

## Functional and logic programming

- written exam -

### Important:

1. Subjects are graded as follows: of - 1p; A – 1.5p; B - 2.5p; C - 2.5p; D - 2.5p.
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, 0):-!.

f(I,Y):-J is I-1, **f(J,V)**, V>1, !, K is I-2, Y is K.

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

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.** Given a nonlinear list that contains numerical and non-numerical atoms, write a LISP program that replaces each even numerical atom on odd levels with the sum of its digits. The superficial level is odd. For example, for the list (A 2 (B 31 F (D 102 5 T (66) E) (D 10 (E R 51)) 99)) the result will be (A 2 (B 31 F (D 3 5 T (66) E) (D 1 (E R 51)) 99)).

**C.** Write a PROLOG program that generates the list of permutations of the set  $1..N$ , having the property that the absolute value of the difference between 2 consecutive values from the permutation is  $\geq 2$ . Write the mathematical models and flow models for the predicates used. For example, for  $N=4 \Rightarrow [[3,1,4,2], [2,4,1,3]]$  (not necessarily in this order).

**D.** An n-ary tree is represented in Lisp as ( node subtree1 subtree2 ...).. Write a function to return the list of nodes on even levels, in increasing level order (0, 2, ...). The root level is assumed zero. **A MAP function shall be used.**

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