# Data Structures 2018
Exercise 6 (Week 42)

- **Notice that based on university's new regulations on degrees, you can have a degree fail from the course which is put to the register.**

  If a student does not participate in the course and does not cancel his/her enrollment, or if he/she discontinues the course, he/she will be assigned a fail grade for the course in question.

- **Students who participate in exercise group must be in place before the exercise group begins (12.15/14.15/16.15). Students who come late do not get the exercise points.**
- **Check the numbers of exercises made before you come to the exercise group. By this means we can save a lot of time when filling the exercise point list.**
- **Notice that pseudocode does not mean the same this as Java code. Pseudocode is not a programming language dependent presentation for an algorithm.**

1.-2. In this task you need the following Java files *PQNode.java* (a doubly linked node of a priority queue), *PriorityQueue.java* (a priority queue implemented with a doubly linked list), and *PQTest.java* (a test program). Implement the following two operations into the file PriorityQueue.java:

`insertItem(long` $k$`, Object` $e$: adds object $e$ into the priority queue according to the principle of insertion sort. Sorting is done according to the key $k$. In other words, after every insertion, the nodes of the priority queue are in an ascending order according to the key values.

`removeMinElement()`: removes and returns the element with the smallest key.

Test your implementation by running the program PQTest.java (note: the test program does not work correctly unless you first implement the above operations).

3. What are the minimum and maximum heights of a binary tree when it has $n$ nodes (i.e. find functions $f(n)$ and $g(n)$ such that $f(n) \leq h \leq g(n)$, where $h$ is the height of the binary tree)? In what cases do these occur ?
4. What is the structure of the binary tree, when the the nodes are
   a) A, B, D, E, F, G, C in preorder and D, F, G, E, B, C, A in postorder?
   b) B, A, D, C, F, E, G in inorder and B, D, F, G, E, C, A in postorder?

5. Describe in pseudo code the following methods for a binary tree implemented as an array: root, parent, leftChild, rightChild, isInternal, isExternal and isRoot.

6. What is the structure of the binary tree, when the array representation is [n, 1, 2, 3, 2, 4, 5, 2, n, n, 5, 6, 7, 8, n, n], where n is a null-reference? (the first n is in index 0).

7.-8. Describe in pseudocode the algorithms removeMinElement and insertItem, when we assume that P is a priority queue implemented as

   a) an array sorted in ascending order ?

   b) an unsorted array ?

   You may assume that the operations only handle the keys, so removeMinElement removes and returns the smallest key in the queue ja insertItem inserts a new key into the queue. Also assume that up to maxElements keys fit in the array. Also define all extra member variables you might need (e.g. the number of elements currently in the table).