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, -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. Given a nonlinear list that contains numerical and non-numerical atoms, write a LISP program that counts for how many sublists (including the initial list) the total number of numerical atoms on odd levels is equal with the total number of non-numerical atoms on odd levels. The superficial level is odd. For example, for the list (A B 12 (5 D (A F (B) D (5 F) 1) 5) C 9 (F 4 (D) 9 (F (H 7) K) (P 4)) X) the result will be 4 (the counted lists being (5 F) (H 7) (P 4) (5 D (A F (B) D (5 F) 1) 5)).

C. Write a PROLOG program that generates the list of all subsets of k elements in arithmetic progression. Write the mathematical models and flow models for the predicates used. For example, for L=[1,5,2,9,3] and k=3 ⇒ [[1,2,3],[1,5,9],[1,3,5]] (not necessarily in this order).

D. 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)))