

Practice and Study Guide for Exam 2

CIS 2168 Data Structures

Answer the questions in the spaces provided. **Please note** that there are no intentional errors in the code provided except in questions asking you to correct said code.

Your written code does not have to be 100% syntactically correct.

You are allowed ONE sheet of notes, front and back.

Name: _____

Page	Points	Score
3	12	
4	6	
5	5	
6	5	
7	5	
8	6	
9	10	
10	10	
11	12	
12	12	
14	10	
15	10	
Total:	103	

Useful notes:

- You are allowed to clarify any answer you give.
 - All questions are essay questions, including the multiple choice.
- You are allowed to ask for clarification.
- Things are never as complicated as they appear, especially the math.
- Never leave a question blank, even if you don't know the answer. We can't give partial credit to blanks.
- Extra credit is available for exceptional answers (up to five additional points).

Don't Panic

For each of the following questions, indicate which data structure would be best suited to handle each scenario. Your choices are **ArrayList**, **LinkedList**, **Stack**, **Queue**, **Tree**, **Priority Queue**, **Set**, or **Map**.

- _____ 12 points

2 Tree Relations and Vocabulary

5. (4 points) Answer the following vocabulary questions.

(a) The node at the top of a tree is called what?

(a) _____

(b) The links from a node to its successors are called what?

(b) _____

(c) The predecessor of a node in a tree is called what?

(c) _____

(d) Nodes that have the same parent are what?

(d) _____

6. (2 points) Describe, without using code, how to calculate the height of a tree recursively.

7. (5 points) Draw an example of each of the following types of binary trees. Use a different example for each possible tree:

(a) Full

(b) Complete

(c) Perfect

3 Tree Operations

8. (5 points) Draw the binary search tree that forms after inserting the following integers (42 inserted first):

42, 10, 50, 12, 17, 80, -12, 100, 96, 105, 86, 72

9. (5 points) Using your previous answer, draw what happens when you remove the following:

42, 12, 17, 96

10. (3 points) Which of the following is the preorder traversal of a binary tree, with subtrees T_L and T_R ?
- A. Process T_L , process root node, process T_R .
 - B. Process root node, process T_L , process T_R .
 - C. Process T_L , process T_R , process root node.
 - D. Process root node, process T_R , process T_L .

11. (3 points) Which of the following is the postorder traversal of a binary tree, with subtrees T_L and T_R ?
- A. Process T_L , process root node, process T_R .
 - B. Process root node, process T_L , process T_R .
 - C. Process T_L , process T_R , process root node.
 - D. Process root node, process T_R , process T_L .

4 Heaps

12. (5 points) Draw the **Min-Heap** that forms after inserting the following integers (8 inserted first, and you can ignore the underlying array):

8, 10, 50, 20, 1, 4, 3

13. (5 points) Using the Heap you drew above, draw the Heap after removing an element twice.

5 Huffman Coding

Consider a document that has the following symbols and frequencies:

Symbol	Frequency
a	50
p	40
l	20
e	60
x	1

14. (6 points) Draw the Huffman Tree for these symbols.

15. (4 points) Encode the string “apple” into binary using this encoding.

6 Coding

16. (12 points) Write a method which, given the root of a tree or subtree, computes and returns the number of nodes in that tree or subtree. **You may not use the size() method; forget that it even existed to begin with.**

```
public static <E> int sizeTree(Node<E> root){
```

17. (12 points) Write a method which, given a Tree, returns whether the Tree is a full tree. This will be slightly different than the recursive traversal methods we've tried so far.

```
public static <E> boolean isFull(Node<E> tree) {
```

18. (0 points) Extra Practice: Write a method which, given two trees or subtrees, returns whether or not the contents of the entire tree are identical (eg do *treeA* and *treeB* store the exact same data in the exact same way).

```
public static boolean equals(Node<E> treeA, Node<E> treeB) {
```

19. (10 points) Write a method which returns what characters occur in a string and how many times each occurs.

```
public static Map<Character, Integer> count(String word) {
```

20. (0 points) Practice Question: Write a method which given an array of integers, categorizes them into numbers divisible by 2, 3, and 5. A number might appear in multiple categories more or none.

```
/* Example Input:
```

```
  [1,2,3,4,5,6,7,15]
```

```
Output:
```

```
  {2=[2,4,6], 3=[3,6,15], 5=[5,15]}
```

```
*/
```

```
public static Map<Integer, List<Integer>> splitNumbersByFactors(int[] arr) {
```

7 Analysis

21. (6 points) What are collisions in Hash Tables? Why do they occur and how are they handled?

22. (4 points) What is the worst case runtime of the insertion and deletion algorithms in a binary search tree and why?