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 both numerical and non-numerical atoms, write a Lisp program that builds a list that contains only numerical atoms, alternatively containing even and odd numbers. Odd numbers are each in a sublist. The even and odd numbers are in the same order relatively to the initial list. We assume that the initial list contains the same number of even and odd numbers. For example, for the list (A B (4 A 2) 11 (5 (A (B 20) C 10) (1(2(3(4)5)6)7 7) X Y Z)) the result will be (4 (11) 2 (5) 20 (1) 10 (3) 2 (5) 4 (7) 6 (7)).

C. Write a PROLOG program that generates the list of all subsets with at least N elements such that the value of sum of all elements from each subset is divisible with 3, from a list of integers. Write the mathematical models and flow models for the predicates used. For example, for the list L=[2,3,4] and **N**=1 ⇒ [[3],[2,4],[2,3,4]] (not necessarily in this order).

D. Given a nonlinear list, write a Lisp function to replace the numerical values on off levels and greater than a given value k to their natural predecessor. The superficial level is assumed 1. **A MAP function shall be used. _Example_** for the list (1 s 4 (3 f (7))) and
a)   k=0 the result is (0 s 3 (3 f (6)))   **b)** k=8 the result is (1 s 4 (3 f (7)))