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. The following function definition in LISP is given
```
(DEFUN F(L)
        (COND
                ((NULL L) 0)
                (> (F (CDR L)) 2) (+ (F (CDR L)) (CAR L)))
                (T (+ (F (CDR L)) 1))
        )
)
```

Rewrite the definition in order to avoid the repeated recursive call **(F (CDR L))**. Do NOT redefine the function. Do NOT use SET, SETQ, SETF. Justify your answer.

B. Given a binary tree in which the nodes contain numerical information and given that the binary tree is represented as a list in which each node is followed by a number (0,1 or 2) that represents the number of children of that node, write a SWI-Prolog program that computes the sum of the first element on each level. For example, for the list [13, 2, 9, 2, 5, 0, 3, 2, 11, 0, 6, 1, 3, 0, 2, 1, 7, 1, 9, 1, 8, 2, 4, 0, 2, 1, 10, 0] the result will be 55.

C. Given a list composed of integer numbers, generate in PROLOG the list of arrangements of N elements ending with an odd value and have the sum S given. Write the mathematical models and flow models for the predicates used. For example, for the list L=[2,7,4,5,3], N=2 and S=7 ⇒ [[2,5], [4,3]] (not necessarily in this order).

D. Given a nonlinear list, write a Lisp function to return the list with all atoms on level **k** replaced by **0**. The superficial level is assumed 1. **A MAP function shall be used.**
Example for the list (a (1 (2 b)) (c (d)))   **(a)** k=2 => (a (0 (2 b)) (0 (d)))
(b) k=1 => (0 (1 (2 b)) (c (d)))   **(c)** k=4 => the list does not change