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(1, 1):-!.
f(K,X):-K1 is K-1, f(K1,Y), Y>1, !, K2 is K1-1, X is K2.
f(K,X):-K1 is K-1, f(K1,Y), Y>0.5, !, X is Y.
f(K,X):-K1 is K-1, f(K1,Y), X is Y-1.
```

Rewrite the definition in order to avoid the recursive call **f(J,V)** in all 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 sequence of the numerical atoms on all odd levels form a zig-zag sequence (element 2 is greater than the first element, element 3 is smaller than element 2, element 4 is greater than element 3, etc.). For example, for the list (10 21 (3 A (B (0 77) 1 77)) C (5 (D 54) 11 6) 89 F H) the result will be true (the zig-zag sequence is (10 21 1 77 54 89)).

C. Write a PROLOG program that generates the list of all subsets with values between [a, b] interval with an even numbers of even values and an odd number of odd values from each subset. Write the mathematical models and flow models for the predicates used. For example, for **a**=2 and **b**=4 ⇒ [[2,3,4]].

D. Given a nonlinear list, write a Lisp function to return the list with all occurrences of the element **e** replaced by the value **e1**. **A MAP function shall be used.**

<u>Example</u> **a)** if the list is (1 (2 A (3 A)) (A)), **e** is A and **e1** is B => (1 (2 B (3 B)) (B))

b) if the list is (1 (2 (3))) and **e** is A => (1 (2 (3)))