

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) NIL)
    (> (F (CAR L)) 0) (CONS (F (CAR L)) (F (CDR L))))
    (T (F (CAR L)))
  )
)
```

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

B. Given a heterogeneous list composed of numbers and nonempty numerical linear lists, write a SWI-Prolog program that builds a list with the minimum values from those sublists for which the sum of the elements is a prime number. The resulted list will contain elements in reverse order of the initial input list. For example, for the list `[[4, 1, 18], 7, 2, -3, [6, 9, 11, 3], 4, [5, 9, 19]]`, the result will be `[3, 1]`.

C. Write a PROLOG program that generates the list of all arrangements of **k** elements from a list of integer numbers, for which the product of the elements is less than a value **V** given. Write the mathematical models and flow models for the predicates used. For example, for the list [1, 2, 3], **k**=2 and **V**=7 \Rightarrow [[1,2],[2,1],[1,3],[3,1],[2,3],[3,2]] (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)** $x=h \Rightarrow \text{NIL}$