**Functional and logic programming**
- **written exam -**

**Important:**

1. Subjects are graded as follows: By default - 1p; A – 2p; B - 4p; C - 3p.
2. Prolog problems will be resolved using SWI Prolog. The following are required: (1) explanation of the code and of the reasoning behind it; (2) recursive model that solves the problem, for all the predicates used; (3) specification of every predicate (parameters and their meaning, flow model, type of the predicate - deterministic/non-deterministic).
3. Lisp problems will be resolved using Common Lisp. The following are required: (1) explanation of the code and of the reasoning behind it; (2) recursive model that solves the problem, for each function used; (3) specification of every function (parameters and their meaning).

**A.** Given the following PROLOG predicate definition **f(integer, integer),** with the flow model (i, o):

```
f(1, 1):-!.
f(K,X):-K1 is K-1, f(K1,Y), Y>1, !, K2 is K1-1, X is K2.
f(K,X):-K1 is K-1, f(K1,Y), Y>0.5, !, X is Y.
f(K,X):-K1 is K-1, f(K1,Y), X is Y-1.
```

Rewrite the definition in order to avoid the recursive call **f(J,V)** in all clauses. Do NOT redefine the predicate. Justify your answer.

**B.** Write a PROLOG program that generates the list or all arrangements of **k** elements from a list of integer numbers, for which the product of the elements is less than a value **V** given. Write the mathematical models and flow models for the predicates used. For example, for the list [1, 2, 3], **k**=2 and **V**=7 ⇒ [[1,2],[2,1],[1,3],[3,1],[2,3],[3,2]] (not necessarily in this order).

**C.** Given a nonlinear list, write a Lisp function to return the list with all occurrences of the element **e** replaced by the value **e1**. **A MAP function shall be used.**

***Example*** **a)** if the list is (1 (2 A (3 A)) (A)), **e** is A and **e1** is B => (1 (2 B (3 B)) (B))

**b)** if the list is (1 (2 (3))) and **e** is A => (1 (2 (3)))