

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 **G** be LISP function and given the following definition

```
(DEFUN F(L)
  (COND
    ((NULL L) 0)
    (> (G L) 2) (+(G L) (F (CDR L))))
    (T (G L))
  )
)
```

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

B. Given two lists composed of integer numbers and sublists of integer numbers, write a SWI-Prolog program that returns a list that contains all sublists that are formed by concatenation of two sublists, one from each of the two lists. For example, for the following two lists: [1,2, [4,2], 6, [3,2]] and [1,2,3,[5,6],8, 5,[2,3], 4,1,[3,3]] the result will be (not necessarily in this order): [[4,2,5,6], [4,2,2,3], [4,2,3,3], [3,2,5,6], [3,2,2,3], [3,2,3,3]].

C. Write a PROLOGO program that generates the list of arrangements of k elements from a list of integer numbers, having the given product P . Write the mathematical models and flow models for the predicates used. For example, for the list $[2, 5, 3, 4, 10]$, $k=2$ and $P=20 \Rightarrow [[2,10],[10,2],[5,4],[4,5]]$ (not necessarily in this order).

D. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a Lisp function to verify whether a node **x** occurs on an even level of the tree. The root level is assumed zero. **A MAP function shall be used.**

Example for the tree (a (b (g)) (c (d (e)) (f)))

a) $x=g \Rightarrow T$

b) $x=h \Rightarrow \text{NIL}$