

## 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.** Let L be a list of numbers and given the following PROLOG predicate definition **f(list, integer)**, with the flow model (i, o):

f([], 0).

f([H|T], S):-**f(T, S1)**, S1<H,!, S is H.

f(\_|T], S):-**f(T, S1)**, S is S1.

Rewrite the definition in order to avoid the recursive call **f(T, S)** 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 verifies if the following three lists are equal: the list of all atoms on levels multiple of 3 (3, 6, etc.), the list of all atoms on levels of the form  $3k+1$  (1, 4, 7, etc.) and the list of all atoms on levels of the form  $3k+2$  (2, 5, 8, etc.). For example, for the list (A 1 (A 1(A 1(B 777 (B (B 777 C) 777 C) C) D) D) D) the result will be true.

**C.** Write a PROLOG program that generates the list of all subsets of sum **S** given, using the elements of a list, such that the number of even elements from each subset is even. Write the mathematical models and flow models for the predicates used. For example for the list [1, 2, 3, 4, 5, 6, 10] and  $S=10 \Rightarrow [[1,2,3,4], [4,6]]$ .

**D.** Given a nonlinear list, write a Lisp function to return the list with all the numerical atoms that are multiple of 3 removed. **A MAP function shall be used.**

**Example**    **a)** if the list is (1 (2 A (3 A)) (6)) => (1 (2 A (A)) NIL)

**b)** if the list is (1 (2 (C))) => (1 (2 (C)))