DATA STRUCTURES LAB WORK

Submitted By

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CE – 2B (2022-23)

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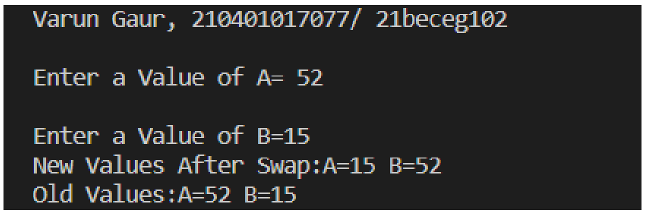
PRACTICAL I

Introduction to Pointers: Call By Value & Call By Reference

CALL BY VALUE

- In call by value method, the value of the actual parameters is copied into the formal parameters.
- In call by value method, we cannot modify the value of the actual parameter by the formal parameter.
- In call by value, different memory is allocated for actual and formal parameters since the value of the actual parameter is copied into the formal parameter.
- The actual parameter is the argument which is used in the function call whereas formal parameter is the argument which is used in the function definition.

```c
#include<stdio.h>
void swap(int,int);
int main()
{
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    int a,b;
    printf("\nEnter a Value of A=");
    scanf("%d",&a);
    printf("\nEnter a Value of B=");
    scanf("%d",&b);
    swap(a,b);
    printf("\nOld Values:");
    printf("A=%d B=%d \n",a,b);
}

void swap(int p,int q)
{
    int tmp;
    tmp=p;
    p=q;
    q=tmp;
    printf("New Values After Swap:");
    printf("A=%d B=%d",p,q);
}
```

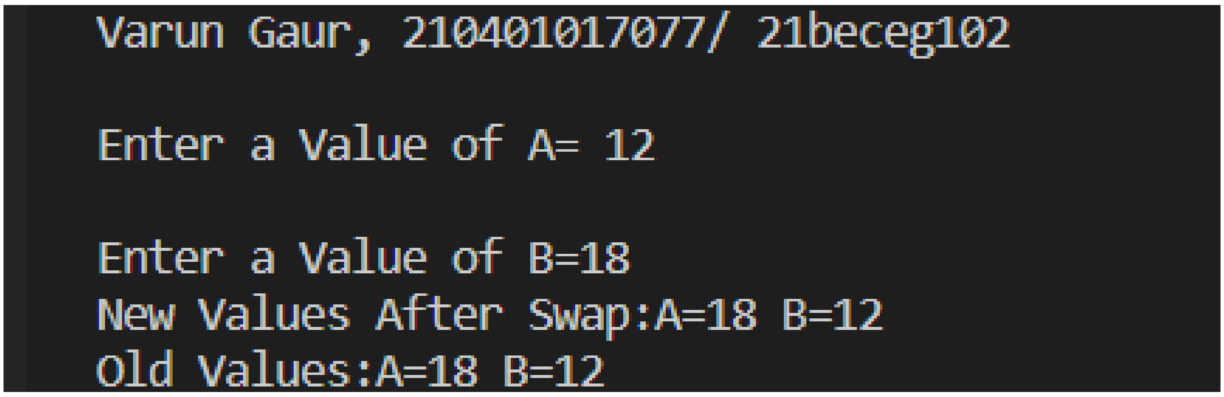


```
Varun Gaur, 210401017077/ 21beceg102

Enter a Value of A= 52

Enter a Value of B=15
New Values After Swap:A=15 B=52
Old Values:A=52 B=15
```

CALL BY REFERENCE

- In call by reference, the address of the variable is passed into the function call as the actual parameter.
- The value of the actual parameters can be modified by changing the formal parameters since the address of the actual parameters is passed.
- In call by reference, the memory allocation is similar for both formal parameters and actual parameters.
- All the operations in the function are performed on the value stored at the address of the actual parameters, and the modified value gets stored at the same address.

```c
#include<stdio.h>
void swap(int*,int*);
int main()
{
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    int a,b;
    printf("\nEnter a Value of A=");
    scanf("%d",&a);
    printf("\nEnter a Value of B=");
    scanf("%d",&b);
    swap(&a,&b);
    printf("\nOld Values:");
    printf("A=%d B=%d \n",a,b);
}
void swap(int *p , int *q)
{
    int tmp;
    tmp=*p;
    *p=*q;
    *q=tmp;
    printf("New Values After Swap:");
    printf("A=%d B=%d",*p,*q);
}
```



```
Varun Gaur, 210401017077/ 21beceg102

Enter a Value of A= 12

Enter a Value of B=18
New Values After Swap:A=18 B=12
Old Values:A=18 B=12
```

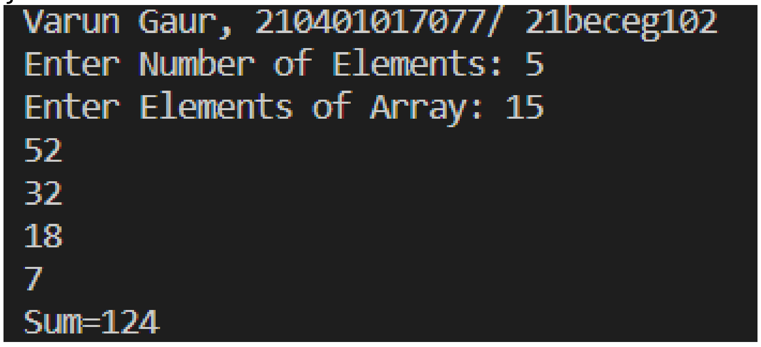
PRACTICAL II

Introduction to Dynamic Memory Allocation: malloc(), calloc(), free()

MALLOC ()

- malloc () is used to allocate a fixed amount of memory during the execution of a program
- malloc () allocates size in bytes of memory from heap, if the allocation succeeds, a pointer to the block of memory is returned else NULL is returned.
- Allocated memory space may not be contiguous.
- Each block contains a size, a pointer to the next block, and the space itself.
- The blocks are kept in ascending order of storage address, and the last block points to the first.
- The memory is not initialized. It initializes each block with default garbage value.

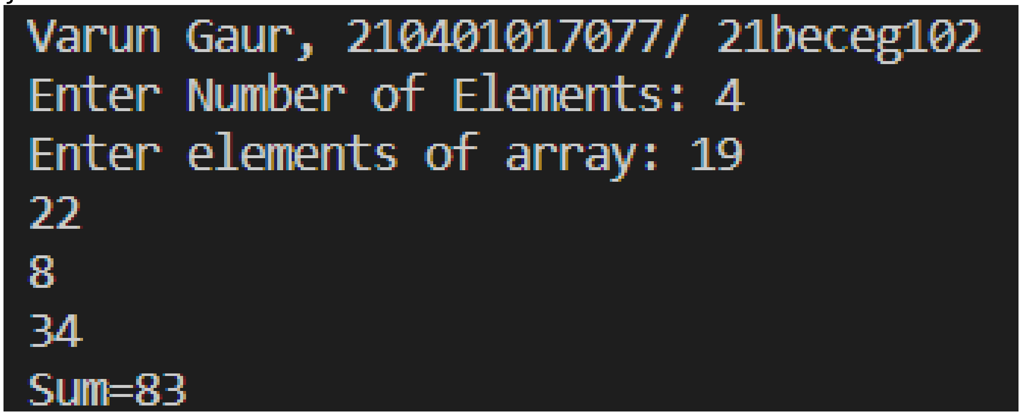
```
#include<stdio.h>
#include<stdlib.h>
int main(){
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    int *ptr;
    int n,i,sum=0;
    printf("Enter Number of Elements: ");
    scanf("%d",&n);
    ptr=(int*)malloc(n*sizeof(int));
    printf("Enter Elements of Array: ");
    for(i=0;i<n;++i)
    {
        scanf("%d",ptr+i);
        sum+=*(ptr+i);
    }
    printf("Sum=%d",sum);
    free(ptr);
    return 0;
}
```



```
Varun Gaur, 210401017077/ 21beceg102
Enter Number of Elements: 5
Enter Elements of Array: 15
52
32
18
7
Sum=124
```

CALLOC ()

```
#include<stdio.h>
#include<stdlib.h>
int main() {
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    int n,i,*ptr,sum=0;
    printf("Enter Number of Elements: ");
    scanf("%d",&n);
    ptr=(int*)calloc(n,sizeof(int)); //memory allocated using calloc
    printf("Enter elements of array: ");
    for(i=0;i<n;++i)
    {
        scanf("%d",ptr+i);
        sum+=*(ptr+i);
    }
    printf("Sum=%d",sum);
    free(ptr);
return 0;
}
```

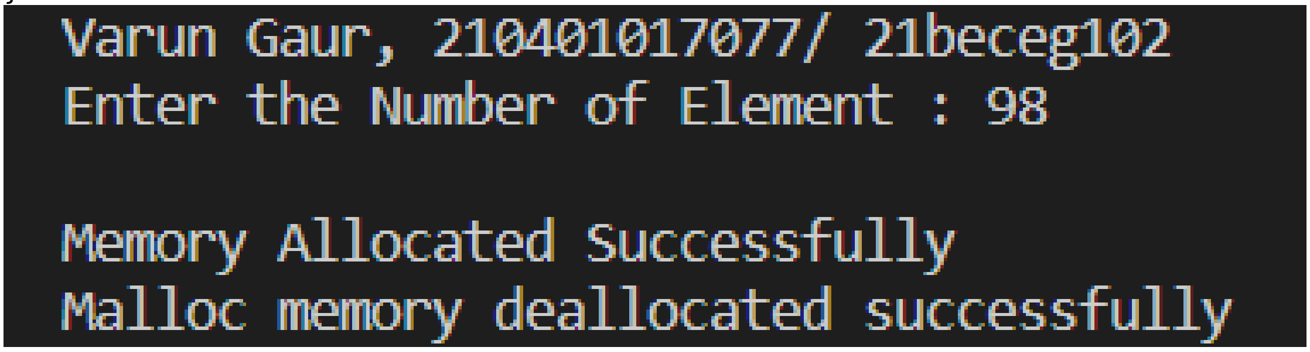


```
Varun Gaur, 210401017077/ 21beceg102
Enter Number of Elements: 4
Enter elements of array: 19
22
8
34
Sum=83
```

FREE ()

- “free” method in C is used to dynamically de-allocate the memory.
- The memory allocated using functions malloc() and calloc() is not de-allocated on their own.
- Hence the free() method is used, whenever the dynamic memory allocation takes place.
- It helps to reduce wastage of memory by freeing it.

```
#include<stdio.h>
#include<stdlib.h>
void main ()
{
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    int* ptr;
    int n, i;
    n = 5;
    printf("Enter the Number of Element : ");
    scanf("%d", &n);
    ptr = (int*) malloc (n*sizeof(int));
    if (ptr == NULL)
    {
        printf("\n Memory not allocated ");
    }
    else
    {
        printf("\nMemory Allocated Successfully");
        free(ptr);
        printf("\nMalloc memory deallocated successfully");
    }
}
```



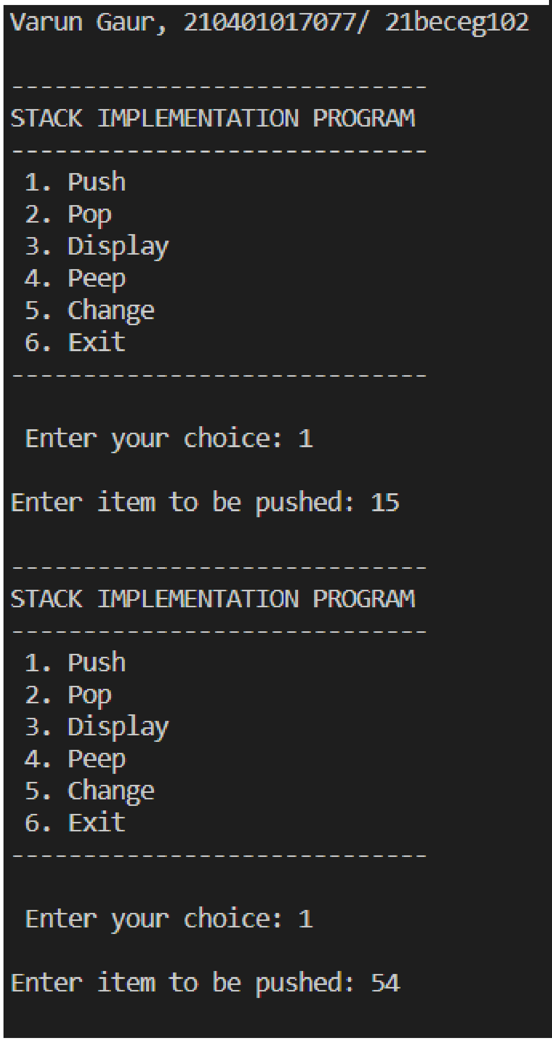
```
Varun Gaur, 210401017077/ 21beceg102
Enter the Number of Element : 98

Memory Allocated Successfully
Malloc memory deallocated successfully
```

PRACTICAL III

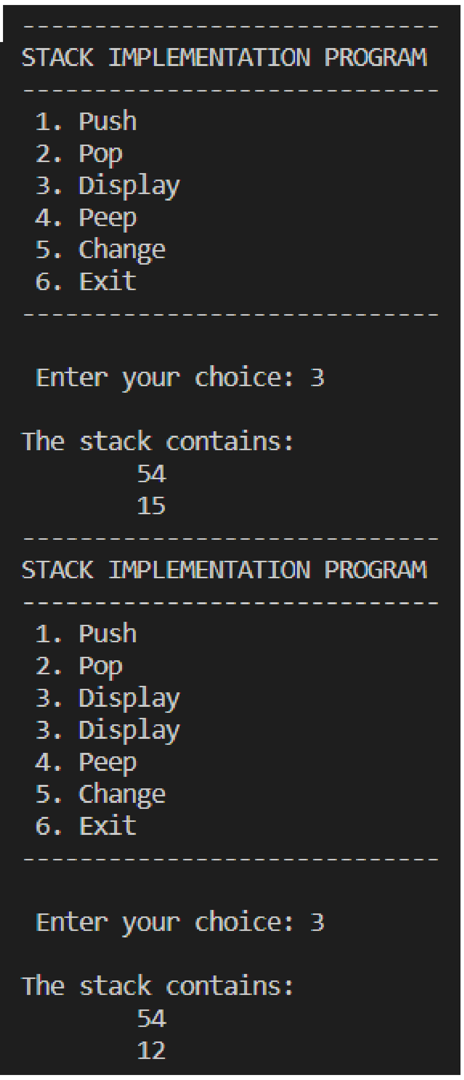
PUSH(), POP(), PEEP(), CHANGE(), DISPLAY()

Implement a program for stack that performs following operations using array. PUSH (b) POP (c) PEEP (d) CHANGE (e) DISPLAY

```
#include<stdio.h>
#define size 5
struct stack
{
    int a[size],top;
    int temp[size], tos;
}s;
void push(int item)
{
    s.a[++s.top] = item;
}
int pop()
{
    return s.a[s.top--];
}
void display()
{
    int i;
    printf("\nThe stack contains: ");
    for(i = s.top; i>=0; i--)
    {
    printf("\n\t%d", s.a[i]);
    }
}
void peep()
{
    printf("\n\tTop : %d", s.top);
    printf("\n\tValue: %d",s.a[s.top]);
}
void change(int row, int new_element)
{
    int i;
    int j = -1;
    printf("\n\tTop: %d", s.top);
    for(i=s.top; i>row; i--)
    {
        s.temp[++j] = s.a[s.top--];
    }
    s.a[s.top] = new_element;
    for(i = j; i>-1; i--)
    {
        s.a[++s.top] = s.temp[j--];
    }
}
int main()
{
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    s.top = -1;
    int item, choice, row, new_element;
    char ans;
    do{
    printf("\n----------------------------");
    printf("\nSTACK IMPLEMENTATION PROGRAM\n");
    printf("----------------------------");
    printf("\n 1. Push\n 2. Pop\n 3. Display\n 4. Peep\n 5. Change \n 6. Exit\n");
    printf("----------------------------\n");
    printf("\n Enter your choice: ");
    scanf("%d", &choice);
    switch(choice){
        case 1:
        if(s.top >= size-1)
        {
            printf("\nStack overflow..\n");
            break;
        }
        printf("\nEnter item to be pushed: ");
        scanf("%d", &item);
        push(item);
        break;

        case 2:
        if(s.top == -1)
        {
            printf("\n..Stack underflow..\n");
            break;
        }
            pop();
            break;

        case 3:
        display();
        break;

        case 4:
        peep();
        break;

        case 5:
        printf("\n\tEnter row no : ");
        scanf("%d",&row);
        printf("\n\tEnter new element: ");
        scanf("%d", &new_element);
        change(row, new_element );
        break;

        case 6:
        return 0;
 }
 }
 while(choice != 6);
 return 0;
}
```



```
Varun Gaur, 210401017077/ 21beceg102

-----------------------------
STACK IMPLEMENTATION PROGRAM
-----------------------------
 1. Push
 2. Pop
 3. Display
 4. Peep
 5. Change
 6. Exit
-----------------------------

 Enter your choice: 1

Enter item to be pushed: 15

-----------------------------
STACK IMPLEMENTATION PROGRAM
-----------------------------
 1. Push
 2. Pop
 3. Display
 4. Peep
 5. Change
 6. Exit
-----------------------------

 Enter your choice: 1

Enter item to be pushed: 54
```



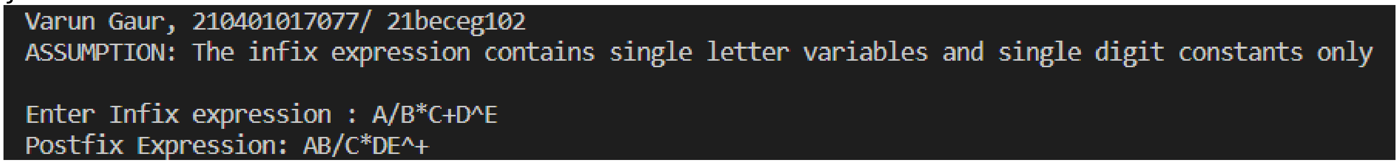
```
-----------------------------
STACK IMPLEMENTATION PROGRAM
-----------------------------
 1. Push
 2. Pop
 3. Display
 4. Peep
 5. Change
 6. Exit
-----------------------------

 Enter your choice: 3

The stack contains:
        54
        15
-----------------------------
STACK IMPLEMENTATION PROGRAM
-----------------------------
 1. Push
 2. Pop
 3. Display
 3. Display
 4. Peep
 5. Change
 6. Exit
-----------------------------

 Enter your choice: 3

The stack contains:
        54
        12
```

PRACTICAL IV

Infix to Postfix

Implement a program to convert infix notation to postfix notation using stack.

```
#include<stdio.h>
#include<stdlib.h>
#include<ctype.h>
#include<string.h>
#define SIZE 100
char stack[SIZE];
int top = -1;
void push(char item)
{
    if(top >= SIZE-1)
    {
        printf("\nStack Overflow.");
    }
    else
    {
        top = top+1;
        stack[top] = item;
        }
}
char pop()
{
    char item ;
    if(top <0)
    {
        printf("stack under flow: invalid infix expression");
        getchar();
        /* underflow may occur for invalid expression */
        /* where ( and ) are not matched */
        exit(1);
    }
    else
    {
        item = stack[top];
        top = top-1;
        return(item);
    }
}
int is_operator(char symbol)
{
    if(symbol == '^' || symbol == '*' || symbol == '/' || symbol == '+' || symbol
=='-')
    {
        return 1;
    }
    else
    {return 0;}
}
int precedence(char symbol)
{
    if(symbol == '^')
    {return(3);}

    else if(symbol == '*' || symbol == '/')
    {return(2);}

    else if(symbol == '+' || symbol == '-')
    {return(1);}

    else
    {return(0);}
}
void InfixToPostfix(char infix_exp[], char postfix_exp[])
{
    int i, j;
    char item;
    char x;
    push('(');
    strcat(infix_exp,")");
    i=0; j=0;
    item=infix_exp[i];
    while(item != '\0')
    {
        if(item == '(')
        {
            push(item);
        }
        else if( isdigit(item) || isalpha(item))
        {
            postfix_exp[j] = item;
            j++;
            }
            else if(is_operator(item) == 1)
            {
                x=pop();
                while(is_operator(x) == 1 && precedence(x)>= precedence(item))
                {
                    postfix_exp[j] = x; j++;
                    x = pop();
                }
                push(x);
                push(item);
            }

            else if(item == ')')
            {
                x = pop();
                while(x != '(')
                {
                    postfix_exp[j] = x;
                    j++;
                    x = pop();
                }
            }

        else
        {
            printf("\nInvalid infix Expression.\n");
            getchar();
            exit(1);
        }

        i++;
        item = infix_exp[i];
    }
    if(top>0)
    {
        printf("\nInvalid infix Expression.\n");
        getchar();
        exit(1);
    }
    if(top>0)
    {
        printf("\nInvalid infix Expression.\n");
        getchar();
        exit(1);
    }
    postfix_exp[j] = '\0';
    }
int main()
{
    printf("Varun Gaur, 210401017077/ 21beceg102\n");

    char infix[SIZE], postfix[SIZE];
    printf("ASSUMPTION: The infix expression contains single letter variables and
single digit constants only \n");
    printf("\nEnter Infix expression : ");
    gets(infix);
    InfixToPostfix(infix,postfix);
    printf("Postfix Expression: ");
    puts(postfix);
    return 0;
}
```



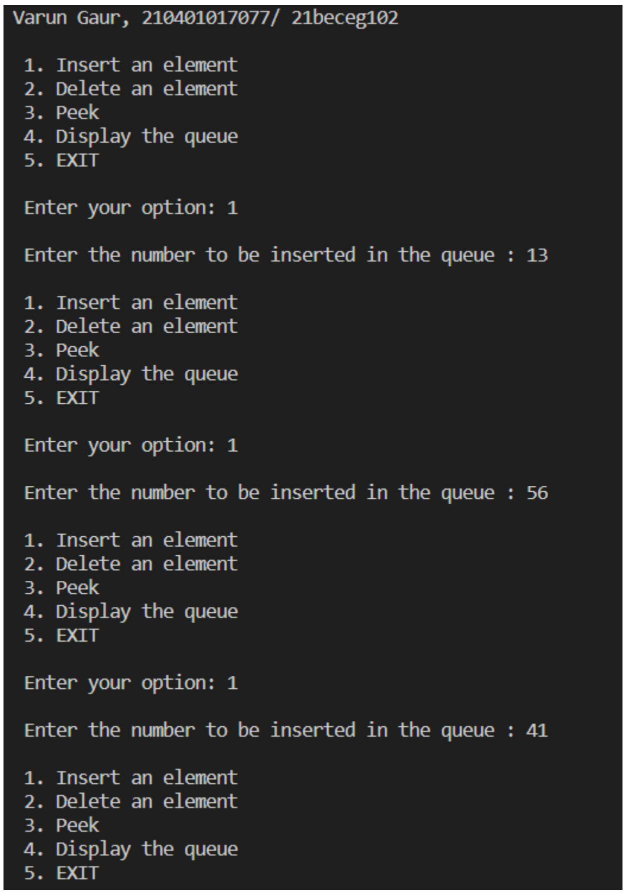
```
Varun Gaur, 210401017077/ 21beceg102
ASSUMPTION: The infix expression contains single letter variables and single digit constants only

Enter Infix expression : A/B*C+D^E
Postfix Expression: AB/C*DE^+
```

PRACTICAL V

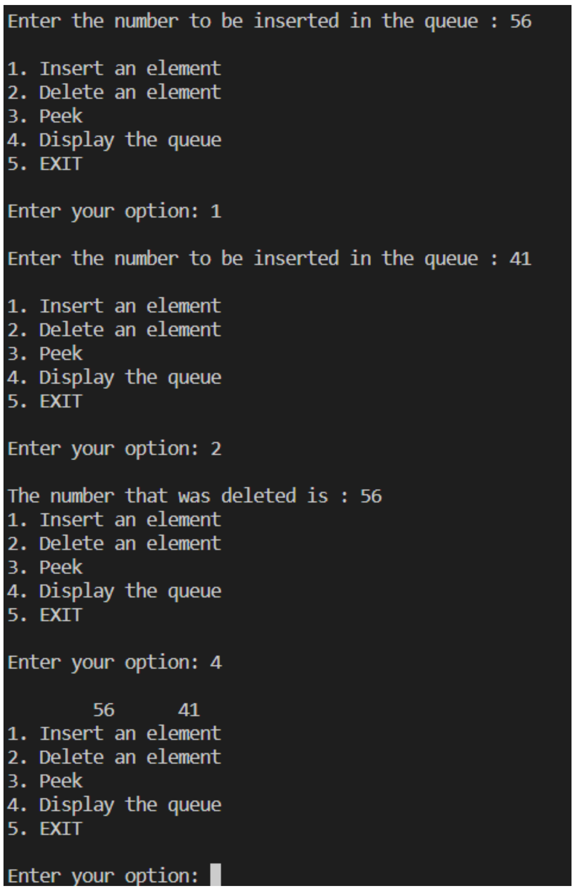
INSERT, DELETE AND DISPLAY using Queue

Write a program to implement QUEUE using arrays that performs the following operations (a)INSERT (b)DELETE (c)DISPLAY

```
#include<stdio.h>
#include<conio.h>
#define MAX 10
int queue[MAX];
int front = -1,rear = -1;
void insert(void);
int delete_element(void);
int peek(void);
void display(void);
void main()
{
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    int option, val;
    do
    {
        printf("\n 1. Insert an element");
        printf("\n 2. Delete an element");
        printf("\n 3. Peek");
        printf("\n 4. Display the queue");
        printf("\n 5. EXIT");
        printf("\n \n Enter your option: ");
        scanf("%d",&option);
switch(option)
{
    case 1:
    insert();
    break;

    case 2:
    val= delete_element();
    printf("\n The number that was deleted is : %d",val);
    break;

    case 3:
    val=peek();
    printf("\n The first value in the queue is: %d",val);
    break;

    case 4:
    display();
    break;
}
}
while(option != 5);
   getch();
   return;
}
void insert()
{
    int num;
    printf(" \n Enter the number to be inserted in the queue : ");
    scanf("%d", &num);
    if(rear == MAX-1)
    printf("\n OVERFLOW");

    if (front == -1 && rear == -1)
    front = rear=0;

    else
    rear++;
    queue[rear] = num;
}
int delete_element()
{
    int val;
    if(front == -1 || front>rear)
    {
        printf("\n UNDERFLOW");
        return -1;
    }
    else
    {
        front++;
        val = queue[front];
        return val;
    }
}
int peek()
{
    return queue[front];
}
void display()
{
    int i;
    printf("\n");
    for(i = front; i<=rear;i++)
    printf("\t %d",queue[i]);
}
```



```
Varun Gaur, 210401017077/ 21beceg102

 1. Insert an element
 2. Delete an element
 3. Peek
 4. Display the queue
 5. EXIT

 Enter your option: 1

 Enter the number to be inserted in the queue : 13

 1. Insert an element
 2. Delete an element
 3. Peek
 4. Display the queue
 5. EXIT

 Enter your option: 1

 Enter the number to be inserted in the queue : 56

 1. Insert an element
 2. Delete an element
 3. Peek
 4. Display the queue
 5. EXIT

 Enter your option: 1

 Enter the number to be inserted in the queue : 41

 1. Insert an element
 2. Delete an element
 3. Peek
 4. Display the queue
 5. EXIT
```



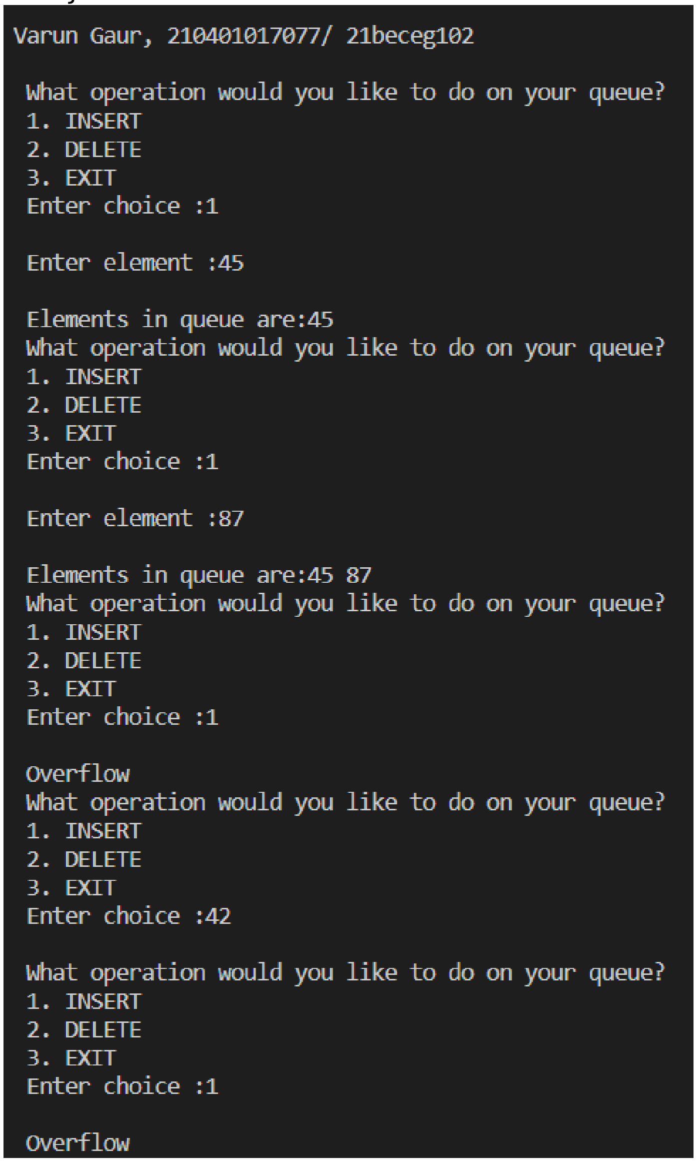
```
Enter the number to be inserted in the queue : 56

1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. EXIT

Enter your option: 1

Enter the number to be inserted in the queue : 41

1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. EXIT

Enter your option: 2

The number that was deleted is : 56
1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. EXIT

Enter your option: 4

        56      41
1. Insert an element
2. Delete an element
3. Peek
4. Display the queue
5. EXIT

Enter your option: 
```

PRACTICAL VI

INSERT, DELETE AND DISPLAY using Circular Queue

Write a program to implement Circular Queue using arrays that performs the following operations. (a)INSERT (b)DELETE (c)DISPLAY

```
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
#define N 2
int r=-1,f=-1,queue[N];
void insert();
void del();
int i;
void main()
{
    printf("Varun Gaur, 210401017077/ 21beceg102\n");
    int ch;
    while(1)
    {
        printf("\n What operation would you like to do on your queue?");
        printf("\n 1. INSERT");
        printf("\n 2. DELETE");
        printf("\n 3. EXIT");
        printf("\n Enter choice :");
        scanf("%d",&ch);
        switch(ch)
        {
            case 1:
            insert();
            break;

            case 2:
            del();
            break;

            case 3:
            exit(0);
            }
        }
    }
void insert(void)

{
    if((f==0 && r==N-1) || (f==r+1))
    {
        printf("\n Overflow");
        return;
    }

    else
    {
        if(f==-1)
        f=r=0;

        else if(r==N-1)
        r=0;

        else
        r=r+1;

        printf("\n Enter element :");
        scanf("%d",&queue[r]);
        printf("\n Elements in queue are:");

        if(f<=r)
        for(i=f;i<=r;i++)
        printf("%d ",queue[i]);

        else
        {
            for(i=f;i<=N-1;i++)
            printf("%d ",queue[i]);

            for(i=0;i<=r;i++)
            printf("%d ",queue[i]);
        }
    }
}
void del(void)
{
    int item;
    if(f==-1)
    {
        printf("\n Underflow");
        return;
    }
    item = queue[f];

    if(f==r)
    f=r=-1;

    else if(f==N-1)
    f=0;
    else
    f=f+1;
    printf("\n Elements in queue are:");

    if(f<=r)
    for(i=f;i<=r;i++)
    printf("%d ",queue[i]);

    else
    {
        for(i=f;i<=N;i++)
        printf("%d ",queue[i]);
        for(i=1;i<=r;i++)
        printf("%d ",queue[i]);
        }
    }
```



```
Varun Gaur, 210401017077/ 21beceg102

 What operation would you like to do on your queue?
 1. INSERT
 2. DELETE
 3. EXIT
 Enter choice :1

 Enter element :45

 Elements in queue are:45
 What operation would you like to do on your queue?
 1. INSERT
 2. DELETE
 3. EXIT
 Enter choice :1

 Enter element :87

 Elements in queue are:45 87
 What operation would you like to do on your queue?
 1. INSERT
 2. DELETE
 3. EXIT
 Enter choice :1

 Overflow
 What operation would you like to do on your queue?
 1. INSERT
 2. DELETE
 3. EXIT
 Enter choice :42

 What operation would you like to do on your queue?
 1. INSERT
 2. DELETE
 3. EXIT
 Enter choice :1

 Overflow
```