

## 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(G L)
  (COND
    ((NULL L) NIL)
    (> (FUNCALL G L) 0) (CONS (FUNCALL G L) (F (CDR L))))
    (T (FUNCALL G L))
  )
)
```

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

**B.** Given a nonlinear list composed of numbers greater or equal to 2, write a SWI-PROLOG program that replaces each nonprime number with the sum of its own proper divisors. Repeat the process until the list contains only prime numbers. **For example**, for the list [10, 20, 30, 40] the result will be [7, 7, 41, 7] (the initial list becomes first [7, 21, 41, 49], then [7, 10, 41, 7] and finally [7, 7, 41, 7]). Return only the final list.

**C.** Write a PROLOG program that generates the list of permutations of the set  $1..N$ , having the property that the absolute value of the difference between 2 consecutive values from the permutation is  $\geq 2$ . Write the mathematical models and flow models for the predicates used. For example, for  $N=4 \Rightarrow [[3,1,4,2], [2,4,1,3]]$  (not necessarily in this order).

**D.** Given a nonlinear list, write a Lisp function to return the list with all non-numerical atoms on even levels removed. The superficial level is assumed 1. **A MAP function shall be used.**

**Example** for the list (a (1 (2 b)) (c (d))) the result is (a (1 (2 b)) ((d)))