

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 (CAR L)) 1) (F (CDR L)))
    (T (+ (F (CAR L)) (F (CDR L)))))
)
```

Rewrite the definition in order to avoid the double recursive call **(F (CAR 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. Write a PROLOG program that generates the list of all subsets with values between $[a, b]$ interval with an even numbers of even values and an odd number of odd values from each subset. Write the mathematical models and flow models for the predicates used. For example, for $\mathbf{a}=2$ and $\mathbf{b}=4 \Rightarrow [[2,3,4]]$.

D. Given a nonlinear list, write a Lisp function to return the list with all atoms on the 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