

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(N)
  (COND
    ((= N 0) 0)
    (> (F (- N 1)) 1) (- N 2))
    (T (+ (F (- N 1)) 1))
  )
)
```

Rewrite the definition in order to avoid the double recursive call **(F (- N 1))**. 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 subsets with values between the $[a, b]$ interval such that the sum of elements from each subset is an odd value. Write the mathematical models and flow models for the predicates used. For example, for $\mathbf{a}=2$ and $\mathbf{b}=4 \Rightarrow [[2,3],[3,4],[2,3,4]]$ (not necessarily in this order).

D. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a function to replace all nodes on odd levels with a given value **e**. The root level is assumed zero. **A MAP function shall be used.**

Example for the tree (a (b (g)) (c (d (e)) (f))) and **e=h** => (a (h (g)) (h (d (h)) (h)))