

## 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(0, -1):-!.

f(I,Y):-J is I-1, **f(J,V)**, V>0, !, K is J, Y is K+V.

f(I,Y):-J is I-1, **f(J,V)**, Y is V+I.

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

**B.** Write a PROLOG program that determines from a list made of integer numbers, the list of subsets with at least 2 elements, composed of numbers in strictly increasing order. Write the mathematical models and flow models for the predicates used. For example for the list [1, 8, 6, 4]  $\Rightarrow$  [[1,8],[1,6],[1,4],[6,8],[4,8],[4,6],[1,4,6],[1,4,8],[1,6,8],[4,6,8],[1,4,6,8]] (not necessarily in this order).

**C.** An n-ary tree is represented in Lisp as ( node subtree1 subtree2 ...). Write a function to replace all nodes on odd levels with a given value **e**. The root level is assumed zero. **A MAP function shall be used.**

**Example** for the tree (a (b (g)) (c (d (e)) (f))) and **e=h** => (a (h (g)) (h (d (h)) (h)))