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(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. Given a nonlinear list that contains numerical and non-numerical atoms, write a Lisp program that builds a list that has a level for each level of the initial list and on each level has three elements: the number of numerical atoms on that level from the initial list, a sublist that contains these information for the rest of the levels and the numbers of nonnumerical atoms from that level in the initial list. For example, for the list (A B (4 A 3) 11 (5 (A (B) C 10) (1(2(3(4)5)6)7) X Y Z)) the result will be (1 (3 (3 (2 (2 (1 0) 0) 1) 2) 4) 2).

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 >=2. Write the mathematical models and flow models for the predicates used. For example, for N=4 ⇒ [[3,1,4,2], [2,4,1,3]] (not necessarily in this order).

D. Write a Lisp function to substitute all numerical values at any level of a given nonlinear list with a given value **e. A MAP function shall be used.**
**Example**, for the list (1 d (2 f (3))), **e**=0 the result is (0 d (0 f (0))).