Prince Sultan University
College of Computer & Information Science

جامعة الأمير سلطان
كلية علوم الحاسب والمعلومات

Final Examination

Term: 162 Year: 2016/2017 (v2)

Course instructor(s): Dr. Basit Qureshi and Dr. Sarab AlMuhaideb

Course title: Data Structures & Algorithms **Course code: CS210**

Exam duration: 3 Hours **Exam date: 22/5/2017**

Number of exam pages: (8) pages

(Including cover page)

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- Students are **NOT** allowed to bring **CELL PHONES, BAGS, SUNGLASSES**, **CALCULATORS** or any electronic devices into the examination hall.
- Students must **SIGN** the attendance sheet.

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Student's Signature:_____

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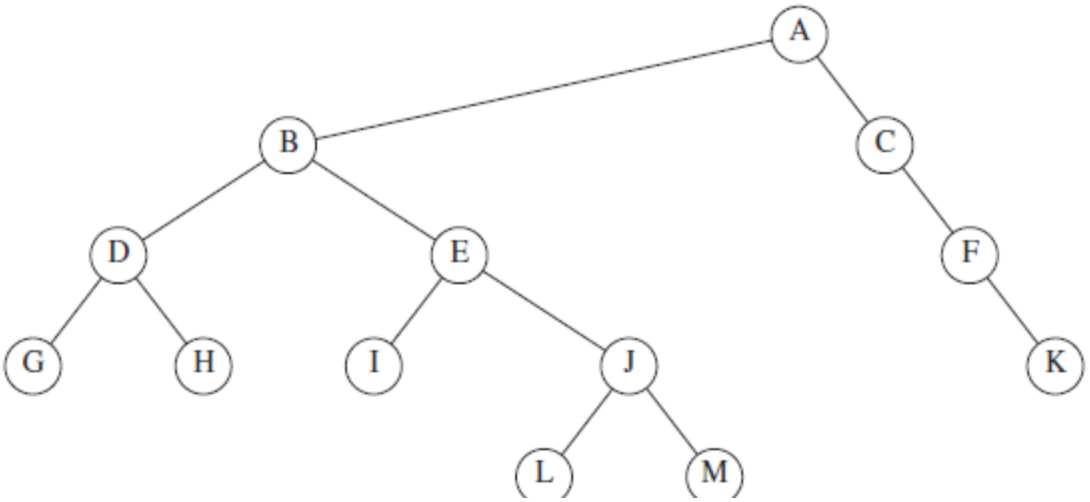
Question No.	Student's Score
Part 1: CLO1/ 10	
Part 2: CLO2 / 10	
Part 3: CLO3 / 10	
Part 4: CLO4 / 10	
Total / 40	

Part I [CLO 1:]: [___/10 Points]

1. (4) Consider the tree given in the diagram below.



a. [0.5] What is the height of the tree?_____

b. [0.5] Identify leaves with no other siblings_____

c. [0.5] Name all descendants of node J?_____

d. [0.5] Name two leaves with the highest depth_____

e. [2] Give the prefix and postfix expressions corresponding to the tree.

Prefix: _____

Postfix: _____

2. (2) Show, using a diagram, why searching in a complete binary tree gives O(log n) time?

3. (4) In this question, consider a priority queue implemented using a max-heap. Every node in the heap stores a key value pair, where the key is the priority (integer) and value is a string.
   a. [2] Illustrate the result of using a linear-time algorithm (top-down heap construction) to build a binary heap using the input
   (10,abc) (2,def) (1,xyz) (11,klm) (10,abd) (5,pqr) (6,stu) and (3,stp)

   b. [1] Show the result of performing **removeMax**() operations in the heap of the previous question.

   c. [1] Explain why **removeMax** takes O(log n) time rather than O(1)?

Part II [CLO2] [___/10 Points]

4. (2) Choose the best answer:
   a. The searching technique that takes O(log n) time to find a data is
      (A) Linear Search **(B)** Binary Search **(C)** Hashing

   b. The searching technique that takes O(1) time to find data is
      (A) Binary Search **(B)** Hashing **(C)** Linear Search

   c. The scenario when first element always is the pivot in Quicksort give run time of:
      (A) O(n) **(B)** O(n log n) **(C)** $O(n^2)$

   d. Which sorting algorithm does minimal number of swaps?
      (A) Selection sort **(B)** Insertion sort **(C)** Both have the same number of swaps.

5. (4) Trace the execution of **bottom-up merge sort** on the sequence B, A, F, C, D, X, Y, Z, K.

B	**A**	**F**	**C**	**D**	**X**	**Y**	**Z**	**K**

6. (4) Trace the execution of **quick sort** on the following shuffled sequence. Assume the pivot is the last element (first from the right).

66	**77**	**11**	**99**	**88**	**33**	**22**	**44**

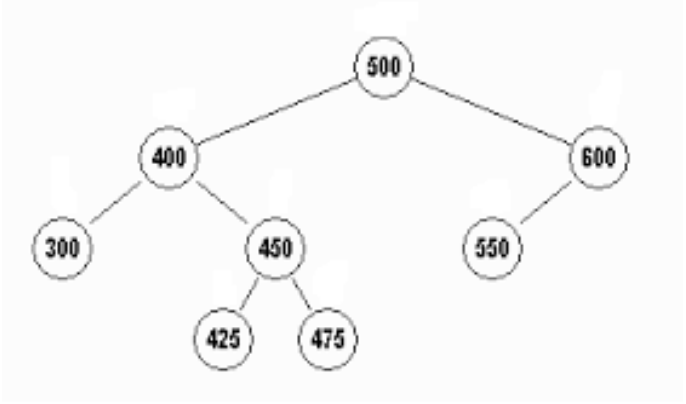
Part III [CLO3] [___/10 Points]

7. (3) This question is related to *binary search trees*.
   a. [2] Show the result of inserting **"hi" "by" "bye" "ha" "fly" "lie" "of" "the"** into an initially empty binary search tree storing strings.

   b. [1] In a BST consisting of 1000 elements (0 – 999), when searching 363, we traverse through the following nodes. Is the order of the traversal sequence correct or not? Explain.

      2, 399, 387, 219, 266, 389, 363.

8. (4) This question is related to the *AVL tree* shown below. Complete the following operations, re-draw the AVL tree as necessary highlighting the case for balancing.



insert(480)

insert(490)

remove(475)

remove(490)

9. (3) Two Binary Trees are similar if they are both empty or if they are both nonempty and left and right sub trees are similar. Write a method **`similar()`** for the BinaryTree class to determine if two Binary Trees are similar returning true and false otherwise.

```
public boolean similar (BTNode<E> p1, BTNode<E> p2){

}
```

Part IV: [CLO4] [___/10 Points]

10. Given input {4371, 1323, 6173, 4199, 4344, 9679, 1989, 2100}, a hash table of size 10 and a hash function $h(x) = x \bmod 10$, show the resulting:

a. (3) Separate chaining hash table.

0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

b. (3) Hash table using linear probing.

0	1	2	3	4	5	6	7	8	9

11. (4) Write method `boolean insert(int n, int [] HT)` that uses linear probing to insert value ***n*** in the Hashtable implemented using an array **HT** of type integers. The method returns true if the value is inserted, false otherwise. Use Hash function ***h(x) = x % 10*** to determine the position.

```
boolean insert(int n, int [] HT){




}
```