CSIEB0100 Data Structures, Fall 2014
Final Exam

ID: _____ Dept:_____ Name: _____

1. **(10%)** Answer the following questions.

(a) What does it mean for a sorting algorithm to be "stable"? Name a stable and a non-stable sorting algorithm. Explain the key reasons for an algorithm to be stable or not stable.

(b) What does it mean for a sorting algorithm to be "in-place"? Name an in-place and a non-in-place sorting algorithm. Explain the key reasons for an algorithm to be in-place or non-in-place.

2. **(10%)** Consider a set of Web pages with hyperlinks pointing to each other.

(a) Design a data structure to represent the link structure between the pages.

(b) A group of pages is called a *self-linking group* if they contain hyperlinks only to each other without any link in or out of the group. Give an algorithm to find all the self-linking groups in the set of Web pages.

3. **(20%)** Given an array containing the digits 7, 4, 2, 8, 1, 0, 6, 3 (written as 74281063), show how the order of the digits changes during each step of the following algorithms.

   (a) insertion sort

   (b) selection sort

   (c) merge sort

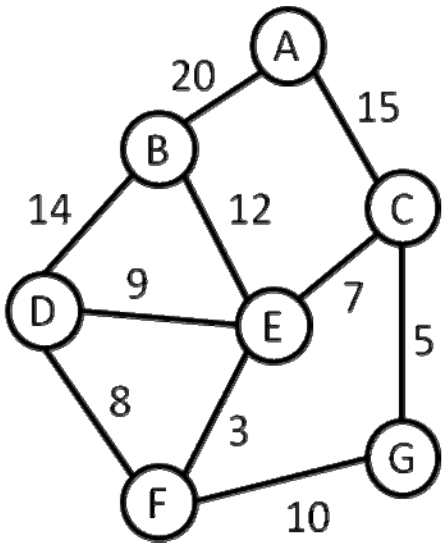
   (d) quick sort

   Show the array after each swap, except in insertion sort. For insertion sort, show the array after each insertion.

4. **(20%)** Answer the following questions about min-heaps.
   (a) How many elements of a min-heap of height *h* can have? Explain your answer.
   (b) Where in a min-heap might the largest element reside, assuming that all elements are distinct? Explain your answer.
   (c) Draw the final min-heap (initially empty) after inserting elements 9, 11, 12, 3, 14, 15, 7, 8, 1 in that order.
   (d) Draw the resulting min-heaps after two deletions.

5. **(20%)** Answer the following questions about binary search trees (BSTs).
   (a) Draw the final BST after inserting elements 17, 35, 5, 38, 29, 2, 11, 9, 16, 7, 8 in that order.
   (b) Draw the tree after deleting 29 from the BST in (a).
   (c) Draw the tree after deleting 9 from (b).
   (d) Draw the tree after deleting 5 from (c).
   (e) List the elements of pre-order, in-order, and post-order traversals of the tree from (d).

6. **(20%)** Answer the questions using the following graph.



(a) Draw the sequence of edges (represented by edge weight) added to the minimal-cost spanning tree generated by the Kruskal's algorithm.
(b) Do the same thing as (a) using Prim's algorithm.
(c) Do the same thing as (a) using Sollin's algorithm.
(d) Find the shortest paths from E to all other vertices using Dijkstra's algorithm.