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 missions of autonomous exploration vehicles (AEVs) owned by companies. Of each *company*, we are interested in the code (identifier), the turnover, and the island where the company is based. Of each company that owns AEVs, we are also interested in the number of employees. Of each *AEV*, we are interested in the company that owns it, the id (unique within the company that owns it), and the weight. There are exactly two types of AEVs: underwater and terrestrial ones. Of each underwater AEV, we are interested in the company that built it and the maximum depth at which it can dive. Of each terrestrial AEV, we are interested in the date of construction and in the contracts for its maintenance (at least one). Every *maintenance contract* for a terrestrial AEV is characterized by the company that carries out the maintenance and by the person that is responsible for it. Given an AEV and a company that has a contract for its maintenance, there is exactly one person responsible for that contract. Of each *mission*, we are interested in the AEV that performed it, the date, the cost, the person who supervised it, and the point of interest (POI) to which the AEV must travel to carry out the mission itself. Note that an AEV can carry out at most one mission per day. Of each *POI* we are interested in its type (e.g., flatland, mountain, underwater, etc.), its name, the island to which it belongs, and the coordinates within the island. There are no two different POIs with the same coordinates belonging to the same island. Of each *island*, we are interested in the name (identifier) and the number of inhabitants. Of each *person*, we are interested in the ssn (identifier), the date of birth, and the POIs the person has visited.

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)* When accessing the data of a mission, we always want to know the person who has supervised it. *(ii)* Terrestrial AEVs are accessed separately from underwater AEVs. *(iii)* When accessing a (terrestrial or underwater) AEV, we are always interested in knowing its weight.

As steps in your design you should produce:

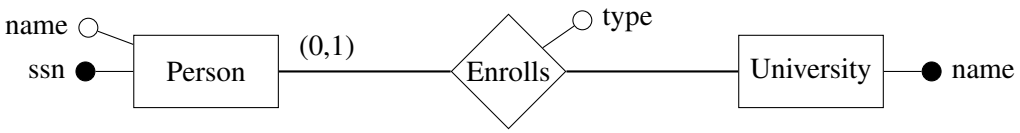
1. [7%] the restructured ER schema (possibly with external constraints),
2. [25%] the direct translation into the relational model (possibly with external constraints), and
3. [10%] the restructured relational schema (again with constraints).

Motivate explicitly how the above indications affect your design.

Problem 3 [18%] In a database, the relation `Lecture(teacher,student,day,month,year)` stores for each private lecture the ssn of the teacher, the ssn of the student, and the date when the lecture was held, while the relation `Person(ssn,age)` specifies ssn and age of persons (teachers and students). Express in SQL the following queries:

1. For each person, compute all persons to which that person has taught at least one private lecture in the years from 2016 to 2019.
2. For each person, compute to how many different persons who are underage (i.e., less than 18 years old) that person has taught private lectures in 2019.
3. Compute the ssn and the age of each person who has taught lectures exclusively from 2015 onwards, but only if the person has taught more than 50 lectures.

Problem 4 [10%] Consider the conceptual schema shown below, representing the fact that a Person is currently enrolled in a university, with the type of enrollment (full-time or part-time).



Suppose now that we want to record not only whether a person is currently enrolled in a university, but also the past enrollments, with their type, start date, and (expected) end date. Consider that a person can be enrolled in at most one university at a time. Restructure the conceptual schema above so that it represents this new state of affairs, and specify also the necessary external constraints (if needed).