**CS 101 Fall 2023 - Quiz 1**

**10/16/2023 - 20 Minutes** **Name:** **ID number:**

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**1. (5 points) Notes of discussion**

I promise that I will complete this QUIZ independently and will not use any electronic products or paper-based materials during the QUIZ, nor will I communicate with other students during this QUIZ.

**True or False: I have read and understood the notes.** √ True ◯ False

**2. (10 points) True or False**

Determine whether the following statements are true or false.

| (a) | (b) | (c) | (d) | (e) |
|---|---|---|---|---|
| T | T | F | T | F |

(a) (2') In a linked list, we can insert after a given node without knowing the head of the linked list.

(b) (2') If we implement a stack using an array, we can get the size of the stack in constant time.

(c) (2') Reversing a singly linked list takes constant time.

(d) (2') If we implement a queue using circular array, the minimal memory we need is related to the maximal possible numbers of elements in the queue.

(e) (2') Given a pointer to any node in a singly linked list, we are able to gain access to every node of it.

**3. (8 points) Array capacity**

Suppose there are two initially empty arrays of capacity 4. Now you will continuously push elements into these arrays. When you want to push an element into a **full** array, you need to increase the array's capacity and copy all the old elements to the new array. The first array's capacity will increase by 2 each time. The second array's capacity will increase by a factor of 2 each time. Answer the following questions, **the questions are independent of each other**.

(a) (2') Suppose we insert 7 elements into the first array, the unused memory is ___1___, the total number of copies is ___10___.

(b) (2') Suppose we insert 7 elements into the second array, the unused memory is ___1___, the total number of copies is ___4___.

(c) (2') Suppose we insert 17 elements into the first array, the unused memory is ___1___, the total number of copies is ___70___.

(d) (2') Suppose we insert 17 elements into the second array, the unused memory is ___15___, the total number of copies is ___28___.

**4. (10 points) Queue and Stack**

As we all know, Queue has three basic operations: `push()`, `pop()`, and `isEmpty()`. In this question, you are only given 2 stacks. These stacks have functions: `push()`, `pop()`, `isEmpty()`, and `top()`. Your task is to use the given two stacks to implement a special Queue.

**NOTE: `pop()` does not return anything.**

(a) (2') First, you need to know the difference between Queue and Stack. Queue's `push()` and `pop()` are ____B____, but stack's `push()` and `pop()` are ____A____.

A. LIFO (Last-In-First-Out) B. FIFO (First-In-First-Out)

Now you are given the pseudocode of Queue's `push()`, `pop()`, and `isEmpty()`, here $S1$ is the first stack and $S2$ is the second stack.

```
1: function QUEUE-PUSH(element)
2:     S2.push(element)
3: end function
```

```
1: function QUEUE-POP
2:     if S1.isEmpty() then
3:         while not S2.isEmpty() do
4:             (1)
5:             (2)
6:             (3)
7:         end while
8:     end if
9:     S1.pop()
10: end function
```

```
1: function QUEUE-ISEMPTY
2:     return (4)
3: end function
```

(b) (4') Fill in the blank (1), (2), and (3) to finsh `pop`, we will **never** try to `pop` element from an empty Queue. You may not need all the blanks.

**Solution:** (1)$S1$.push($S2$.top()) (2)$S2$.pop()

(c) (2') Fill in the blank (4).

**Solution:** $S1$.isEmpty() and $S2$.isEmpty()

(d) (2') However, every stack has its capacity (the maximal number of elements that it can store). $S1$'s capacity is $n$ and $S2$'s capacity is $m$. What is the capacity of your Queue in the worst case?

**Solution:** $\min(n, m)$