

COMS W3134 Midterm Sample Questions - Spring 2015

October 19, 2015

Name: _____

UNI: _____

Total Points:

Time:

Instructions:

Do not turn this page before the official start time!

The exam is closed book, closed notes. Calculators are permitted.

Read the directions for each question carefully. We will give partial credit based on the work you write down, so show your work! You must hand in any scrap paper you used. Before handing in your exam, please initial each page.

Start with the easy questions and return to the more difficult ones later.

If you have questions, raise your hand and wait for a TA.

Good luck!

Academic Honesty Statement:

I certify that I have neither given nor received unauthorized help on this exam and that I did not use any notes, electronic devices, or other aids not specifically permitted. I understand that any violation of this policy can result in an exam grade of zero and will be reported.

Signature: _____

Question 1

Assume you are given a Simple Linked List (i.e. not a doubly linked list) containing an even number of elements. For example

$$L = [A \ B \ C \ D \ E \ F].$$

- a) Draw the linked node structure of L , including a head node.
- b) Describe an $O(N)$ algorithm (in pseudocode or your own words) that flips every adjacent pair of elements in the list. For instance, the algorithm should convert L into $[\ B \ A \ D \ C \ F \ E]$. Assume the list implementation does not provide an iterator.

Question 2

Perform the following sequence of operations on an initially empty Circular Array Queue of size 3. Show the layout of the array and the value of the start and end marker after each step.

enqueue(A), enqueue(B), dequeue(), enqueue(C), dequeue(), enqueue(D).

Question 3

Analyze the running time of the following Java method in Big-O notation. Provide as tight a bound as possible. Then answer the following questions: What is the return value of `foo(11)`? What does the method `foo` compute in general?

```
public static String foo (Integer n) {
    if (n <= 1) return n.toString();
    Integer bar = n % 2;
    return foo(n / 2) + bar.toString() ;
}
```

Question 4

```
public static void foo(LinkedList<Integer> l1, LinkedList<Integer> l2){
    for (Integer b : l1) {
        if (b > -1)
            System.out.println(l2.get(b));
    }
}
```

- Assume that $l1$ has N elements, what should the input look like so that the method runs in $O(N)$ (this is the best-case input).
- What is the big-O running time in the worst case? Provide as tight a bound as possible.

Question 5

Draw an expression tree for the following expression and give the expression in postfix and prefix notation.

$$(A - B / (C + D)) * E * (F + G / H)$$

Question 6

- (a) Write the following arithmetic expression in post-order notation. $5 + 3 * (2 + 4) - 13$.
- (b) Use a stack to evaluate the post-order expression. Show the push and pop operations used for each input character, and the resulting stack after each step.

Question 7

Prove by induction that any full Binary Tree has an odd number of nodes.

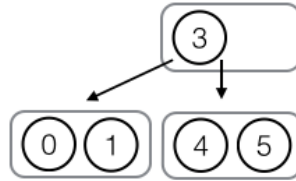
Question 8

An anagram is a word play in which the letters of one word are rearranged to form another word. For some word pairs, a single stack can be used to convert word A into word B. You can only scan the input word once (left to right) and you need to print the characters in the output word in sequence (left to right). For each of the following word pairs, show a sequence of push and pop operations that successfully transforms the input word into the output word, or explain why the conversion is impossible.

- aple, pale
- insult, sunlit
- rescued, reduced
- rescued, secured

Question 9

Consider a 3-ary B-Tree:



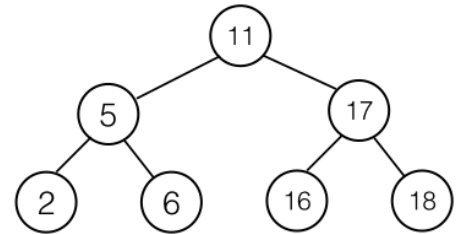
Perform the following sequence of operations. Draw the new B-tree after each step.
 (1) insert 6. (2) insert 2. (3) insert 7. (4) remove 4.

Question 10

Perform the following sequence of insertions on the AVL Tree on the right.

insert(15), insert(14), insert(13), insert(12)

For every insertion, specify for which node the balance condition is violated (if any) and state what type of rotation is needed to restore balance. Draw the new tree after each insertion. Label every node with the height of its left and right subtree.



Question 11

The Hash Table on the right uses linear probing with $f(i) = 2i$.

- Fill the table by inserting the following integer keys (in order) using the hash function $hash(x) = x \% 11$.
16, 28, 6, 38, 5, 11, 49
- What is the load factor of the hash table?

index	key
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	