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(list, integer),** with the flow model (i, o):

```
f([], -1):-!.
f([_|T], Rez):- f(T,S), S<1, !, Y is S+2.
f([H|T], Rez):- f(T,S), S<0, !, Y is S+H.
f([_|T], Rez):- f(T,S), Y is S.
```

Rewrite the definition in order to avoid the recursive call **f(T,S)** in all clauses. Do NOT redefine the predicate. Justify your answer.

B. Given a nonlinear list containing numerical and non-numerical atoms, write a LISP program that replaces non-numerical atoms with the number of occurrences of that atom at the level of the list on which it is located. For example, for the list (F A 12 13 (B 11 (A D 15) C C (F)) 18 11 D (A F) F), the result will be (2 1 12 13 (1 11 (1 1 15) 2 2 (1)) 18 11 1 (1 1) 2).

C. Write a PROLOG program that generates the list of all subsets with N elements, using the elements of a list, such that the sum of elements from a subset is an even number. Write the mathematical models and flow models for the predicates used. For example, for the list L=[1, 3, 4, 2] and N=2 ⇒ [[1,3], [2,4]].

D. Write a Lisp function to substitute an element **e** by other element **e1** at all odd levels of a nonlinear list. The superficial level is assumed 1. **A MAP function shall be used.**
Example, for the list (1 d (2 d (d))), **e**=d and **e1**=f the result is (1 f (2 d (f))).