

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)
    ((LISTP (CAR L)) (APPEND (F (CAR L)) (F (CDR L)) (CAR (F (CAR L)))))
    (T (LIST(CAR 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 applies a stable sorting on this list and sorts the elements in increasing order by the remainder of the division with 3. For example, for the list [10, 5, 6, 12, 7, 3, 20, 30] the result will be [6, 12, 3, 30, 10, 7, 5, 20]. (Obs: stable sort means that elements that are equal elements will remain in the same order as in the initial list, for example 6 and 12).

C. Write a PROLOG program that generates the list of all subsets with at least N elements such that the value of sum of all elements from each subset is divisible with 3, from a list of integers. Write the mathematical models and flow models for the predicates used. For example, for the list $L=[2,3,4]$ and $N=1 \Rightarrow [[3],[2,4],[2,3,4]]$ (not necessarily in this order).

D. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a Lisp function to determine the path from the root to a given node. **A MAP function shall be used.**

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

(a) nod=e => (a c d e) **(b)** nod=v => ()