

This is a closed book exam: the only resources allowed are blank paper, pens, and your head. 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 information system relating to the hospitalisation of patients. Of each *hospital*, we are interested in the code (identifier), the number of employees (but this information is not always available), the region in which it is located, and the departments of which it is composed (at least one). There are two types of hospitals: public and private. Of *public hospitals*, we are interested also in the year of foundation, and of *private hospitals*, also in the various persons who have directed them, each with the starting date and the salary. Note that on each date and in each hospital, at most one person begins their *direction* role. Note also that the same person may direct the same hospital in different periods. Of each *department*, we are interested in the code (unique within the hospital in which it is located), the size in square meters and, in the case of an *obstetrics department*, also the number of beds. For each *admission* of a person to a department, various kinds of information are recorded; those of interest for the database are: the date, the occupied bed (positive integer number unique within the department), the person admitted, and the cost of the admission. When the admission is for a *delivery*, the department must be the obstetrics department, and in this case the information about the persons born from the delivery (possibly more than one) is also recorded. Note that a bed can be occupied by a maximum of one person per day and the same person cannot be admitted more than once per day. Finally, of each *person*, we are interested in the tax code (identifier), the name, the surname, and the date of birth.

Problem 2 [42%] Carry out the logical design of the database, producing the complete relational schema with constraints, taking into account the following indications: (i) we want to avoid null values in the database; (ii) for an admission, we are always interested in knowing the person who has been admitted.

As steps in your design you should produce:

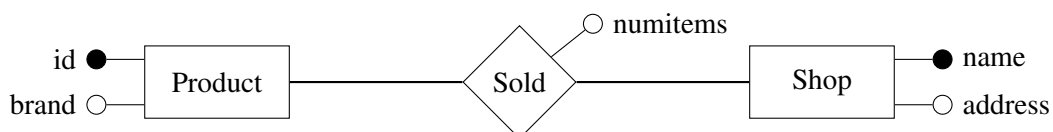
1. [7%] the restructured ER schema (possibly with external constraints),
2. [25%] the direct translation into the relational model (possibly with external constraints), and
3. [10%] the restructured relational schema (again with constraints).

Motivate explicitly how the above indications affect your design.

Problem 3 [18%] Consider a database that includes the relations **Municipality** and **Residence**. For each municipality, the relation **Municipality**(name, province, year) stores the name of the municipality, the name of the province in which the municipality is located and the year in which the last municipal election was held. The relation **Residence**(code, municipality, salary) stores, for each person, the tax code, the municipality of residence, and the annual salary.

1. We call a province “obsolete” if all municipalities with names different from the one of the province itself had their last municipal election before 2016. Write a *query in relational algebra* that returns the provinces that are obsolete.
2. Given a province, we often want to know the name of the municipality (or municipalities, if there are more than one), among those in that province, in which lives the person (or the persons, if there are more than one) with the highest salary within the province. Write a *SQL query* that returns this information for each province.

Problem 4 [10%] Consider the conceptual schema shown below, which models how many items of each product have been sold by each shop.



Suppose that, due to a revision of the requirements, it has become of interest to know the number of items of each product sold by each shop also in past years, once per year. Show the conceptual schema resulting from the revision.