Data Structures (IT205)
First Midsemester-semester Exam
3^{rd} September, 2012

Time: 2 hours **marks: 60**

This question paper consists of 5 questions printed on 2 pages back-to-back. Please ensure your question paper is complete

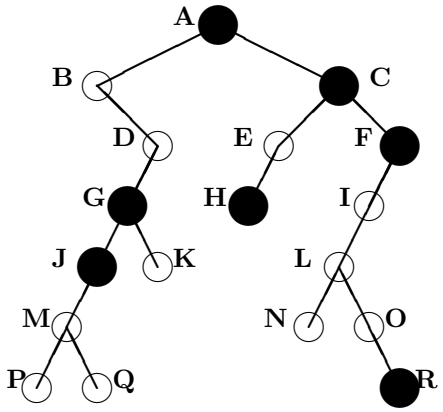
1. Consider a binary tree stored in the pointer based method (each node having a parent field, a left-child field and a right-child field, in addition to its key data). The nodes are classified into two different categories, colour coded as BLACK and WHITE respectively.

   (a) Write a routine to print all the BLACK nodes first, followed by the WHITE nodes. The nodes within each colour group should respect the level-order traversal specification.

   (b) Write a routine to print the nodes of the above tree in alternating order of colours. This means you need to print a BLACK node followed by a WHITE node and then a BLACK node again and repeat this until all the vertices have been listed. If at some stage the nodes of one of the two colours get exhausted then you should continue with only the remaining colour nodes. The order restricted to each colour group of nodes should respect the level-order traversal specification.

   [For the example tree given below, the output for the algorithms should be:
   part(a) A, C, F, G, H, J, R, B, D, E, I, K, L, M, N, O, P, Q
   part(b) A, B, C, D, F, E, G, I, H, K, J, L, R, M, N, O, P, Q]

   [12 marks]



2. You have a stack S_1 with $n(\geq 4)$ elements stored on it. You are provided two empty stacks S_2 and S_3 with sufficient capacity to store n elements of the type currently on stack S_1. Write a routine to rearrange the elements onto stack S_1 in such a way that finally no element is immediately above or below an element it was immediately above or below at the beginning. Your procedure should use as few push and pop operations as possible overall. You may use the stacks S_2 and S_3 as working space.

   How many PUSH and POP operations does your procedure use for an n element input stack?

   [12 marks]

3. A continuous stream of jobs arrive and are enlisted for processing on a machine. Each of the jobs has a priority number associated with it. After finishing a job, the machine selects the earliest arriving job among the pending jobs of highest priority. Design a data structure and write a routine, making use of two queues and one temporary variable, to enforce this protocol of job-scheduling. The temporary variable can be used to store the priority of the least priority job waiting to be executed.

   [HINT: if the newly arriving job is of lower or equal priority than the least priority job already waiting, it is enqueued in the normal fashion. Otherwise, it has to be promoted to a higher position in the queue. This can be done by moving some elements from one queue to the other, then enqueueing the new element behind them and then transferring the rest of the elements also from the first queue to the second]

   [12 marks]

4. Consider the following set of data with two key fields as given below

$$\{<1,6>,<2,7>,<3,9>,<4,3>,<5,1>,<6,2>,<7,5>,<8,8>,<9,4>\}$$

   .

   (a) Draw a binary tree with nine nodes and label each node with one of the above ordered pairs, using each ordered pair as a label *exactly* once. You need to draw the tree such that the labelling you give respects the binary search tree property on the first key and the binary minimum heap property on the second key.

   (b) Repeat the above question (not verbatim!!) interchanging the roles of the first and second keys. In other words. you need to draw a binary tree on 9 nodes and label with the same ordered pairs as before, but the first key set of key values need to respect the binary min heap property and the second set of key values need to respect the binary search tree property.

   (c) If you ignore the labels are the two trees you got in the above two questions the same or different? If they are different draw the superimposition of the two individual trees and label the nodes into three classes according to whether they appear only in the first tree, only in the second tree or in both trees.

   [12 marks]

5. Suppose you have an n node binary tree for which the order in which the nodes are printed is the same order under level-order traversal and zig-zag traversal.

   (a) What can you say about the structure of the tree?

   (b) How many such trees are there on n nodes (as a function of n)?

   (c) Which of the pointer fields of each node will be the same throughout all the n-node trees satisfying this condition?

   [12 marks]