i<j THEN
                        Exchange(A[i],A[j])
        WHILE(i<j)

          Exchange(A[j],A[low])
         RETURN j
END;
```

Worst Case Time Complexity:O(N^2)
Best Case Time Complexity: Ω(N$\log_2$N)
Space Complexity: Θ($\log_2$N)

```
#include<stdio.h>
 void swap(int arr[],int i,int j){
   int temp=arr[i];
   arr[i]=arr[j];
   arr[j]=temp;
}

 int partition(int arr[],int l,int r){
   int pivot= arr[r];
   int i=l-1;
   for(int j=l;j<r;j++){
      if(arr[j]<pivot)
      {
            i++;
            swap(arr,i,j);
        }
    }
    swap(arr,i+1,r);
    return i+1;
}

void quickSort(int arr[],int l,int r){
    if(l<r){
        int pi=partition(arr,l,r);
        quickSort(arr,l,pi-1);
        quickSort(arr,pi+1,r);
         }
}
int main()

{
    int n;
    printf("Enter size of array:");
    scanf("%d",&n);
    int arr[n];
    printf("Enter array elements:");
    for(int i=0;i<n;i++)
        scanf("%d",&arr[i]);

    quickSort(arr,0,n-1);
    printf("Sorted matrix is: ");
    for(int i=0;i<n;i++)
        printf("%d ",arr[i]);
    return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array-6
Enter the elements of array-7 6 5 9 2 1
Sorted array is :1 2 5 6 7 9
```

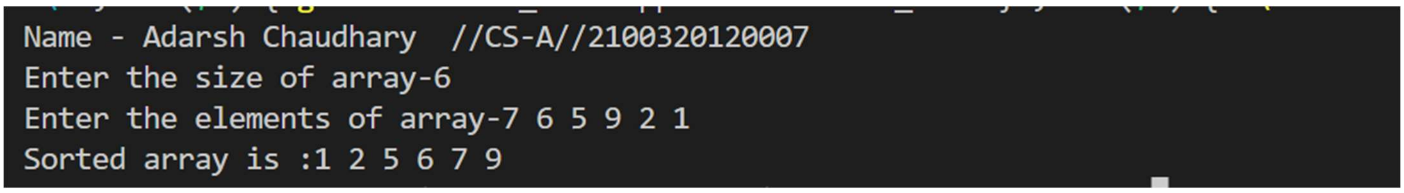
PROGRAM 10 - Program for Merge sort

```
ALGORITHM: MergeSort(A[],low,high)
BEGIN:
        IF low<high DO
                Mid=(low+high)/2
                MergeSort(A[],low,mid)
                MergeSort(A[],mid+1, high)
                Merge(A, low,mid,high)
END;
 ALGORITHM: Merge(A[], low,mid,high)
BEGIN:
        i=low,j=mid+1,k=high
        WHILE i<=mid AND j<=high DO
                IF A[i]<A[j] THEN
                        C[k]=A[i]
                        i=i+1
                        k=k+1
                ELSE
                        C[k]=A[j]
                        j=j+1
                        k=k+1
        WHILE i<=mid DO
                C[k]=A[i]
                i=i+1
                k=k+1
        WHILE j<=high DO
                C[k]=A[j]
                J=j+1
               k=k+1
        FOR i=low TO high DO
                A[i]=C[i]
END;
```

Time Complexity: O(Nlog$_2$N)
Space Complexity: ϴ(N)

```c
#include<stdio.h>

void merge (int arr[],int l,int mid,int r)
{
   int n1=mid-l+1;
   int n2=r-mid;

   int a[n1];
   int b[n2];
   for (int i=0;i<n1;i++)
      a[i]=arr[l+i];

    for (int i=0;i<n2;i++)
      b[i]=arr[mid+1+i];

    int i=0;
    int j=0;
    int k=l;

    while(i<n1 && j<n2)
    {
      if(a[i]<b[j])
      {
         arr[k]=a[i];
         k++;
         i++;
      }
      else
      {
        arr[k]=b[j];
        k++;
        j++;
      }
    }
    while(i<n1){
      arr[k]=a[i];
         k++;
         i++;
    }

    while(j<n2)
    {
       arr[k]=b[j];
         k++;
         j++;
    }
}

void mergeSort(int arr[],int l,int r)
{
   if(l<r){
        int mid=(l+r)/2;
        mergeSort(arr,l,mid);
        mergeSort(arr,mid+1,r);

        merge(arr,l,mid,r);
    }
}

int main()
{   int n;
    printf("Enter size of array:");
    scanf("%d",&n);
    int arr[n];
    printf("Enter array-");
     for(int i=0;i<n;i++)
    {
        scanf("%d",&arr[i]);
    }

    mergeSort(arr,0,n-1);//l=0  r=n-1

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

    return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array-6
Enter the elements of array-7 6 5 9 2 1
Sorted array is :1 2 5 6 7 9
```

PROGRAM 7C - Program for Insertion sort

ALGORITHM: InsertionSort(A[], N)
BEGIN:

```
        FOR i=2 TO N DO
            key=A[i]
            j=i-1
            WHILE j>=1  AND A[j]>key DO
                A[j+1]=A[j]
                j=j-1
            A[j+1]=key
```

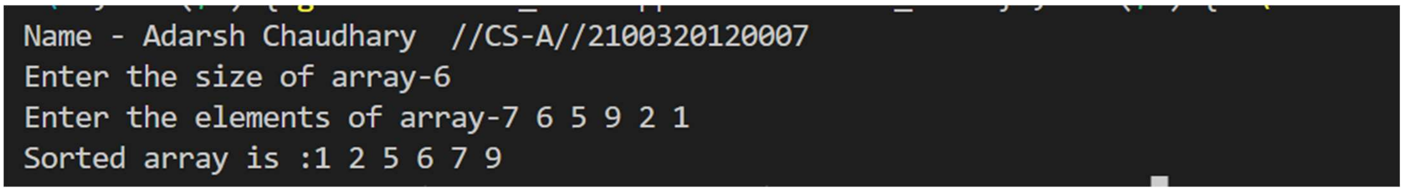
END;

Worst Case Time Complexity:O(N^2)
Best Case Time Complexity: Omega(N)
Space Complexity:Θ(1)

```
#include<stdio.h>

int main()

{
  int n;
  printf("Enter size of array:");
  scanf("%d",&n);
  int arr[n];
  printf("Enter array-");
   for(int i=0;i<n;i++)
  {
    scanf("%d",&arr[i]);
  }
   for(int i=1;i<n;i++)
  {
    int current=arr[i];
    int j=i-1;

    while(arr[j]>current&&j>=0)
    {
      arr[j+1]=arr[j];
      j--;

    }
   arr[j+1]=current;
```

```
    }

    printf("Sorted array is-");
    for (int i=0;i<n;i++)
    {
        printf("%d ",arr[i]);

    }

    return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array-6
Enter the elements of array-7 6 5 9 2 1
Sorted array is :1 2 5 6 7 9
```

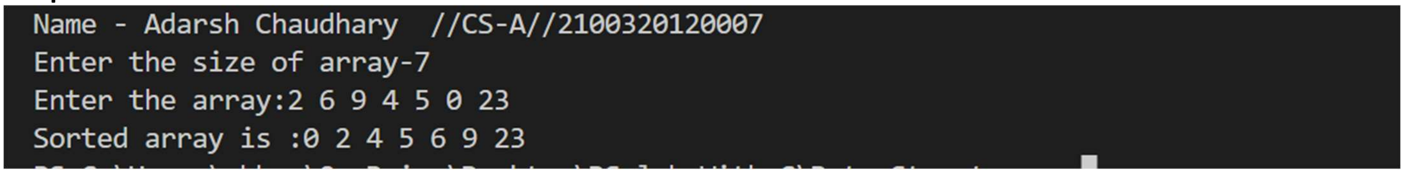
PROGRAM 7A - Program for Bubble sort

```
ALGORITHM:  BubbleSort(A[], N)
BEGIN:
        FOR i=1 TO N-1 DO
              FOR j=1 TO N-i DO
                     IF A[j]>A[j+1]
                            k=A[j]
                            A[j]=A[j+1]
                            A[j+1]=k
END;
```

Worst Case Time Complexity:O(N^2)
Best Case Time Complexity: Omega(N)
Space Complexity:Ɵ(1)

```
#include<stdio.h>

int main()

{
  int n;
  printf("Enter the size of array-");
  scanf("%d",&n);
  int arr[n];
  printf("Enter the array:");
  for(int i=0;i<n;i++){
    scanf("%d",&arr[i]);

  }
  int count=1;
  while(count<n){
    for(int i=0;i<n-count;i++){
      if(arr[i]>arr[i+1])
      {int temp=arr[i];
      arr[i]=arr[i+1];
      arr[i+1]=temp;}
    }
    count++;
  }
  printf("Sorted array is :");
  for(int i=0;i<n;i++){
    printf("%d ",arr[i]);
    }
    return 0 ;
}
```

Output:



```
Name - Adarsh Chaudhary  //CS-A//2100320120007
Enter the size of array-7
Enter the array:2 6 9 4 5 0 23
Sorted array is :0 2 4 5 6 9 23
```