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. Let **G** be LISP function and given the following definition

```
(DEFUN F(L)
        (COND
                ((NULL L) 0)
                (> (G L) 2) (+(G L) (F (CDR L))))
                (T (G L))
        )
)
```

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

B. Given a list that represents a set, write a SWI-Prolog program that return all possible solutions to divide the set in *k* subsets. The *k* subsets must be disjoint and each element from the initial set must be part of one of the subsets. For example, for the set [1,2,3] and k = 2, the solution is (not necessarily in this order): [[[3, 2], [1]], [[2], [3, 1]], [[3], [2,1]]].

C. Given a list composed of integer numbers, generate in PROLOG the list of arrangements of N elements ending with an odd value and have the sum S given. Write the mathematical models and flow models for the predicates used. For example, for the list L=[2,7,4,5,3], N=2 and S=7 ⇒ [[2,5], [4,3]] (not necessarily in this order).

D. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a Lisp function to verify whether a node **x** occurs on an even level of the tree. The root level is assumed zero. **A MAP function shall be used.**

Example for the tree (a (b (g)) (c (d (e)) (f))) **a)** **x**=g => T **b)** x=h => NIL