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. Given the following PROLOG predicate definition **f(integer, integer),** with the flow model (i, o):

```
f(0, 0):-!.
f(I,Y):-J is I-1, f(J,V), V>1, !, K is I-2, Y is K.
f(I,Y):-J is I-1, f(J,V), Y is V+1.
```

Rewrite the definition in order to avoid the recursive call **f(J,V)** in both clauses. Do NOT redefine the predicate. Justify your answer.

B. Given a nonlinear list of both numerical and non-numerical atoms, write a LISP program that builds a linear list composed only from those non-numerical atoms that occur an even number of times in the initial list. The result will contain each element only once, in reverse order of the initial list. **For example**, for the list (F A 2 3 (B 1 (A D 5) C C (F)) 8 11 D (A F) F), the result will be (C D F). You are NOT allowed to use predefined LISP functions *reverse* or *member*.

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. Given a nonlinear list, write a Lisp function to return the list with all atoms on even levels replaced by zero. 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 (0 (2 b)) (0 (d))).