This is a closed book exam: the only resources allowed are blank paper, pens, and your head, but you may use a handwritten A4 page with information that you consider useful for solving the exam exercises. Explain your reasoning. Write clearly, in the sense of logic, language, and legibility. The clarity of your explanations affects your grade. Good luck!

Write your name and student number on *all* solution sheets and here.   Name: . . . .
At the end of the exam, hand in *all* sheets that you received, including this one.   Student number: . . . .

Problem 1 [30%] Design the Entity-Relationship schema of an application for managing the assignment of lectures to contract teachers within a private school, for which the following information is of interest. Of each *lecture*, we are interested in the year in which it is held, the length (in hours), and the teaching unit that teaches it, where a teaching unit may teach at most one lecture per year. Each lecture covers one or more topics. Each *topic* is identified by its name, and of each topic we are also interested in the description and the main person who defined it. Notice that a topic may be covered by zero, one, or more lectures. Each *teaching unit* is identified by a code (assigned by the school for payment purposes), and we are interested in its specialization. There are exactly two types of teaching units: persons, and teaching groups. Of each *person* we are interested in the ssn (identifier), the year of birth, the residence, and the type of degree (BSc, MSc, PhD, MA, etc.). Of each *teaching group* we are interested in the year in which it was formed and its composition for the various lectures. Notice that the composition of a teaching group may vary between lectures, and for each lecture it is simply given by the persons (at least two) that are part of the teaching group for that lecture, together with the role played by the person (leader, assistant, translator, etc.).

Problem 2 [40%] Carry out the logical design of the database, producing the complete relational schema with constraints, taking into account that when we access a topic, we also want to know the main person who defined it.

In your design you should follow the methodology adopted in the course, and you should produce:

1. [7%] the restructured Entity-Relationship schema (possibly with external constraints),
2. [25%] the direct translation into the relational model (possibly with external constraints), and
3. [8%] the restructured relational schema (again with constraints).

You should motivate explicitly how the above indications affect your design.

Problem 3 [20%] Consider a database D containing the two relations:

 (i) `Member(`<u>`code`</u>`,level)`, which stores the player code and level (an integer) of the members of a chess club;
(ii) `Game(winner,loser)`, which stores the result of the games played between members of the club (where both `winner` and `loser` are foreign keys to `code` of `Member`).

We call "wow" a member who has won at least one game and *all* the games they have won are with members of equal or greater level than their own.

1. Assuming that there are no null values in the database, write a SQL query that computes the code of all wow members of the club.
2. Assuming that there may be null values in the database, but only for the attribute `level`, say whether the query written for Item 1 is correct or not. If the answer is yes, give reasons for the answer. If the answer is no, write the correct SQL query.

Problem 4 [10%] Consider the ER schema S shown below and answer the following questions:

1. [5%] What problems, if any, does schema S suffer from that impair its quality?
2. [5%] What transformations should be performed on schema S to obtain a schema S' equivalent to S in which quality is maximized?