C-DAC Mumbai

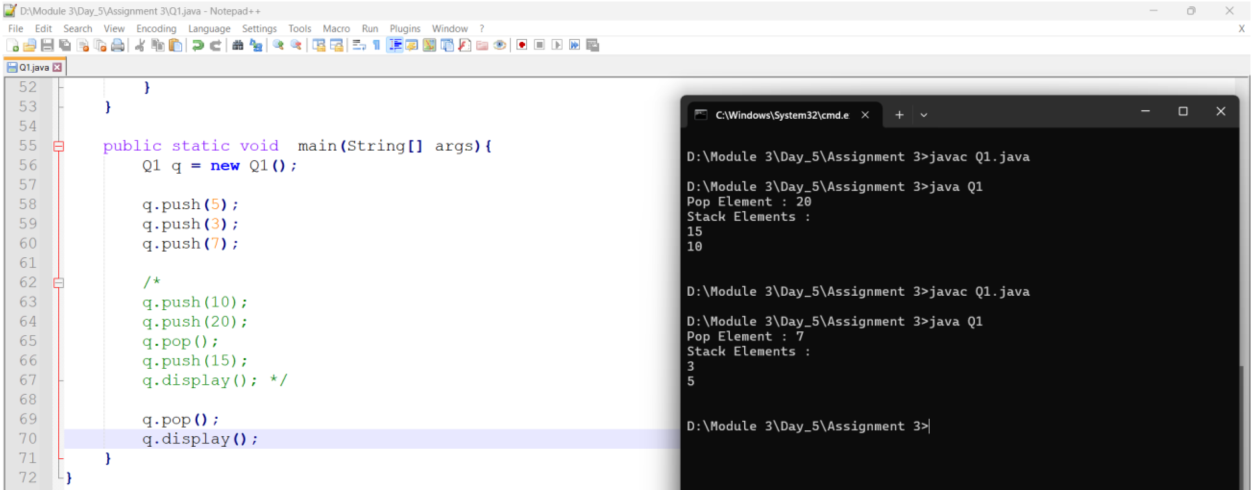
Date 29/09/2024

Subject: Algorithm and Data Structure
Assignment 3

1. Implement a Stack using an array.

- **Test Case 1**:
  Input: Push 5, 3, 7, Pop
  Output: Stack = [5, 3], Popped element = 7
- **Test Case 2**:
  Input: Push 10, Push 20, Pop, Push 15
  Output: Stack = [10, 15], Popped element = 20

```
class Q1{
    int max = 10;
    int top;
    int arr[] = new int[max];

    Q1(){
        top = -1;
    }

    boolean isEmpty(){
        return (top < 0);
    }

    boolean push(int x){
        if(top > (max-1)){
            return false;
        }

        arr[++top] = x;
        return true;
    }

    void pop(){
        if(top < 0){
            System.out.println("Stack is Empty...");
            return;
        }
        else{
            System.out.println("Pop Element : " + arr[top--]);
        }

    }
    void show(int index){
        if(index < 0){
            return;
        }
        else{
            System.out.println(arr[index] + " ");
            show (index - 1);
        }
    }

    void display(){
        if(isEmpty()){
            System.out.println("Stack is Empty...");
        }
        else{
            System.out.println("Stack Elements : ");
            show(top);
            System.out.println();
        }
    }

    public static void  main(String[] args){
        Q1 q = new Q1();

        q.push(5);
        q.push(3);
        q.push(7);

        /*
        q.push(10);
        q.push(20);
        q.pop();
        q.push(15);
        q.display(); */

        q.pop();
        q.display();
    }
}
```


D:\Module 3\Day_5\Assignment 3\Q1.java - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
Q1.java
C:\Windows\System32\cmd.e

```
        }
    }

    public static void  main(String[] args){
        Q1 q = new Q1();

        q.push(5);
        q.push(3);
        q.push(7);

        /*
        q.push(10);
        q.push(20);
        q.pop();
        q.push(15);
        q.display(); */

        q.pop();
        q.display();
    }
}
```

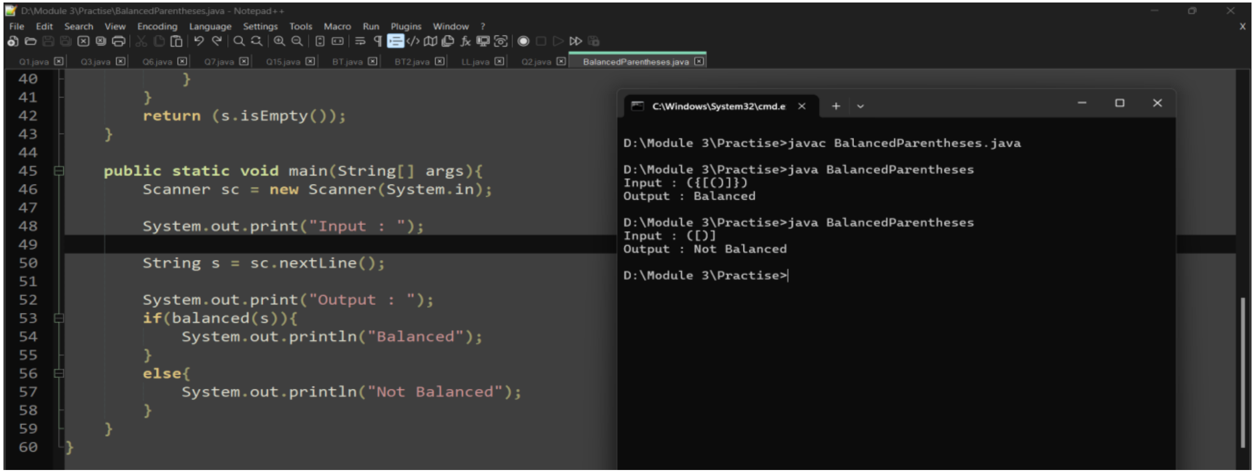
```
D:\Module 3\Day_5\Assignment 3>javac Q1.java

D:\Module 3\Day_5\Assignment 3>java Q1
Pop Element : 20
Stack Elements :
15
10


D:\Module 3\Day_5\Assignment 3>javac Q1.java

D:\Module 3\Day_5\Assignment 3>java Q1
Pop Element : 7
Stack Elements :
3
5


D:\Module 3\Day_5\Assignment 3>
```

2. Check for balanced parentheses using a stack.

- **Test Case 1**:
  Input: "({[()]})"
  Output: Balanced
- **Test Case 2**:
  Input: "([)]"
  Output: Not Balanced

```
 import java.util.*;

class BalancedParentheses{

         @SuppressWarnings({ "rawtypes", "unchecked" })
        public static boolean balanced(String input){
                Stack s = new Stack();

                char[] c = input.toCharArray();

                for(int i=0; i<c.length; i++)
                {
                        char current = c[i];

                         if (current == '(' || current == '[' || current == '{'){
                                s.push(current);
                                continue;
                        }
                        if(s.isEmpty()){
                                return false;
                        }

                        char popchar;
                        switch(current){
                                case ')':
```

```
                    popchar = (char)s.pop();
                    if(popchar != '(')
                                return false;
                    break;
                case ']':
                    popchar = (char)s.pop();
                    if(popchar != '[')
                        return false;
                    break;
                case '}':
                    popchar = (char)s.pop();
                    if(popchar != '{')
                        return false;
                    break;
            }
        }
        return (s.isEmpty());
    }

    public static void main(String[] args){
        Scanner sc = new Scanner(System.in);

        System.out.print("Input : ");

        String s = sc.nextLine();

        System.out.print("Output : ");
        if(balanced(s)){
            System.out.println("Balanced");
        }
        else{
            System.out.println("Not Balanced");
        }
    }
}
```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File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
Q1.java
Q3.java
Q6.java
Q7.java
Q15.java
BT.java
BT2.java
LL.java
Q2.java
BalancedParentheses.java
C:\Windows\System32\cmd.e

```
            }
        }
        return (s.isEmpty());
    }

    public static void main(String[] args){
        Scanner sc = new Scanner(System.in);

        System.out.print("Input : ");

        String s = sc.nextLine();

        System.out.print("Output : ");
        if(balanced(s)){
            System.out.println("Balanced");
        }
        else{
            System.out.println("Not Balanced");
        }
    }
}
```

```
D:\Module 3\Practise>javac BalancedParentheses.java

D:\Module 3\Practise>java BalancedParentheses
Input : ({[()]})
Output : Balanced

D:\Module 3\Practise>java BalancedParentheses
Input : ([)]
Output : Not Balanced

D:\Module 3\Practise>
```

3. Reverse a string using a stack.

- **Test Case 1**:
  Input: "hello"
  Output: "olleh"
- **Test Case 2**:
  Input: "world"
  Output: "dlrow"

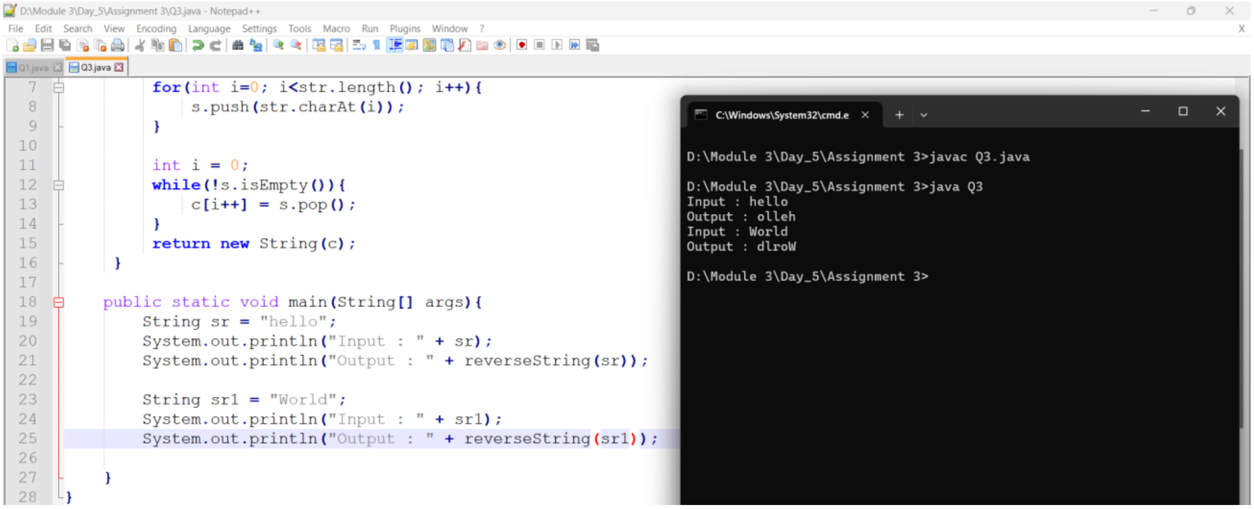
```
import java.io.*;
import java.util.*;
class Q3{
     public static String reverseString(String str){
          char[] c = new char[str.length()];
          Stack<Character> s = new Stack<Character>();
          for(int i=0; i<str.length(); i++){
               s.push(str.charAt(i));
          }

          int i = 0;
          while(!s.isEmpty()){
               c[i++] = s.pop();
          }
          return new String(c);
     }

     public static void main(String[] args){
          String sr = "hello";
          System.out.println("Input : " + sr);
          System.out.println("Output : " + reverseString(sr));

          String sr1 = "World";
          System.out.println("Input : " + sr1);
          System.out.println("Output : " + reverseString(sr1));

     }
}
```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Q1.java
Q3.java
C:\Windows\System32\cmd.e

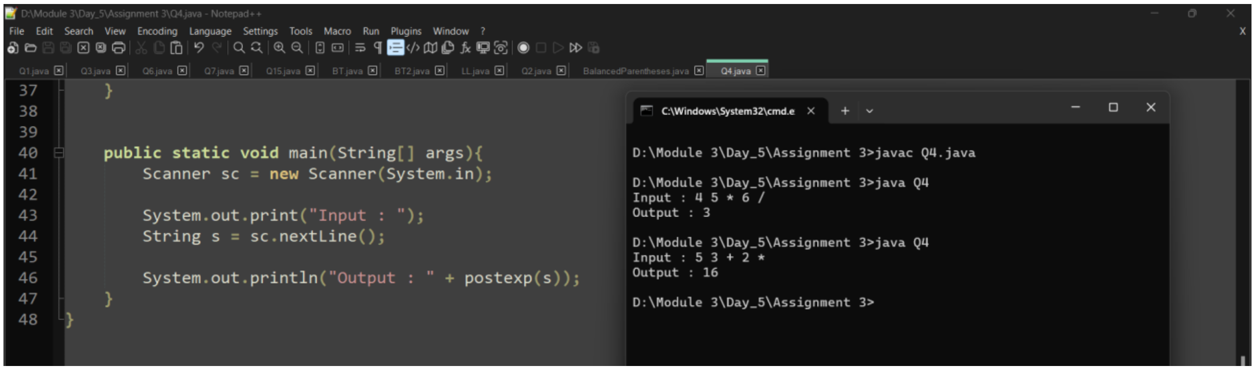
```java
        for(int i=0; i<str.length(); i++){
            s.push(str.charAt(i));
        }

        int i = 0;
        while(!s.isEmpty()){
            c[i++] = s.pop();
        }
        return new String(c);
    }

    public static void main(String[] args){
        String sr = "hello";
        System.out.println("Input : " + sr);
        System.out.println("Output : " + reverseString(sr));

        String sr1 = "World";
        System.out.println("Input : " + sr1);
        System.out.println("Output : " + reverseString(sr1));

    }
}
```

```
D:\Module 3\Day_5\Assignment 3>javac Q3.java

D:\Module 3\Day_5\Assignment 3>java Q3
Input : hello
Output : olleh
Input : World
Output : dlroW

D:\Module 3\Day_5\Assignment 3>
```

4. Evaluate a postfix expression using a stack.

- **Test Case 1**:
  Input: "5 3 + 2 *"
  Output: 16
- **Test Case 2**:
  Input: "4 5 * 6 /"
  Output: 3

```java
import java.util.*;

class Q4{
        @SuppressWarnings({"rawtypes", "unckecked"})
        public static int postexp(String str){
                Stack<Integer> st = new Stack<>();

                for(String s : str.split(" ")){
                        if(isNumeric(s)){
                                st.push(Integer.parseInt(s));
                        }
                        else{
                                int op1 = st.pop();
                                int op2 = st.pop();

                                switch(s){
                                        case "+":
                                                st.push(op2 + op1);
                                                break;
                                        case "-":
                                                st.push(op2 - op1);
                                                break;
                                        case "*":
                                                st.push(op2 * op1);
                        break;
                case "/":
                        st.push(op2 / op1);
                        break;
            }
        }
    }
    return st.pop();
}

private static boolean isNumeric(String str){
    return str.matches("-?\\d+(\\.\\d+)?");
}


public static void main(String[] args){
    Scanner sc = new Scanner(System.in);

    System.out.print("Input : ");
    String s = sc.nextLine();

    System.out.println("Output : " + postexp(s));
}
}
```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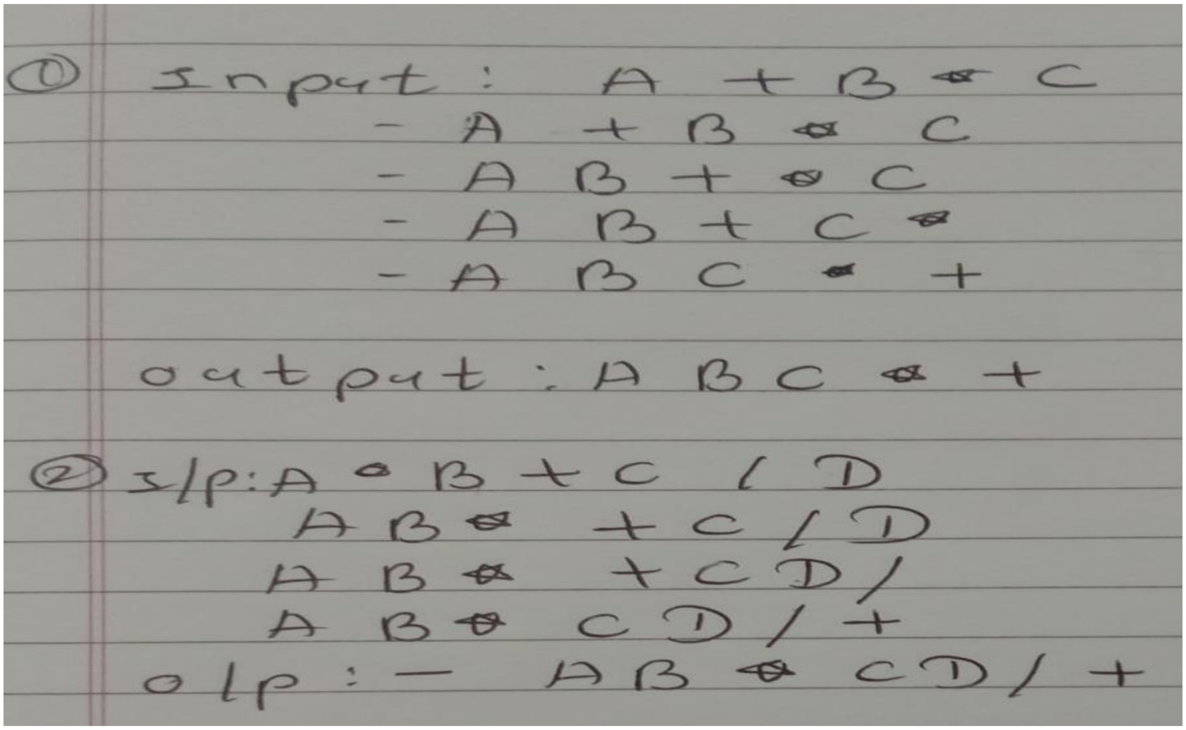
Q1.java
Q3.java
Q6.java
Q7.java
Q15.java
BT.java
BT2.java
LL.java
Q2.java
BalancedParentheses.java
Q4.java
C:\Windows\System32\cmd.e

```
    }


    public static void main(String[] args){
        Scanner sc = new Scanner(System.in);

        System.out.print("Input : ");
        String s = sc.nextLine();

        System.out.println("Output : " + postexp(s));
    }
}
```

```
D:\Module 3\Day_5\Assignment 3>javac Q4.java

D:\Module 3\Day_5\Assignment 3>java Q4
Input : 4 5 * 6 /
Output : 3

D:\Module 3\Day_5\Assignment 3>java Q4
Input : 5 3 + 2 *
Output : 16

D:\Module 3\Day_5\Assignment 3>
```

5. Convert an infix expression to postfix using a stack.

- **Test Case 1**:
  Input: "A + B * C"
  Output: "A B C * +"
- **Test Case 2**:
  Input: "A * B + C / D"
  Output: "A B * C D / +"



① Input : A + B * C
- A + B * C
- A B + * C
- A B + C *
- A B C * +

output : A B C * +

② I/p: A * B + C / D
A B * + C / D
A B * + C D /
A B * C D / +
o/p :- A B * C D / +

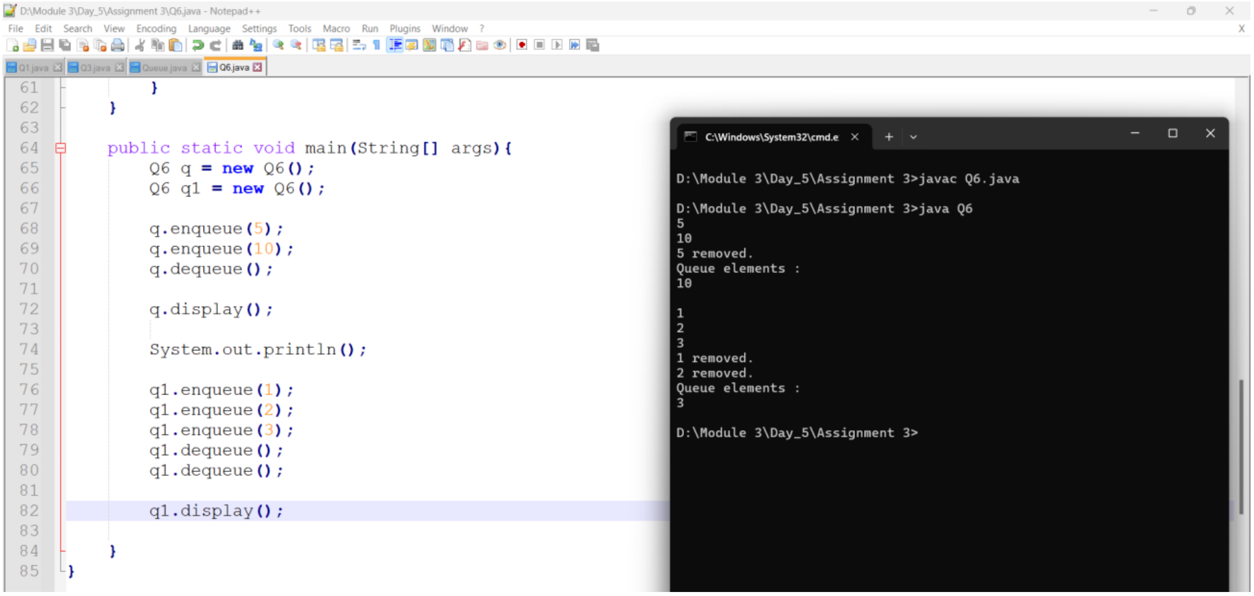
6. Implement a Queue using an array.

- **Test Case 1**:
  Input: Enqueue 5, Enqueue 10, Dequeue
  Output: Queue = [10], Dequeued element = 5
- **Test Case 2**:
  Input: Enqueue 1, 2, 3, Dequeue, Dequeue
  Output: Queue = [3], Dequeued elements = 1, 2

```
class Q6{
        int size = 5;
        int Q[] = new int[size];
        int front, rear;

        public Q6(){
                front = -1;
                rear = -1;
        }

        boolean isEmpty(){
                return (front == -1 || front > rear);
        }

        boolean isFull(){
                return (rear == size-1);
        }

        void enqueue(int x){
```

```
        if(isFull()){
                System.out.println("Queue is Full.");
        }
        else {
                if(front == -1){
                        front = 0;
                }
                rear++;
                Q[rear] = x;
                System.out.println(x);
        }
}

void dequeue(){
        if(isEmpty()){
                System.out.println("Queue is Empty..");
        }
        else{
                System.out.println(Q[front] + " removed.");
                front++;
                if(front > rear){
                        front = -1;
                        rear = -1;
                }
        }

}

void display(){
        if(isEmpty()){
                System.out.println("Queue is Empty");
        }
        else{
                System.out.println("Queue elements : ");
                for(int i=front; i<=rear; i++){
                        System.out.print(Q[i] + " ");
                        if (i < rear) {
   System.out.print(", ");
 }
                }
                System.out.println();
        }
}

public static void main(String[] args){
        Q6 q = new Q6();
        Q6 q1 = new Q6();
```

```
                q.enqueue(5);
                q.enqueue(10);
                q.dequeue();

                q.display();

                System.out.println();

                q1.enqueue(1);
                q1.enqueue(2);
                q1.enqueue(3);
                q1.dequeue();
                q1.dequeue();

                q1.display();

        }
}
```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Q1.java
Q3.java
Queue.java
Q6.java
C:\Windows\System32\cmd.e

```
        }
    }

    public static void main(String[] args){
        Q6 q = new Q6();
        Q6 q1 = new Q6();

        q.enqueue(5);
        q.enqueue(10);
        q.dequeue();

        q.display();

        System.out.println();

        q1.enqueue(1);
        q1.enqueue(2);
        q1.enqueue(3);
        q1.dequeue();
        q1.dequeue();

        q1.display();

    }
}
```

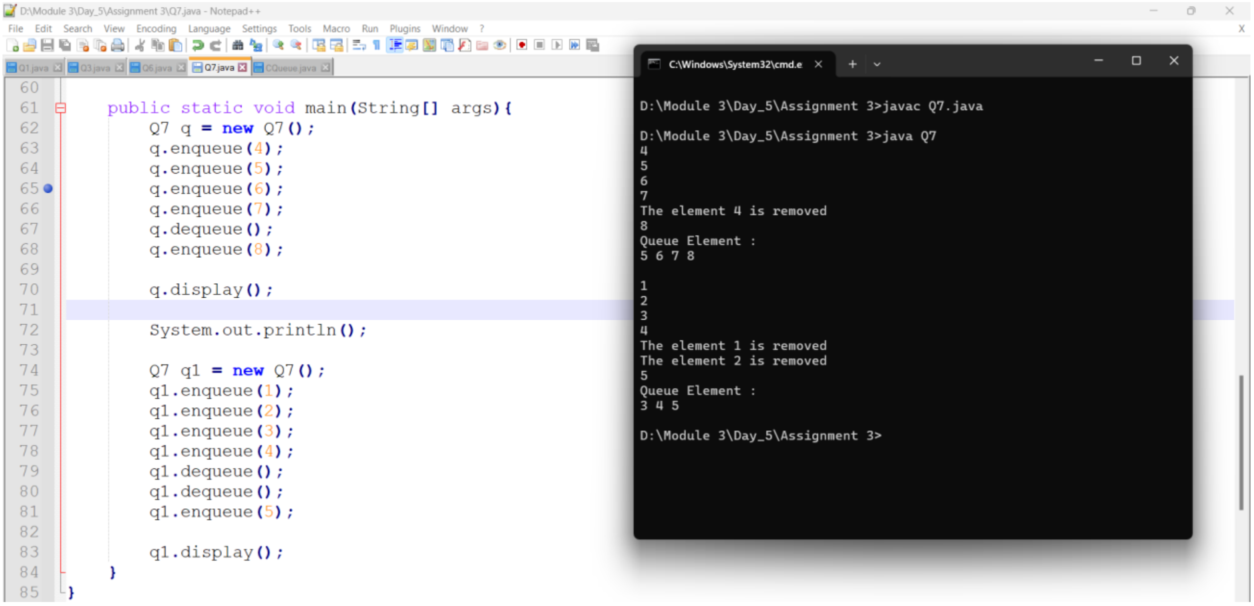
```
D:\Module 3\Day_5\Assignment 3>javac Q6.java

D:\Module 3\Day_5\Assignment 3>java Q6
5
10
5 removed.
Queue elements :
10

1
2
3
1 removed.
2 removed.
Queue elements :
3

D:\Module 3\Day_5\Assignment 3>
```

7. Implement a Circular Queue using an array.

- **Test Case 1**:
  Input: Enqueue 4, 5, 6, 7, Dequeue, Enqueue 8
  Output: Queue = [8, 5, 6, 7]
- **Test Case 2**:
  Input: Enqueue 1, 2, 3, 4, Dequeue, Dequeue, Enqueue 5
  Output: Queue = [5, 3, 4]

```
class Q7{
        int size = 5;
        int[] Q = new int[size];
```

```
int front, rear;

Q7(){
        front = -1;
        rear = -1;
}

boolean isEmpty(){
        return (front == -1);
}

boolean isFull(){
        return ((rear + 1) % size == front);
}

void enqueue(int x){
        if(isFull()){
                System.out.println("Queue is full.");
        }
        else {
                if(front == -1){
                        front = 0;
                }
                Q[++rear] = x;
                System.out.println(x);
        }

}

void dequeue(){
        if(isEmpty()){
                System.out.println("Queue is empty.");
        }
        else{
                System.out.println("The element " + Q[front] + " is removed");
                front++;
                if(front > rear){
                        front = -1;
                        rear = -1;
                }
        }

}

void display(){
        if(isEmpty()){
                System.out.println("Queue is empty...");
        }
        else{
            System.out.println("Queue Element : ");
            for(int i=front; i<=rear; i++){
                System.out.print(Q[i] + " ");
            }
            System.out.println();
        }
    }

    public static void main(String[] args){
        Q7 q = new Q7();
        q.enqueue(4);
        q.enqueue(5);
        q.enqueue(6);
        q.enqueue(7);
        q.dequeue();
        q.enqueue(8);

        q.display();

        System.out.println();

        Q7 q1 = new Q7();
        q1.enqueue(1);
        q1.enqueue(2);
        q1.enqueue(3);
        q1.enqueue(4);
        q1.dequeue();
        q1.dequeue();
        q1.enqueue(5);

        q1.display();
    }
}
```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Q1.java
Q3.java
Q6.java
Q7.java
CQueue.java
C:\Windows\System32\cmd.e

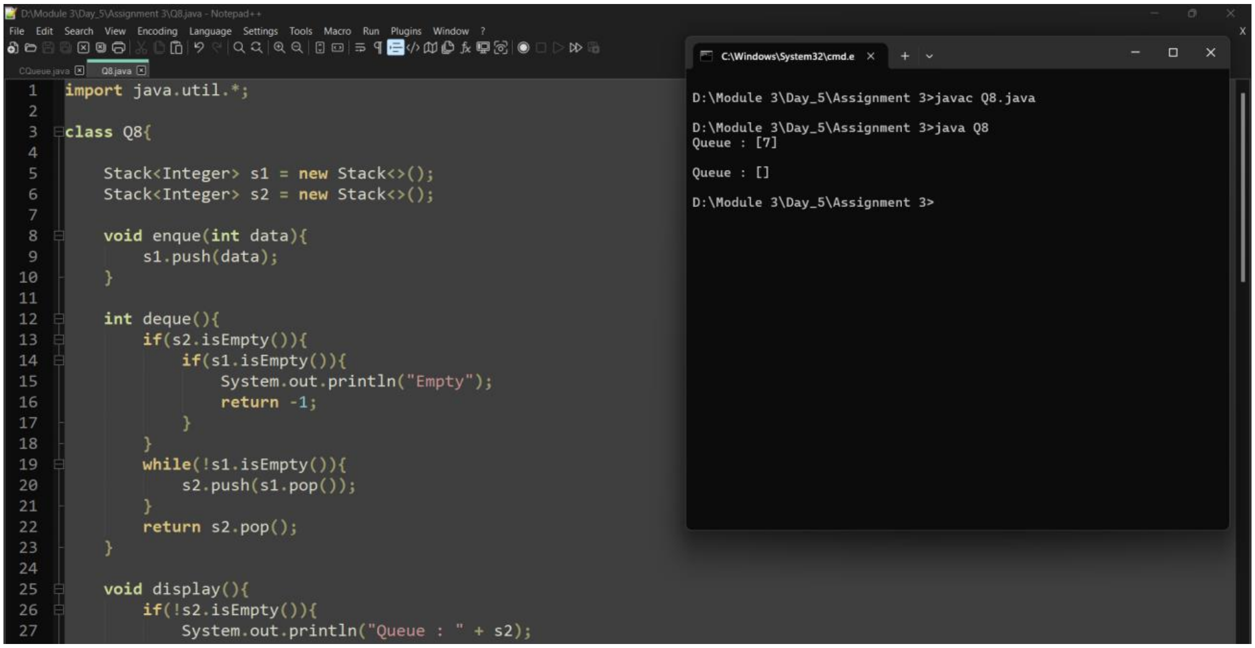
```java

    public static void main(String[] args){
        Q7 q = new Q7();
        q.enqueue(4);
        q.enqueue(5);
        q.enqueue(6);
        q.enqueue(7);
        q.dequeue();
        q.enqueue(8);

        q.display();

        System.out.println();

        Q7 q1 = new Q7();
        q1.enqueue(1);
        q1.enqueue(2);
        q1.enqueue(3);
        q1.enqueue(4);
        q1.dequeue();
        q1.dequeue();
        q1.enqueue(5);

        q1.display();
    }
}
```

```
D:\Module 3\Day_5\Assignment 3>javac Q7.java

D:\Module 3\Day_5\Assignment 3>java Q7
4
5
6
7
The element 4 is removed
8
Queue Element :
5 6 7 8

1
2
3
4
The element 1 is removed
The element 2 is removed
5
Queue Element :
3 4 5

D:\Module 3\Day_5\Assignment 3>
```

8. Implement a Queue using two Stacks.

- **Test Case 1**:
  Input: Enqueue 3, Enqueue 7, Dequeue
  Output: Queue = [7], Dequeued element = 3
- **Test Case 2**:
  Input: Enqueue 10, 20, Dequeue, Dequeue
  Output: Queue = [], Dequeued elements = 10, 20

```java
import java.util.*;

class Q8{

        Stack<Integer> s1 = new Stack<>();
        Stack<Integer> s2 = new Stack<>();

        void enque(int data){
                s1.push(data);
        }

        int deque(){
                if(s2.isEmpty()){
                        if(s1.isEmpty()){
                                System.out.println("Empty");
                                return -1;
                        }
                }
                while(!s1.isEmpty()){
                        s2.push(s1.pop());
        }
        return s2.pop();
    }

    void display(){
        if(!s2.isEmpty()){
            System.out.println("Queue : " + s2);
        }
        else{
            System.out.println("Queue : " + s1);
        }
    }

    public static void main(String[] args){
        Q8 q = new Q8();

        q.enque(3);
        q.enque(7);
        q.deque();
        q.display();

        System.out.println();

        Q8 q1 = new Q8();
        q1.enque(10);
        q1.enque(20);
        q1.deque();
        q1.deque();
        q1.display();
    }
}
```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CQueue.java
Q8.java
C:\Windows\System32\cmd.e

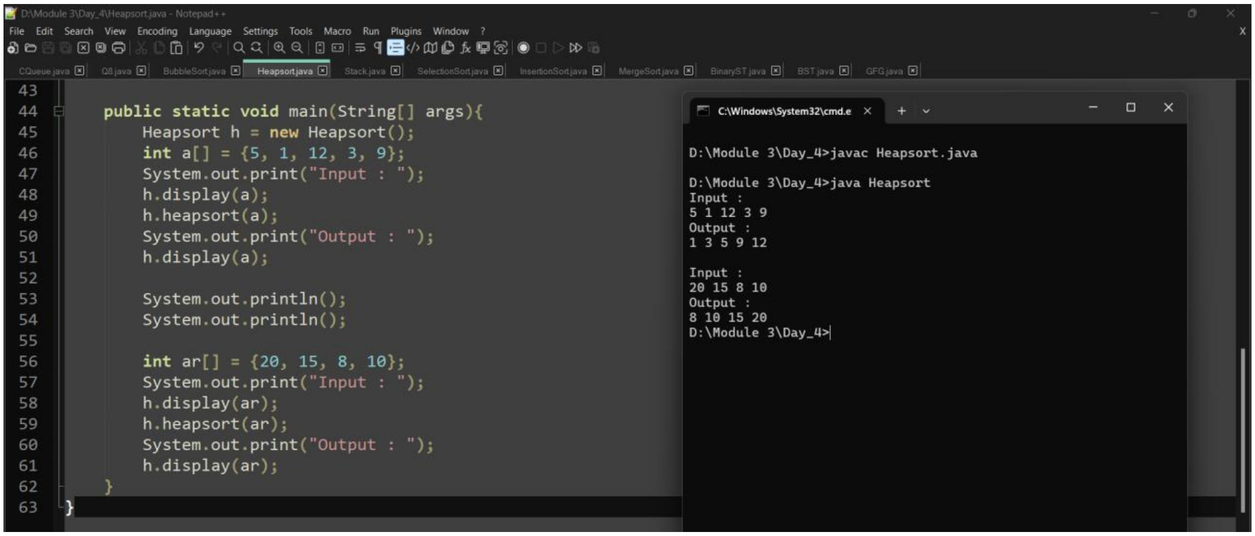
```java
import java.util.*;

class Q8{

    Stack<Integer> s1 = new Stack<>();
    Stack<Integer> s2 = new Stack<>();

    void enque(int data){
        s1.push(data);
    }

    int deque(){
        if(s2.isEmpty()){
            if(s1.isEmpty()){
                System.out.println("Empty");
                return -1;
            }
        }
        while(!s1.isEmpty()){
            s2.push(s1.pop());
        }
        return s2.pop();
    }

    void display(){
        if(!s2.isEmpty()){
            System.out.println("Queue : " + s2);
```

```
D:\Module 3\Day_5\Assignment 3>javac Q8.java

D:\Module 3\Day_5\Assignment 3>java Q8
Queue : [7]

Queue : []

D:\Module 3\Day_5\Assignment 3>
```

11. Sort an array using a heap (Heap Sort).

- **Test Case 1**:
  Input: [5, 1, 12, 3, 9]
  Output: [1, 3, 5, 9, 12]
- **Test Case 2**:
  Input: [20, 15, 8, 10]
  Output: [8, 10, 15, 20]

```
class Heapsort{
        void heapify(int arr[], int n, int i){
                int largest = i; // Root
                int l = 2*i + 1; // LC
                int r = 2*i + 2; // RC

                if(l<n && arr[l] > arr[largest])
                        largest = l;
                if(r<n && arr[r] > arr[largest])
                        largest = r;

                if(largest != i){
                        int temp = arr[i];
                        arr[i] = arr[largest];
                        arr[largest] = temp;
                        heapify(arr, n, largest);
                }
        }

        void heapsort(int arr[]){
                System.out.println();
        int n = arr.length;
        for(int i=n/2-1; i>=0; i--){
            heapify(arr, n, i);
        }
        for(int i=n-1; i>0;i--){
            int temp = arr[0];
            arr[0] = arr[i];
            arr[i] = temp;
            heapify(arr, i, 0);
        }

    }

    void display(int[] arr){
        System.out.println();
        int n = arr.length;
        for(int i=0;i<n;i++){
            System.out.print(arr[i] + " ");
        }
    }

    public static void main(String[] args){
        Heapsort h = new Heapsort();
        int a[] = {5, 1, 12, 3, 9};
        System.out.print("Input : ");
        h.display(a);
        h.heapsort(a);
        System.out.print("Output : ");
        h.display(a);

        System.out.println();
        System.out.println();

        int ar[] = {20, 15, 8, 10};
        System.out.print("Input : ");
        h.display(ar);
        h.heapsort(ar);
        System.out.print("Output : ");
        h.display(ar);
    }
}
```


D:\Module 3\Day_4\Heapsort.java - Notepad++
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CQueue.java
Q8.java
BubbleSort.java
Heapsort.java
Stack.java
SelectionSort.java
InsertionSort.java
MergeSort.java
BinaryST.java
BST.java
GFG.java
C:\Windows\System32\cmd.e

```java

    public static void main(String[] args){
        Heapsort h = new Heapsort();
        int a[] = {5, 1, 12, 3, 9};
        System.out.print("Input : ");
        h.display(a);
        h.heapsort(a);
        System.out.print("Output : ");
        h.display(a);

        System.out.println();
        System.out.println();

        int ar[] = {20, 15, 8, 10};
        System.out.print("Input : ");
        h.display(ar);
        h.heapsort(ar);
        System.out.print("Output : ");
        h.display(ar);
    }
}
```

```
D:\Module 3\Day_4>javac Heapsort.java

D:\Module 3\Day_4>java Heapsort
Input :
5 1 12 3 9
Output :
1 3 5 9 12

Input :
20 15 8 10
Output :
8 10 15 20
D:\Module 3\Day_4>
```

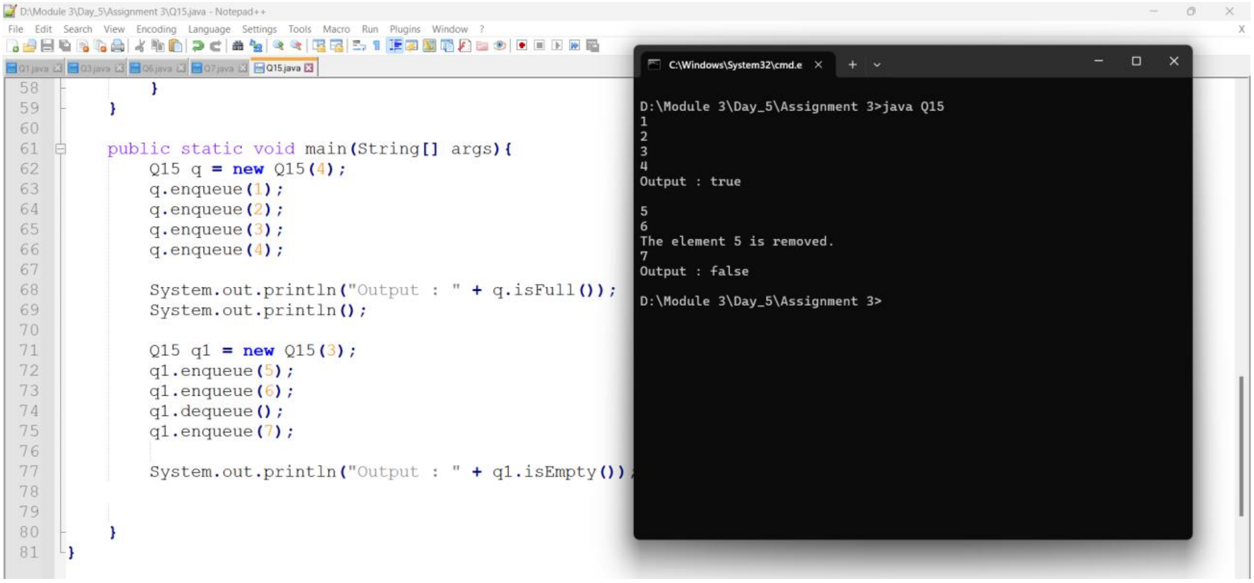
15. Design a Circular Queue with a fixed size, supporting enqueue, dequeue, and isFull/isEmpty operations.

- **Test Case 1**:
  Input: Size = 4, Enqueue 1, 2, 3, 4, isFull()
  Output: True
- **Test Case 2**:
  Input: Size = 3, Enqueue 5, 6, Dequeue, Enqueue 7, isEmpty()
  Output: False

```
class Q15{
	int[] Q;
	int front, rear, size, capacity;

	public Q15(int capacity){
		this.capacity = capacity;
		Q = new int[capacity];
		front = -1;
		rear = -1;
		size = 0;
	}

	boolean isEmpty(){
		return size==0;
	}

	boolean isFull(){
		return size==capacity;
	}

	void enqueue(int x){
		if(isFull()){
			System.out.println("Queue is full");
```

```
        }
        else{
            if(front == -1){
                front = 0;
            }
            rear = (rear+1) % capacity;
            Q[rear] = x;
            size++;
            System.out.println(x);
        }
    }

    void dequeue(){
        if(isEmpty()){
            System.out.println("Queue is Empty");
            return;
        }
        else{
            System.out.println("The element " + Q[front] + " is removed.");
            front = (front+1) % capacity;
            size--;
        }
    }

    void display(){
        if(isEmpty()){
            System.out.println("Queue is Empty");
        }
        else {
            System.out.println("Queue Elements :");
            for(int i=front; i<=rear; i++){
                System.out.print(Q[i] + " --> ");
            }
            System.out.println();
        }
    }

    public static void main(String[] args){
        Q15 q = new Q15(4);
        q.enqueue(1);
        q.enqueue(2);
        q.enqueue(3);
        q.enqueue(4);

        System.out.println("Output : " + q.isFull());
        System.out.println();

        Q15 q1 = new Q15(3);
```

```
                q1.enqueue(5);
                q1.enqueue(6);
                q1.dequeue();
                q1.enqueue(7);

                System.out.println("Output : " + q1.isEmpty());


        }
}
```


D:\Module 3\Day_5\Assignment 3\Q15.java - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
Q1.java
Q3.java
Q6.java
Q7.java
Q15.java
C:\Windows\System32\cmd.e

```
            }
        }

    public static void main(String[] args){
        Q15 q = new Q15(4);
        q.enqueue(1);
        q.enqueue(2);
        q.enqueue(3);
        q.enqueue(4);

        System.out.println("Output : " + q.isFull());
        System.out.println();

        Q15 q1 = new Q15(3);
        q1.enqueue(5);
        q1.enqueue(6);
        q1.dequeue();
        q1.enqueue(7);

        System.out.println("Output : " + q1.isEmpty());


    }
}
```

```
D:\Module 3\Day_5\Assignment 3>java Q15
1
2
3
4
Output : true

5
6
The element 5 is removed.
7
Output : false

D:\Module 3\Day_5\Assignment 3>
```