

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) 0)
    ((> (F (CAR L)) 2) (+ (CAR L) (F (CDR L))))
    (T (F (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 linear list of numbers, write a SWI-Prolog program that replaces every sequence of consecutive equal numbers with the sum of the sequence. This process must be repeated until there are no consecutive equal elements in the list. For example, for the list [1, 2, 1, 1, 4, 5, 6, 7, 7, 7, 3, 3, 3, 3, 3, 3, 10], the result will be [1, 8, 5, 6, 42, 10].

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. 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)))