

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
    ((ATOM L) -1)
    ((> (F (CAR L)) 0) (+ (CAR L) (F (CAR L)) (F (CDR L))))
    (T (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 numerical linear list, write a SWI-Prolog program that returns (in a list of pairs) all possible partitions of the initial list in two sublists, such that all elements of the sublists are relatively prime numbers (all elements of the first sublist are relatively prime and all elements of the second list are relatively prime). To avoid generating the same partition twice (ex: [A, B] and [B, A]), the first sublist will contain at most the same number of elements as the second sublist. For example, for the list [3, 5, 7, 9], the result will be (not necessarily in this order): [[5, 3], [9, 7]], [[7, 3], [9, 5]], [[3], [9, 7, 5]], [[9, 5], [7, 3]], [[9, 7], [5, 3]], [[9], [7, 5, 3]].

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. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a Lisp program to return the ***height*** of a node of a tree. **A MAP function shall be used.**

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

a) nod=e => the height is 0 **b)** nod=v => the height is -1 **c)** nod=c => the height is 2.