

EXAM EXAMPLE

This exam example for PG4200 is composed of 10 questions/exercises. Each question is worth 10 points, for a total of 100 points. You have 3 hours to answer as many of them as possible.

All the questions are written in English. To answer these questions, it is preferred that you do it in English. However, any other language officially recognized by Kristiania (e.g., Norwegian) is obviously acceptable.

When writing code on a piece of paper, it is obviously expected that there will be syntactic errors. Those will not reduce your grade. Still, the more you can be close to the actual Java syntax, the better. But, in the worst case, pseudo-code could still be acceptable (i.e., better than nothing). If you do not remember the exact name for a specific class/method, use a meaningful name that somehow reflects the needed functionality.

1) Consider 4 functions representing runtimes of 4 different algorithms for the same problem, for which we have the following bounds based on the input size n . What can you say about their relative performance? Which one is best? Which one would you choose? Motivate your answer in *details*.

$$f(n) = O(\log n), g(n) = \Omega(n), t(n) = \Omega(n \log n), k(n) = O(n^2)$$

2) Explain the main differences between the *List* and the *Set* data structures.

3) What are the main properties that differentiate Red-Black Trees from Binary Search Trees?

4) Explain what is an *immutable* object. Why the *keys* in a Map (and values in a Set) data structure must be immutable? Explain in *details*, in particular what could happen if such keys are modified after an insertion.

5) In relation to streams in data structures, explain in *details* what are the main differences between the *map* and *flatMap* methods and what they do.

6) Explain in *details* what a Linear Congruential Generator is, what is used for, and how it works.

7) In the context of Genetic Algorithms, explain in *details* what *Elitism* is, what is used for, how it works, and why it is important.

8) Given the following method signature, implement a Quick Sort algorithm.

```
public <T extends Comparable<T>> void sort(T[] array)
```

9) Given the following interface, implement a concrete Hash Map for it:

```
public interface MyHashMap<K, V> {  
    void put(K key, V value);  
    void delete(K key);  
    V get(K key);  
}
```

10) Considering the following beginning of the class for

```
public class UndirectedGraph<V> implements Graph<V>{  
    /**  
     * Key -> a vertex in the graph  
     * Value -> set of all vertices that connect to the Key,  
     *         ie the Key is the "from"/"source"  
     */  
    protected Map<V, Set<V>> graph = new HashMap<>();
```

Implement a method for a Breadth-First Search with signature

```
public List<V> findPathBFS(V start, V end)
```

Assume that the rest of that class is implemented (as seen in class), but that the method *findPathBFS* is missing and you need to implement it.

THIS MARKS THE END OF THE EXAM TEXT