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## UCS 2312 Data Structures Lab

## Assignment 4: StackADT and its application

**Date of Assignment: 03.10.2023**

Create an ADT for the stack data structure with the following functions. stack*ADT* will have the integer array, top and size. [CO1, K3]

a. createStack(top) – initialize size and top with -1
b. push(top,data) – push data into the stack if stack is not full. Print a message when stack is full
c. pop(top) – decrements the top by 1
d. peek(top)– returns the element at top, if stack is not empty, otherwise returns -1
e. isEmpty(top) – returns 1 if stack empty, otherwise returns 0
f. isFull(top) – returns 1 if stack full, otherwise returns 0

Test the operations of stackADT with the following test cases

| **Operation** | **Expected Output** |
|---|---|
| peek(top) | Empty |
| push(top,2) | 2 |
| push(top,4) | 4, 2 |
| push(top,6) | 6, 4, 2 |
| push(top,8) | Full |
| pop(top) | |
| peek(top) | 4 |
| peek(top) | 4 |
| pop(top) | |
| pop(top) | |
| peek(top) | Empty |
| pop(top) | |
| pop(top) | |
| push(top,11) | 11 |
| peek(top) | 11 |

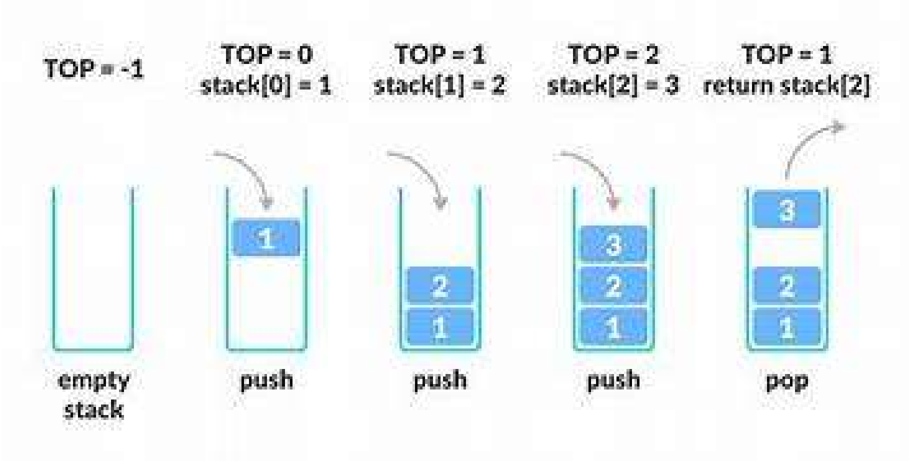
Best practices to be followed:

- Design before coding
- Usage of algorithm notation
- Use of multi-file C program
- Versioning of code

Application using Stack

1. Evaluate the infix to postfix expression using Stack
   Example: (2+3)*(4+5)
   Ans: 23+45+*
2. Convert the given decimal number into binary using stack
   Example: 14
   Ans: 1110

**Data Structure – Stack:**



**Algorithm –**

**Algorithm: Evaluate the infix to postfix expression using Stack**

Input – char[] infix, char[] postfix

Output – char[] postfix

```
1.  if operand, add to postfix
2.  if stack is empty or peek(s)==‘(’ or precedence(peek(s)) < infix[i]
        push (s,infix[i])
3.  else
        postfix[c++] = peek(s)
        pop(s)
        push (s,infix[i])
4.  if infix[i]==‘(’
        push (s,infix[i])
5.  if infix[i]==‘)’
        while (peek(s)==‘(’)
            postfix[c++] = peek(s)
            pop(s);
```

**Algorithm: Convert the given decimal number into binary using stack**

Input – number to be converted to binary

Output – binary equivalent of number

```
1.  createStack(top,100)
2.  while (num != 0)
        rem = num%2
        push(top, rem)
        num/=2
3.  while (peek(top) != -1)
        print pop(top)
```

**stack.h code:**

```
struct stack
{
       int top;
       int a[100];
       int size;
};
void createStack(struct stack *top,int size)
{
      top->size=size;
      top->top=-1;
}
int isFull(struct stack *top)
{
      if(top->top<(top->size-1))
           return 0;
      return 1;
}
void push(struct stack *top,int data)
{
      if(isFull(top))
           printf("Stack Full\n");
      else
           top->a[++top->top]=data;
}
int isEmpty(struct stack *top)
{
      if(top->top==-1)
           return 1;
      return 0;
}
void pop(struct stack *top)
```

```
{
      if(isEmpty(top))
            printf("Stack empty\n");
      else
      {
            --top->top;
            printf("Element Popped\n");
      }
}
int peek(struct stack *top)
{
      if(isEmpty(top))
            return -1;
      else
            return top->a[top->top];
}
```

**main.c code:**

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

int main()
{
      int size;
      printf("Enter size: ");
      scanf("%d", &size);
      struct stack *top = (struct stack *) malloc(sizeof(struct stack));
      createStack(top, size);

      int choice = 1;
      while(choice)
      {
        printf("\n0: QUIT\n1: Push\n2: Pop\n3: Peek\nEnter choice:");
        scanf("%d", &choice);
        switch(choice)
        {
            case 0: break;
            case 1:
            {
                int data;
                printf("Enter data: ");
                scanf("%d", &data);
                push(top, data);
                break;
            }
            case 2:
            {
                pop(top);
                break;
            }
            case 3:
            {
                int val = peek(top);
                if(val!= -1)
                    printf("Peek is %d\n", val);
                else
                    printf("Stack is Empty\n");
                break;
            }
            default: printf("\nEnter valid Choice");
        }
    }
}
```

**APPLICATIONS:**

**1. Evaluate the infix to postfix expression using Stack**

**InfixToPostfix.h code:**

```
struct stack
{
       int top;
       char a[100];
       int size;
};
void createStack(struct stack *top,int size)
{
      top->size=size;
      top->top=-1;
}
int isFull(struct stack *top)
{
      if(top->top<(top->size-1))
            return 0;
      return 1;
}
void push(struct stack *top,char data)
{
      if(isFull(top))
            printf("Stack Full\n");
      else
            top->a[++top->top]=data;
}
int isEmpty(struct stack *top)
{
      if(top->top==-1)
            return 1;
```

```
        return 0;
}
char pop(struct stack *top)
{
        char data;
        if(isEmpty(top))
                return -1;
        else
        {
                data=top->a[top->top];
                --top->top;
        }
        return data;
}
char peek(struct stack *top)
{
        if(isEmpty(top))
                return ' ';
        else
                return top->a[top->top];
}
```

**InfixToPostfix.c code:**

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

int precedence (char ch)
{
        switch (ch)
        {
                case '+':
                case '-':
```

```
           return 1;
           case '*':
           case '/':
           return 2;
           case '(':
           case ')':
           return 3;
           default:
           return 0;
     }
}

int isOperator (char ch)
{
     if (ch=='+' || ch=='-' || ch=='*' || ch=='/'|| ch=='('|| ch==')')
         return 1;
     return 0;
}

void main ()
{
    struct stack *s = (struct stack*)malloc(sizeof(struct stack));
    char postfix[100];
    createStack(s, 100);
    int len=0,i=0,j=0,k;
    char infix[100];
    printf ("Infix Expression : ");
    scanf ("%s", infix);
    while (infix[i]!='\0')
    {
      len++; i++;
    }
```

```
for (i=0;i<len;i++)
{
    if (isOperator(infix[i]))
    {
        if (isEmpty(s))
           push (s,infix[i]);
        else
        {
            if (infix[i]==')')
            {
                while (peek(s)!='(')
                {
                    if (peek(s)!='(' && peek(s)!=')')
                    postfix[j++] = peek(s);
                    pop (s);
                }
                pop(s);
            }
else if (precedence(infix[i])>precedence(peek(s)) || peek(s)=='(')
               push (s,infix[i]);
            else
            {
            while (precedence(infix[i])<=precedence(peek(s)))
                        {
                            postfix [j++] = peek(s);
                    pop(s);
                         }
                push (s,infix[i]);
            }
        }
    }
    else
```

```
            postfix[j++] = infix[i];
    }
    while (!isEmpty(s))
    {
        postfix[j++] = peek(s);
        pop (s);
    }
    printf("Postfix Expression : ");
    for (k=0;k<j;k++)
       printf ("%c",postfix[k]);
    printf ("\n");
}
```

**2. Convert the given decimal number into binary using stack**

**DecimalToBianry.h code:**

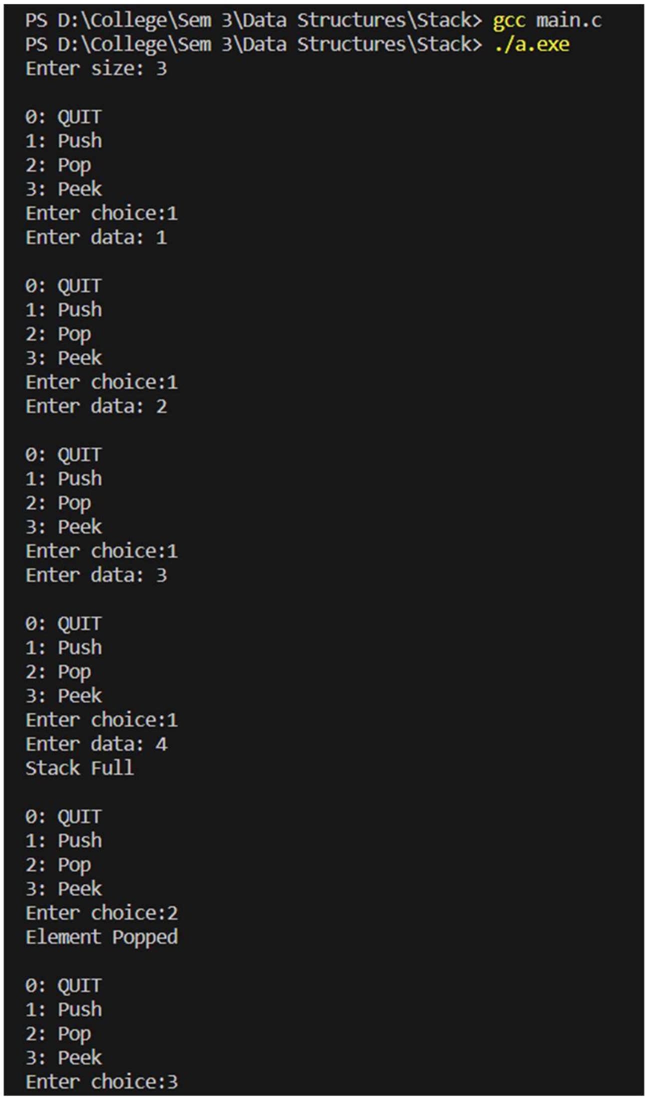
```
struct stack
{
     int top;
     int a[100];
     int size;
};
void createStack(struct stack *top,int size)
{
    top->size=size;
    top->top=-1;
}
int isFull(struct stack *top)
{
    if(top->top<(top->size-1))
        return 0;
    return 1;
}
void push(struct stack *top,int data)
```

```
{
      if(isFull(top))
            printf("Stack Full\n");
      else
            top->a[++top->top]=data;
}
int isEmpty(struct stack *top)
{
      if(top->top==-1)
            return 1;
      return 0;
}
int pop(struct stack *top)
{
      int data;
      if(isEmpty(top))
            return -1;
      else
      {
            data=top->a[top->top];
            --top->top;
      }
      return data;
}
int peek(struct stack *top)
{
      if(isEmpty(top))
            return -1;
      else
            return top->a[top->top];
}
```

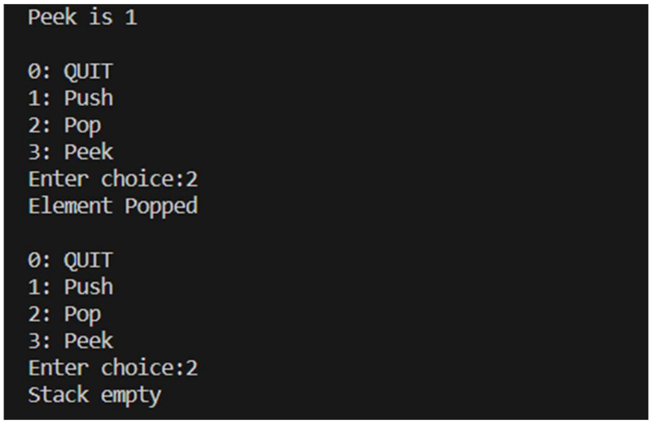
**DecimalToBinary.c code:**

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

void DecimalToBinary(int num)
{
    struct stack *top = (struct stack *) malloc(sizeof(struct stack));
     createStack(top, 100);
    int rem;
    while(num!=0)
    {
        rem = num%2;
        push(top, rem);
        num/=2;
    }
    while(peek(top)!=-1)
        printf("%d", pop(top));
    printf("\n");
}

void main()
{
    int num;
    printf("Enter an integer : ");
    scanf("%d",&num);
    printf("Binary Equivalent is : ");
    DecimalToBinary(num);
}
```

**Output Screen:**

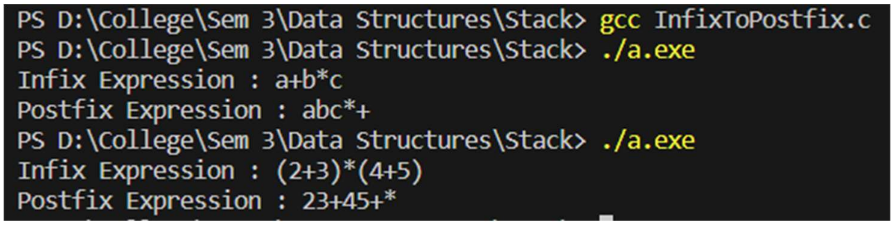


```
PS D:\College\Sem 3\Data Structures\Stack> gcc main.c
PS D:\College\Sem 3\Data Structures\Stack> ./a.exe
Enter size: 3

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:1
Enter data: 1

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:1
Enter data: 2

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:1
Enter data: 3

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:1
Enter data: 4
Stack Full

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:2
Element Popped

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:3
```



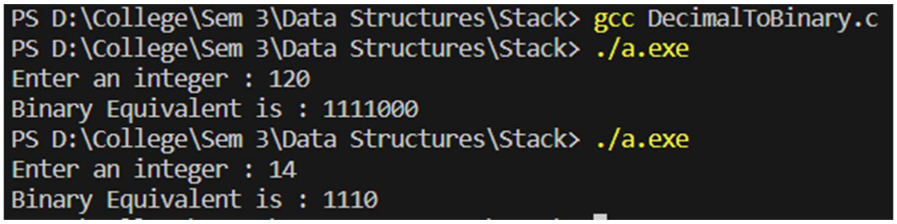
```
Peek is 1

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:2
Element Popped

0: QUIT
1: Push
2: Pop
3: Peek
Enter choice:2
Stack empty
```

**Infix to Postfix Output Screen:**



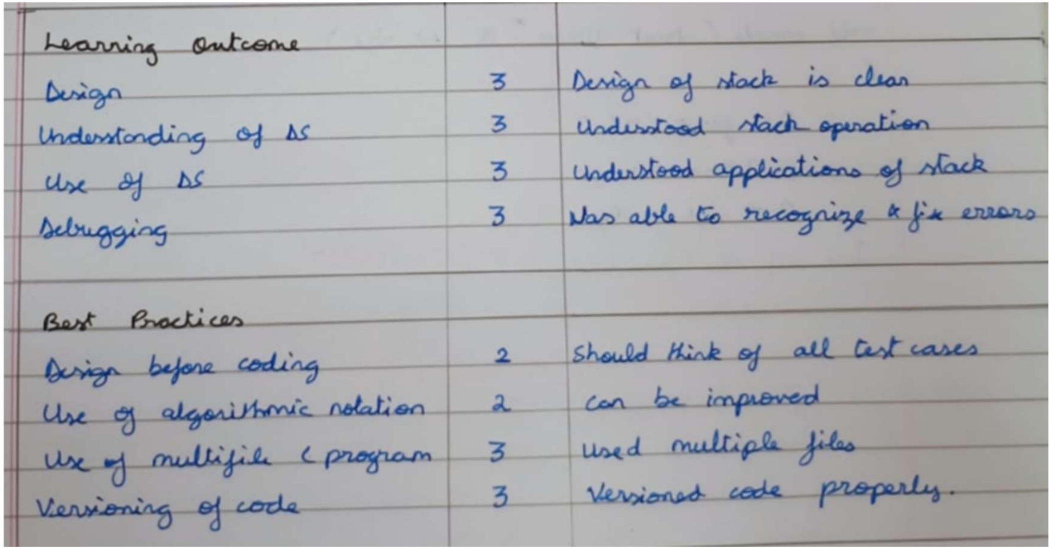
```
PS D:\College\Sem 3\Data Structures\Stack> gcc InfixToPostfix.c
PS D:\College\Sem 3\Data Structures\Stack> ./a.exe
Infix Expression : a+b*c
Postfix Expression : abc*+
PS D:\College\Sem 3\Data Structures\Stack> ./a.exe
Infix Expression : (2+3)*(4+5)
Postfix Expression : 23+45+*
```

**Decimal to Binary Output Screen:**



```
PS D:\College\Sem 3\Data Structures\Stack> gcc DecimalToBinary.c
PS D:\College\Sem 3\Data Structures\Stack> ./a.exe
Enter an integer : 120
Binary Equivalent is : 1111000
PS D:\College\Sem 3\Data Structures\Stack> ./a.exe
Enter an integer : 14
Binary Equivalent is : 1110
```

**Learning Outcome:**



| Learning Outcome | | |
|---|---|---|
| Design | 3 | Design of stack is clear |
| Understanding of DS | 3 | Understood stack operation |
| Use of DS | 3 | Understood applications of stack |
| Debugging | 3 | Was able to recognize & fix errors |
| | | |
| Best Practices | | |
| Design before coding | 2 | Should think of all test cases |
| Use of algorithmic notation | 2 | Can be improved |
| Use of multifile C program | 3 | Used multiple files |
| Versioning of code | 3 | Versioned code properly. |