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 with flow model (i, o):

```
f([],0).
f([H|T],S):-f(T,S1),S1>=2,!,S is S1+H.
f([_|T],S):-f(T,S1),S is S1+1.
```

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 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 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. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a Lisp function to determine the path from the root to a given node. **A MAP function shall be used.**
Example for the tree (a (b (g)) (c (d (e)) (f)))
(a) nod=e => (a c d e) (**b)** nod=v => ()