SLIIT

Discover Your Future

IT2070 – Data Structures and Algorithms

Lecture 02

Introduction to Queue

stack
top
maxSize
StackArray

pop()
push()
peek()
isEmpty()
isFull()

Queue
front //to store elements and remove[indexes]
rear
maxSize
Queue Array
nItems.//for when full or empty should be checked

insert()
remove()
peekfront()
isEmpty()
isFull()

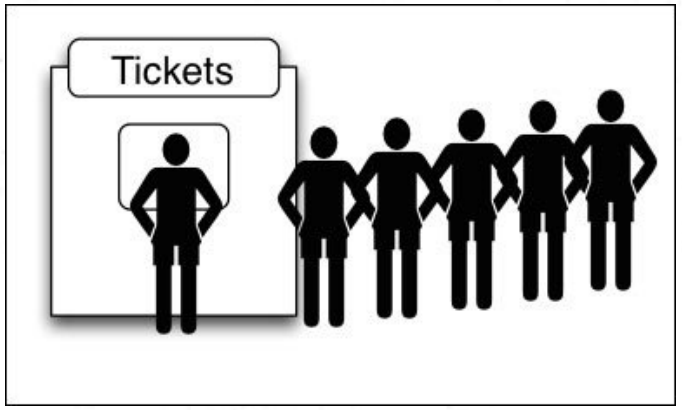
front

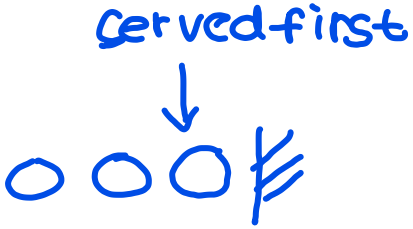
rear

we can only remove from top in the stack

two access points

Queues





- Imagine a queue in real life
- The first item inserted is the first item to be removed

unlike stack

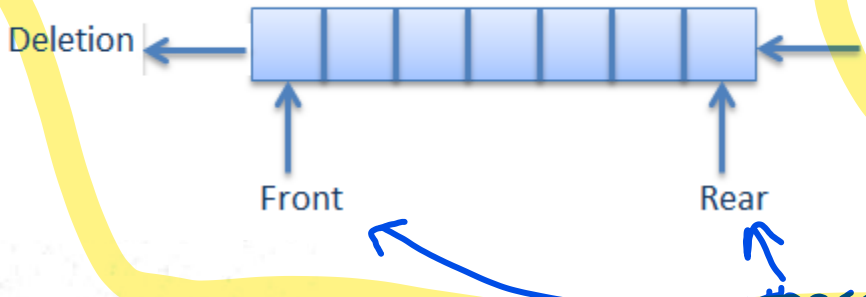
First in First out[FIFO]

in stack the last person inserted is the last out person(Last in First Out [LIFO])

Queues

remove()
in some books dequeue()

insert()
enqueue()



these are the two pointers of a queue

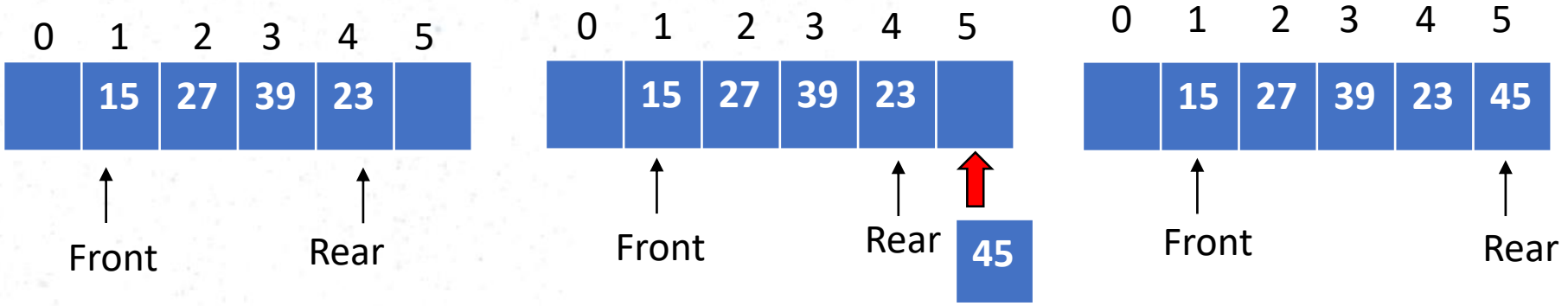
- In a queue all insertions are made at the Rear end and deletions are made at the Front end.
- Insertions and deletions are restricted from the Middle of the Queue.

- Adding an item is called insert
- Removing an item is called remove

removed first

- The elements are inserted and removed according to the First-In-First-Out (FIFO) principle.

Queue - Insert

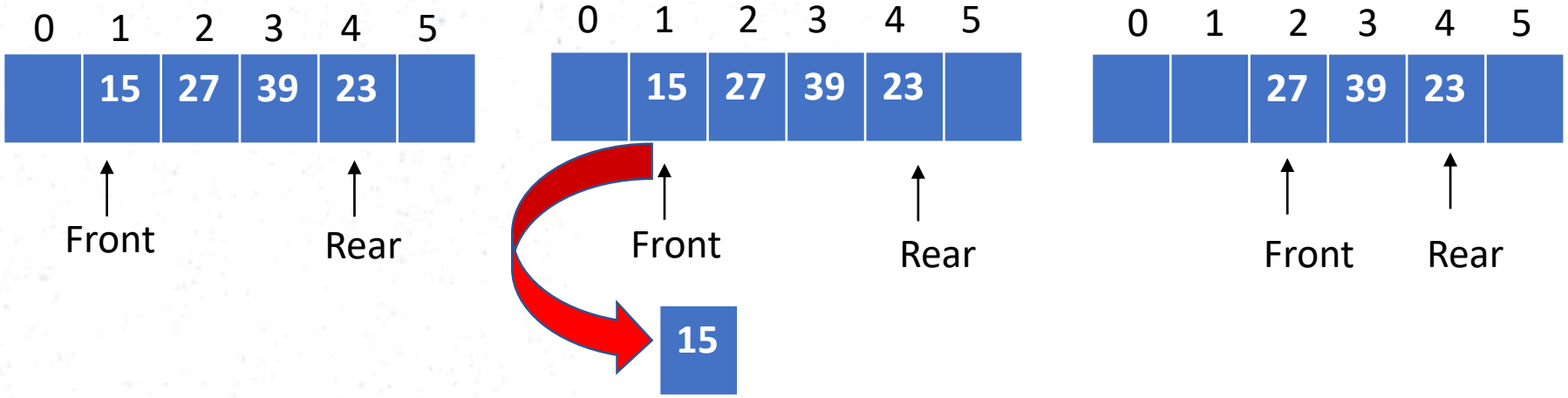


Before inserting

Item 45 is inserted to the rear

After inserting

Queue - Remove

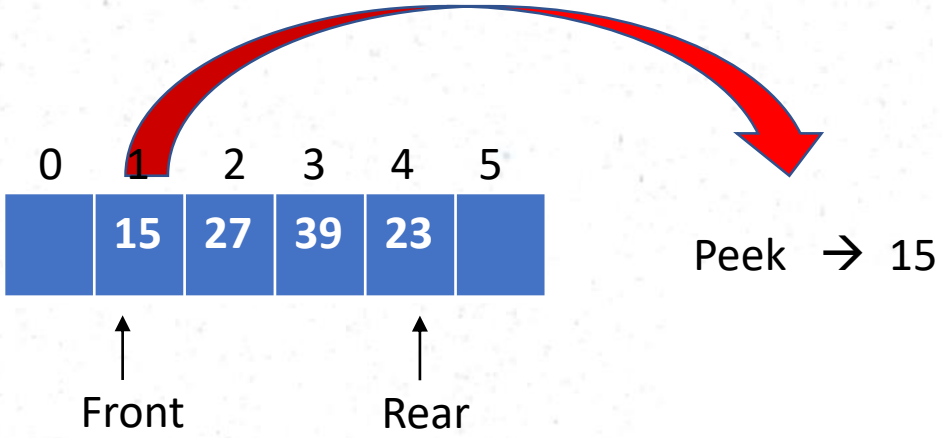


Before removing

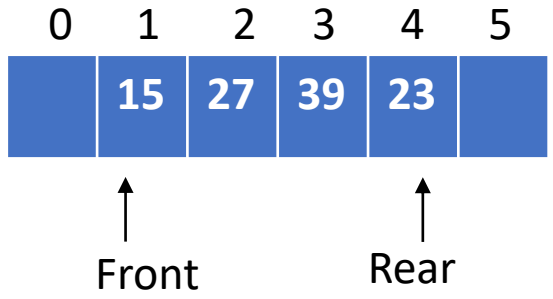
Front item is removed

After removing

Queue - PeekFront



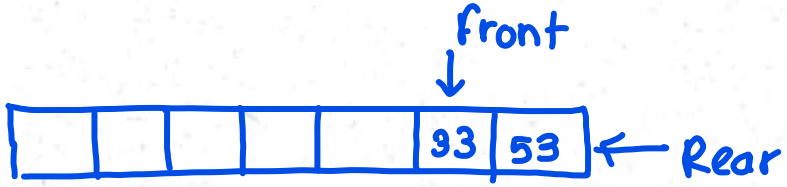
Peek → 15



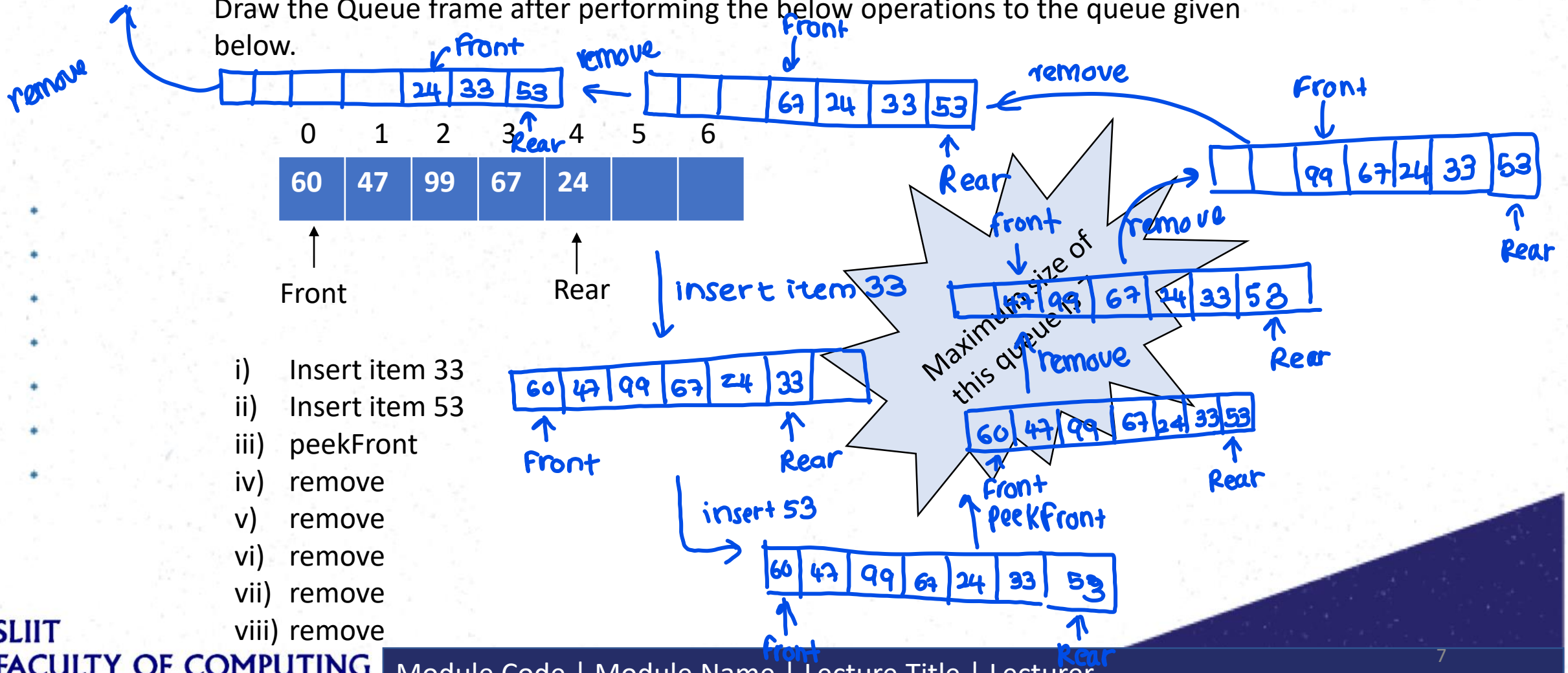
Queue remains the same

Peek is used to read the value from the Front of the queue without removing it. You can peek only the Front item, all the other items are invisible to the queue user.

Question 01



Draw the Queue frame after performing the below operations to the queue given below.

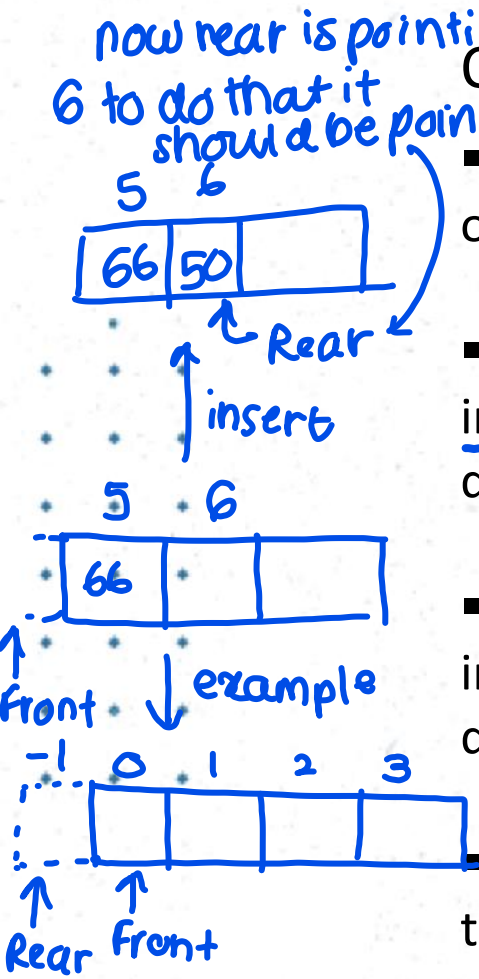


i) Insert item 33
ii) Insert item 53
iii) peekFront
iv) remove
v) remove
vi) remove
vii) remove
viii) remove

Uses of Queue

- There are various queues quietly doing their job in a computer's operating system.
  - printer queue
  - stores keystroke data as you type at the keyboard
  - pipeline

Queue - Implementation



Queue implementation using an **array** with restricted access

- Constructor creates a new Queue of a size specified in its argument.
- Variable ***front***, which stores the index of the item on the front of the queue.
- Variable ***rear***, which stores the index of the item on the end of the queue.
- Variable *nItems*, which stores the total number of the items in the queue.

```
class QueueX {
    private int maxSize;    // size of queue array
    private int [] queArray;
    private int front;          //front of the queue
    private int rear;           //rear of the queue
    private int nItems;  //no of items of the queue

    publc QueueX (int s) {// constructor

            maxSize = s;      // set array size
            queArray = new int [maxSize];
            front = 0;
            rear = -1;
            nItems = 0;          // no items
    }
    ..........................
    ..........................
}
```

//set size

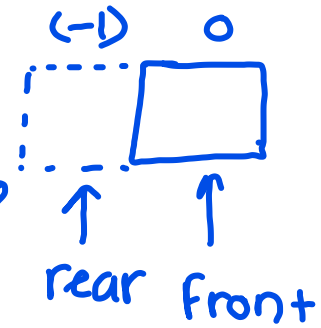
rear is pointing to the last item ∴whenever we want to add a new item we have to increase the rear pointer by 1 or else the current item will be overwritten

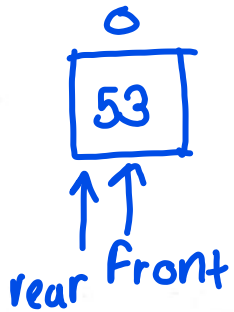
Queue – Implementation - insert

```
class QueueX {
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;          //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s)  {  // constructor

                maxSize = s;      // set array size
                queArray = new int [maxSize];
                front = 0;
                rear = -1;
                nItems = 0;           // no items
        }
      public void insert(int j)  {
                // increment rear
                // insert an item
      }
}
```





Queue – Implementation - insert

```
class QueueX {
        private int maxSize;    // size of queue array
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        private int nItems;  //no of items of the queue

        publc QueueX(int s) { // constructor

                maxSize = s;      // set array size
                queArray = new int [maxSize];
                front = 0;
                rear = -1;
                nItems = 0;          // no items
        }
    public void insert(int j) {
                // increment rear and insert an item
                queArray[++rear] = j;
                nItems++;
    }
}
```
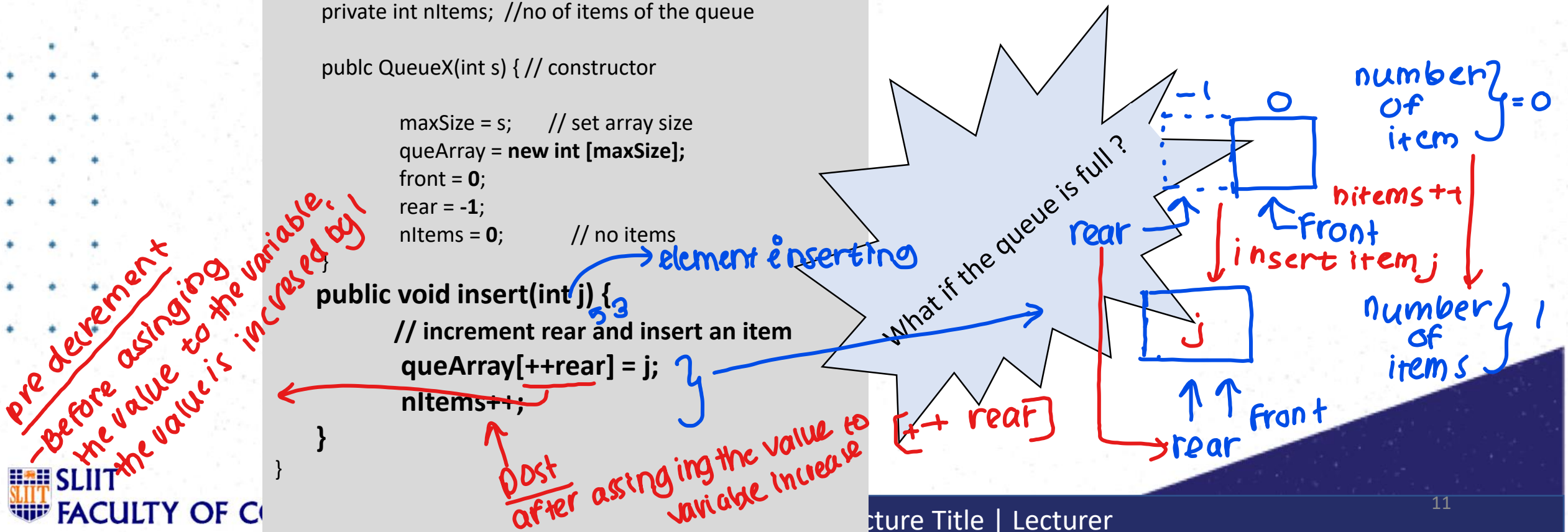
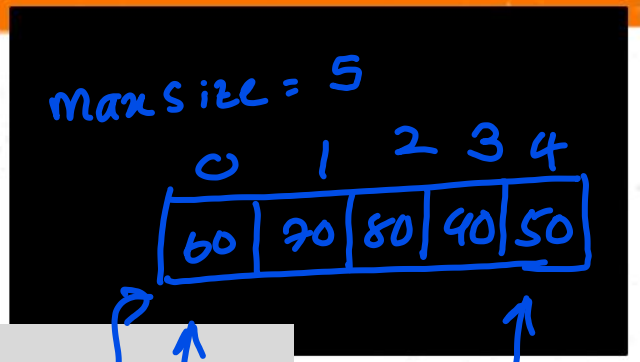



Queue – Implementation - insert




```
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                        maxSize = s;      // set array size
                        queArray = new int [maxSize];
                        front = 0;
                        rear = -1;
                        nItems = 0;           // no items
        }
```

```
public void insert(int j) {
                // check whether queue is full
                 if (rear == maxSize – 1)
                        System.out.println("Queue is full");
                else {
                        queArray[++rear] = j;
                        nItems++;

                }
        }
}
```

Queue – Implementation – remove/peekF

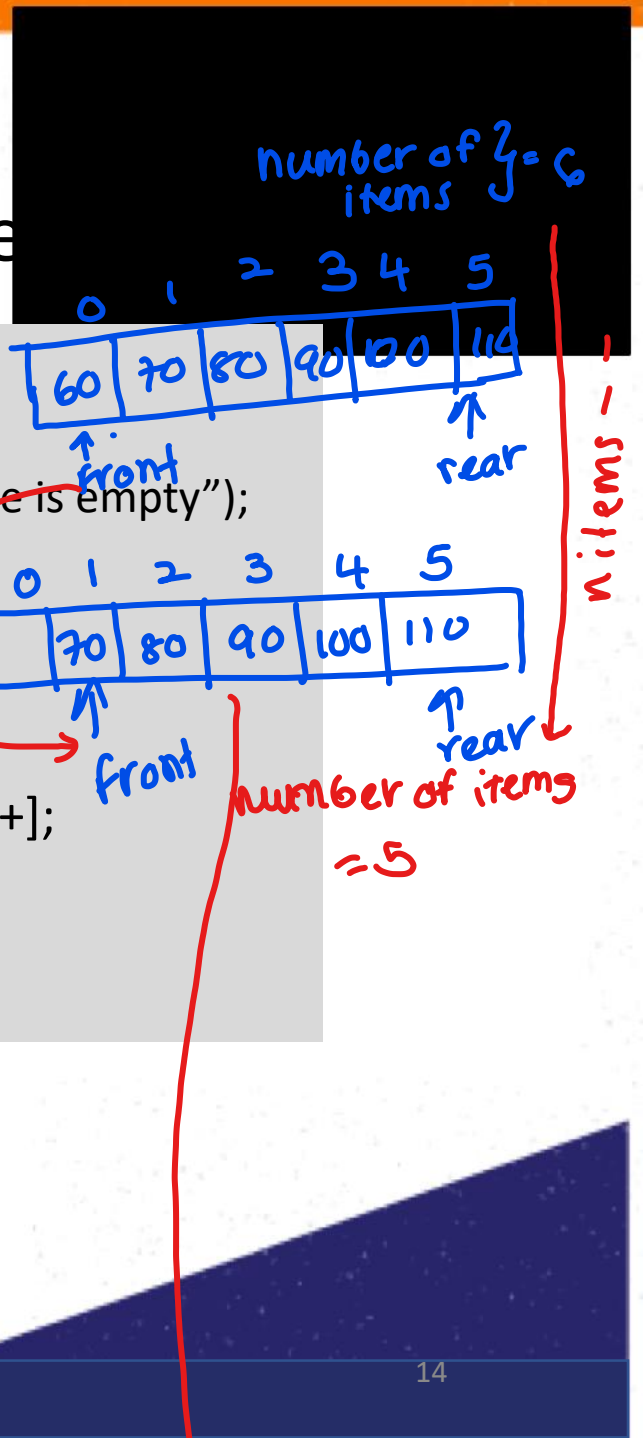
```
class QueueX {
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;          //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s) { // constructor

                        maxSize = s;       // set array size
                        queArray = new int [maxSize];
                        front = 0;
                        rear = -1;
                        nItems = 0;           // no items
        }
     public void insert(int j) {

                       // check whether queue is full
                        if (rear == maxSize – 1)
                            System.out.println(“Queue is full”);
                       else {

                                              queArray[++rear] = j;
                                              nItems++;


                       }
     }
}
```

```
public int remove()  {
            // check whether queue is empty
            // if not
           // access item and increment front
 }

public int peekFront()  {
            // check whether queue is empty
            // if not
             // access item
 }
```

Queue – Implementation – remove

```
class QueueX{
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;           //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s) {// constructor

                        maxSize = s;       // set array size
                        queArray = new int [maxSize];
                        front = 0;
                        rear = -1;
                        nItems = 0;            // no items
        }
    public void insert(int j) {

                    // check whether queue is full
                     if (rear == maxSize – 1)
                          System.out.println(“Queue is full”);
                    else {

                                        queArray[++rear] = j;
                                        nItems++;


                    }
    }
}
```

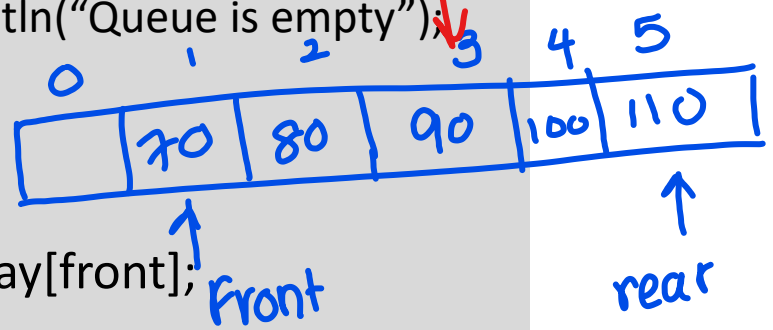
```
public int remove() {
        if (nItems == 0)  {
            System.out.println(“Queue is empty”);
            return -99;
        }
        else   {
            nItems--;
            return queArray[front++];
        }
}
```



Queue – Implementation – peekFron

```
class QueueX{
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;           //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s) {// constructor

                        maxSize = s;      // set array size
                        queArray = new int [maxSize];
                        front = 0;
                        rear = -1;
                        nItems = 0;           // no items
        }
    public void insert(int j) {

                    // check whether queue is full
                     if (rear == maxSize – 1)
                          System.out.println(“Queue is full”);
                    else {

                                        queArray[++rear] = j;
                                        nItems++;


                    }
    }
}
```

```
public int peekFront() {
    if (nItems == 0)  {
        System.out.println(“Queue is empty”);
        return -99;
     }
    else {
        return queArray[front];
    }
}
```



Question 02

isEmpty() method of the Queue class returns true if the Queue is empty and isFull() method returns true if the Queue is full.

Implement isEmpty() and isFull() methods of the Queue class.

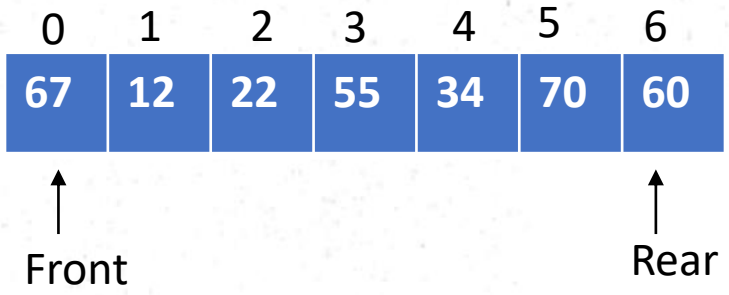
```
public boolean isEmpty(){
    return nItems == 0;
}
public boolean is full(){
 return nitems rear = maxsize - 1;
}
```

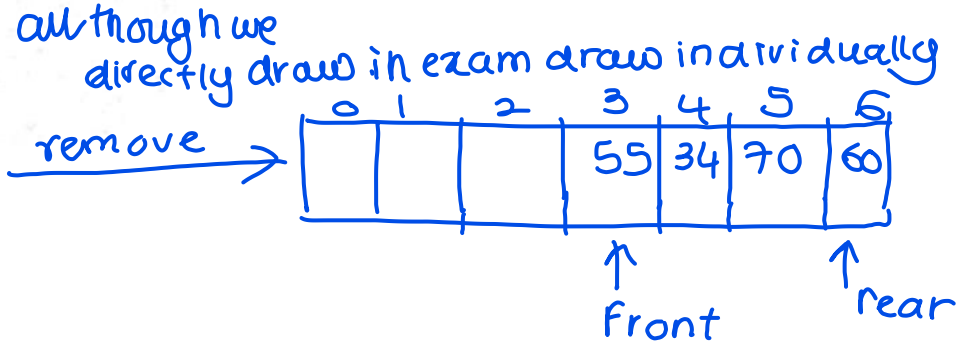
This is wrong

return nItems == maxSize;

Question 03

Draw the Queue frame after performing the below operations to the queue given below.

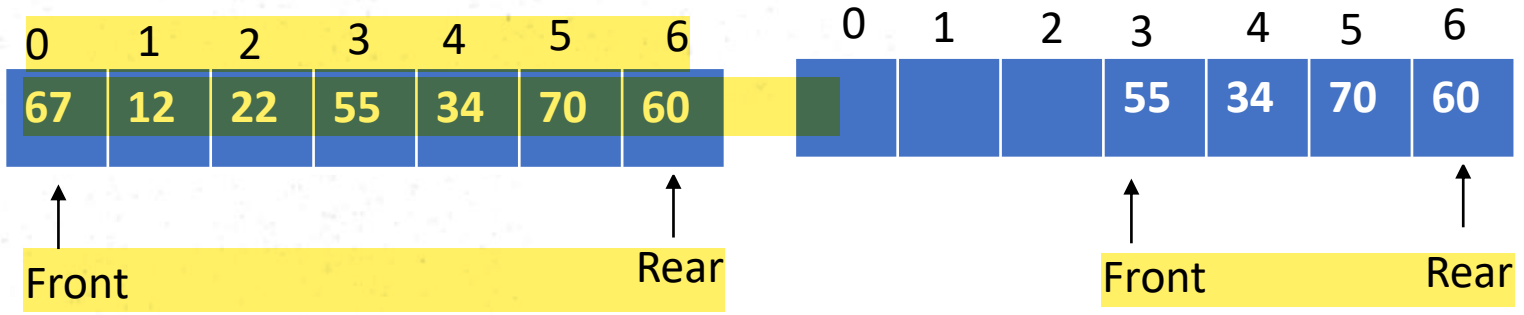




i) remove
ii) remove
iii) remove
iv) Insert item 88

Question 03 Contd..

Draw the Queue frame after performing the below operations to the queue given below.



i) remove
ii) remove
iii) remove
iv) Insert item 88

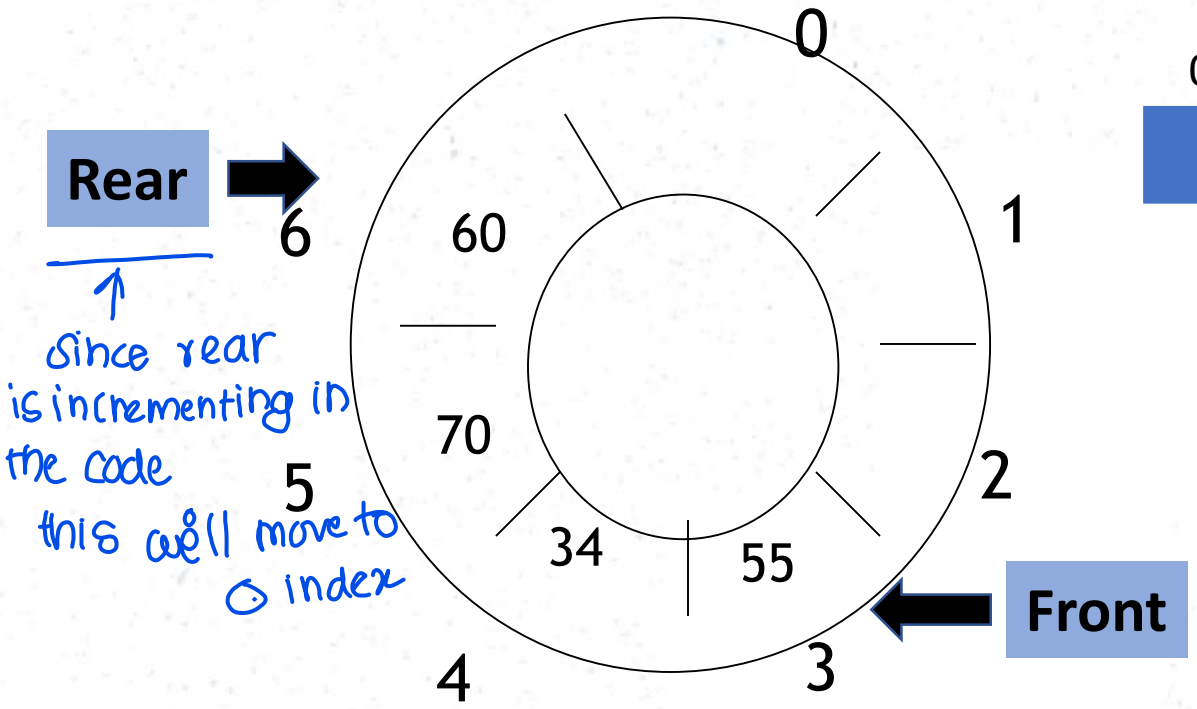
Although the queue is not full we cannot insert more elements. it would cause an error

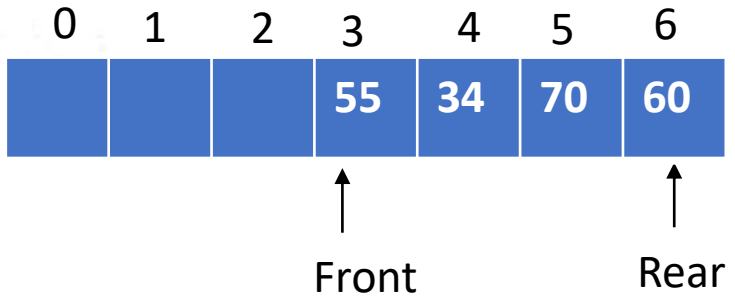
but we have empty slots in the front this is waste of space

Any Suggestions?

How to overcome this situation??

We can use a Circular Queue





Circular Queue

- Circular queues are queues that wrap around themselves.
- These are also called ring buffers.

reusability is lacking in linear queues

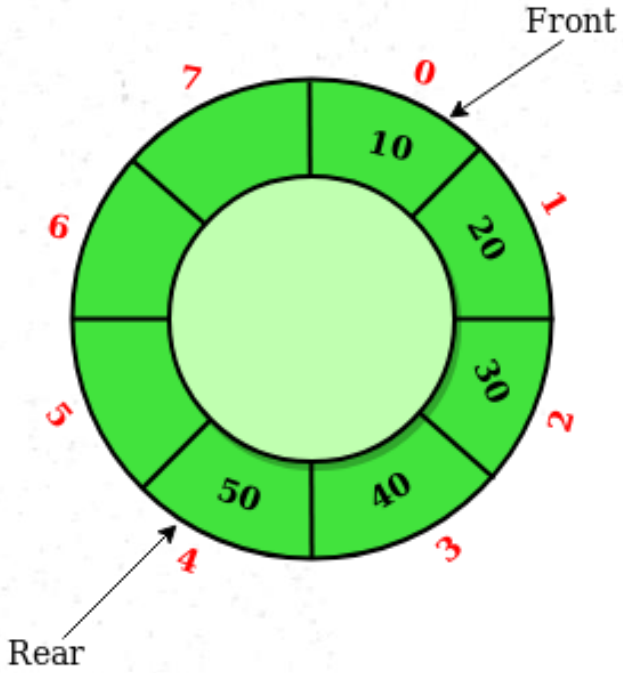
- The problem in using the linear queue can be overcome by using circular queue.
- When we want to insert a new element we can insert it at the beginning of the queue.

  i.e. if the queue is not full we can make the rear start from the beginning by wrapping around

  If rear was 3 then the next element should be stored in index 4
  If rear was 7 then the next element should be stored in index 0

Question 04

Draw the Queue frame after performing the below operations to the circular queue given below.

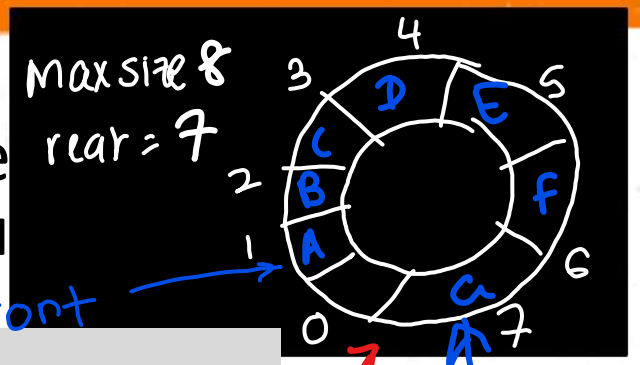


i) insert(14);
ii) insert(29);
iii) insert(33);
iv) insert(88);
v) peekFront();
vi) remove();
vii) remove();
viii) insert(90);
ix) insert(100);
x) peekFront();

Inserting an element to Linear Queue

```
public void insert(int j)  {
      // check whether queue is full
      if ( rear == maxSize - 1)
          System.out.println("Queue is full");
      else  {
          queArray[++rear] = j;
          nItems++;

      }
}
```

Inserting an ele to Circular Qu




```
public void insert(int j)  {
      // check whether queue is full
      if (nItems == maxSize)
          System.out.println("Queue is full");
      else {
          if(rear == maxSize - 1)
              rear = -1;

          queArray[++rear] = j;

          nItems++;
```

condition satisfied

rear

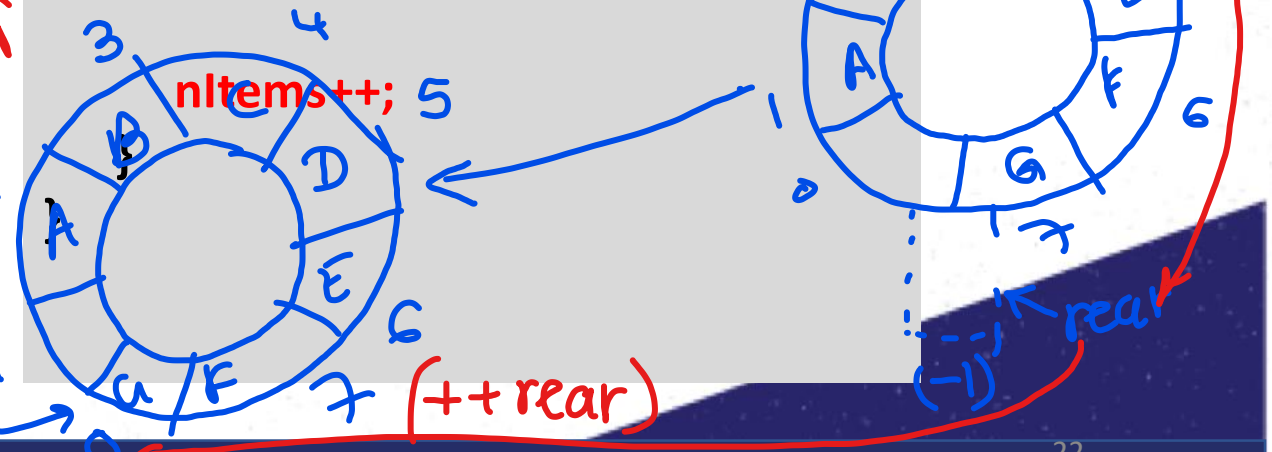
rear = -1

number of items

front

rear

(++rear)



Removing an element from Linear Queue

```
public int remove()  {
      // check whether queue is empty
      if ( nItems == 0)
          System.out.println("Queue is empty");
      else {
          nItems--;
          return queArray[front++];

      }
}
```

Removing an ele from Circular Q

```
public int remove() {
      // check whether queue is empty
      if ( nItems == 0)
          System.out.println("Queue is empty");
      else  {
          int temp = queArray[front++];
          if (front == maxSize)
              front  = 0;

          nItems--;

          return temp;

      }
}
```

this reads the front value and then increment front+1

Question 05

Implement isFull(), isEmpty() and peekFront() methods of the Circular Queue class.

```
public boolean isFull(){
    return nItems == maxSize;
}
```

```
public boolean isEmpty(){
    return nItems = 0;
}
```

```
public int peekFront(){
    if(nItem == 0)
        //Display the message}
    {
    else { return queArray[front];}
}
```

Question 06
Creating a Queue

Using the implemented QueueX class, Write a program to create a queue with maximum size 10 and insert the following items to the queue.

10 25 55 65 85

Delete all the items from the queue and display the deleted items.

Creating a Queue

```
class QueueApp {
        public static void main(String[] args) {
                QueueX  theQueue = new QueueX(10);  // create a queue with max size 10

                theQueue. insert(10);  // insert given items
                theQueue. insert(25);
                theQueue. insert(55);
                theQueue. insert(65);
                theQueue. insert(85);

                while( !theQueue.isEmpty() ) {    // until it is empty, delete item from queue

                        int val = theQueue.remove();
                        System.out.print(val);
                        System.out.print(" ");
                }
        }
} // end of class
```

this is storing the value which is removed

References

1. Mitchell Waite,Robert Lafore, Data Structures and Algorithms in Java,2nd Edition, Waite Group Press,1998.