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(N)
      (COND
            ((= N 1) 1)
            (> (F (- N 1)) 2) (- N 2))
            (> (F (- N 1)) 1) (F (- N 1)))
            (T (- (F (- N 1)) 1))
      )
)
```
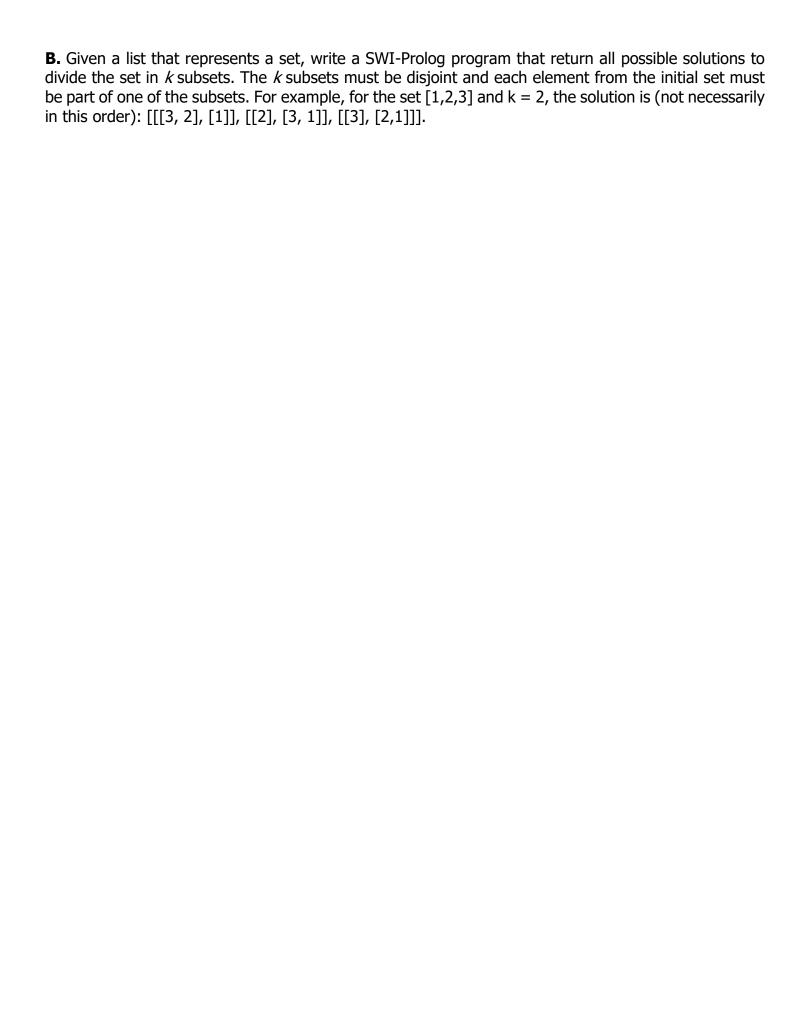
Rewrite the definition in order to avoid the repeated call **(F (- N 1))**. Do NOT redefine the function. Do NOT use SET, SETQ, SETF. Justify your answer.

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. Write a PROLOG program that generates the list of permutations of the set 1..N, having the property that the absolute value of the difference between 2 consecutive values from the permutation is >=2. Write the mathematical models and flow models for the predicates used. For example, for N=4 ⇒ [[3,1,4,2], [2,4,1,3]] (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)))