

# CSCI 313 Data Structure

## Midterm 1 - A

First Name: \_\_\_\_\_

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1. **CircularlyLinkedList** is defined as following(12 points):

Class CircularlyLinkedList<E> implements List<E>, Iterable<E>{

```
class Node{...}
```

```
private Node tail;
```

```
private int size;
```

```
//methods we implemented in class.
```

```
public Iterator<E> iterator(){
```

```
    return new ListIterator();
```

```
}
```

```
//Implement its iterator class for CircularlyLinkedList
```

```
private class ListIterator implements Iterator<E>{
```

```
    //you may declare variables here.
```

```
private Node node = tail.next;
```

```
private int index = 0;
```

```
public ListIterator(){
```

```
}
```

```
public Boolean hasNext(){
```

```
    return index < size;
```

```
}
```

```
public E next(){
```

```
    E val = node.val;
```

```
    node = node.next;
```

```
    return val;
```

```

    }
    public void remove(){
        throw new NoSupportedException();
    }
}
}

```

2. Estimate the runtime using Big-O (**8 points**):

a) What's the runtime of **hasNext()** and **next()** method in Q1.

$O(1)$

b)  $T(n) = 10\log_2(n^2) + 15\log_2((2n)^2) + 5\log_2(n^3) + 200\log_2(1000^5)^2 + 10000$

$O(\lg n)$

c)  $T(n) = 5T(n/3) + 100n^3$

$a = 5, b = 3, d = 3$

$5 < 3^3 = 27$

$O(n^3)$

d)  $T(n) = 10T(n/2) + 1000n^2$

$a = 10, b = 2, d = 3$

$10 > 2^3$

$O(n^{\lg 10})$

e)  $T(n) = 64(n/4) + 3n^3$

$a = 64, b = 4, d = 3$

$O(n^3 \log_4 n)$

$$f) T(n) = 3T(n - 2) + 1$$

Assume  $n = k \cdot 2 + 1$ ,  $k$  is 1,2,3,4,5,6.....

$$T(n - 2) = 3T(n - 4) + 1$$

$$T(n - 4) = 3T(n - 6) + 1$$

·  
·  
·

$$T(1) = 1$$

$$T(n) = 3T(n - 2) + 1 = 3^2T(n - 4) + 3 \cdot 1 = 3^3T(n - 6) + 3^2 + 3 + 1$$

$$= 3^k T(1) + 3^{k-1} + \dots + 3 + 1$$

$$= O(3^{n/2})$$

### 3. Middle of the linked list(5 points)

Given a non-empty, singly linked list with head node **head**, return a middle node of linked list. **If there are two middle nodes, return the second middle node.**

**0 points if you have more than 12 lines code.**

ListNode class is defined as following:

```
class ListNode{
    int val;
    ListNode next;
}
```

Ex1:

1 -> 2 -> 3 -> 4 -> 5: returns node 3

1 -> 2 -> 3 -> 4 : returns node 3

```
public ListNode middleNode(ListNode head) {
    ListNode first = head;
    ListNode second = head;
    While(second != null && second.next != null){
        first = first.next;
        Second = second.next.next;
    }
    Return first
}
```