Data Structures (IT205)
Midsemester Reexam
21^{st} November, 2012

Time: 2 hours **marks: 80**

This question paper consists of 4 questions printed on a single. Please ensure your question paper is complete. Attempt ALL questions.

1. Suppose you start with an empty 2-3-4 tree and perform a sequence of only inserts and no deletes. How many keys need to be inserted before the height of the tree becomes 3? Does this number depend on the sequence being inserted or only on the number of inserts?

2. Suppose you have a modified definition of Binary Search Trees, which require that all nodes with key value less than the key value of the root must go into the left subtree and all nodes with key value greater than the key value of the root go into the right subtree (as in the normal BST). However, the rule gets flipped at level 1 (children of the root), meaning the nodes of the left subtree with key less than the key of the left child of the root go into its right subtree and those with key values greater go into its left subtree. Same rule applies at the right child of the root. At level 2, the rule is again back to that at level 0 (i.e same as for root). The rule alternates at every level. Assuming only distinct keys are present:

   (a) Write a routine for inserting a node into such a tree satisfying this modified search tree condition.

   (b) Write routines for searching for a key in this tree and also for finding the successor of an element and the maximum element in the tree. Justify your routines by explaining why they are correct.

3. Suppose you are given the final tree after a sequence of ONLY inserts into a red black tree. Can you immediately conclude the structure of the resulting tree if the sequence of inserts is reversed? Find if there is a pattern by trying with some example sequences and draw a conclusion.

4. A binary minimum heap is stored in an array as you are aware. An inversion in an array of distinct elements is the number of pairs of elements which are stored in the array with the larger element appearing before the smaller element. Given a positive integer n what is the smallest and largest possible number of inversions in a binary minimum heap on n distint elements. Derive either a closed-form expression or write an algorithm to compute this value.