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 list composed of integer numbers and sublists of integer numbers, write a SWI-Prolog program that verifies if all the elements of the list (including those in sublists) form a symmetrical sequence. For example, for the list [1, 5, [2,4], 7, 11, 25, [11, 7, 4], 2, 5, 1] the result will be true.

C. Write a PROLOG program that generates the list or 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 ⇒ [[1,2],[2,1],[1,3],[3,1],[2,3],[3,2]] (not necessarily in this order).

D. Given a nonlinear list, write a Lisp function to replace the numerical values on off levels and greater than a given value k to their natural predecessor. The superficial level is assumed 1. **A MAP function shall be used.** ***Example*** for the list (1 s 4 (3 f (7))) and

a) k=0 the result is (0 s 3 (3 f (6))) **b)** k=8 the result is (1 s 4 (3 f (7)))