**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 L be a list of numbers and given the following PROLOG predicate definition with flow model (i, o):

```
f([],-1).
f([H|T],S):-f(T,S1), S1<1, S is S1-H, !.
f([_|T],S):-f(T,S).
```

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

**B.** Given a nonlinear list that contains numerical and non-numerical atoms, write a Lisp program that verifies if the following three lists are equal: the list of all atoms on levels multiple of 3 (3, 6, etc.), the list of all atoms on levels of the form *3k+1* (1, 4, 7, etc.) and the list of all atoms on levels of the form *3k+2* (2,5,8, etc.). For example, for the list (A 1 (A 1(A 1(B 777 (B (B 777 C) 777 C) C) D) D) D) the result will be true.

**C.** Write a PROLOG program that generates the list of all permutations with the property the absolute value of difference between two consecutive values from each permutation is <=3. Write the mathematical models and flow models for the predicates used. For example, for L=[2,7,5] ⇒ [[2,5,7], [7,5,2]] (not necessarily in this order).

**D.** Given a nonlinear list, write a Lisp function to return the list with all occurrences of an element **e** removed. **A MAP function shall be used.**
***Example*** **a)** if the list is (1 (2 A (3 A)) (A)) and **e** is A => (1 (2 (3)) NIL)
**b)** if the list is (1 (2 (3))) and **e** is A => (1 (2 (3)))