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 for an application that manages conferences and the participants who register for them. Each *participant* is uniquely identified by an ssn, and we are also interested in their name, nationality, and affiliation (if available). Each *conference* is uniquely identified by its name and start-date, and for each conference we also want to know its end-date. Each *registration* refers to exactly one participant and exactly one conference, and we are also interested in the registration date and the registration type (e.g., full, workshop-only, etc.). Notice that a participant cannot have more than one registration on the same date. A conference may offer some extras (e.g., lunch vouchers), whose cost depends on the conference offering them. Each *extra* is uniquely identified by its name, and we also want to know its description, the conferences that offer it (at least one), and the corresponding cost at each conference. A registration may include some extras, with a quantity (e.g., 5 lunch vouchers). Note that these extras have to be among those offered by the conference for which the registration is done. There are exactly two forms of registrations: *paid registrations*, which are associated with a fee; and *free registrations*, for which some of the included extras may be waived (e.g., if a free registration includes lunch vouchers, they may be waived).

Problem 2 [40%] Carry out the logical design of the database, producing the complete relational schema with constraints, taking into account the following indications: *(i)* We access free and paid registrations together, and every time we access a registration, we always want to know whether it is free or paid. *(ii)* Every time we access a registration, we always want to know the conference for which it is done.

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) `Review(viewer,movie,rating)`, which stores the ratings given by viewers to movies.
(ii) `Subscribed(viewer,platform)`, which stores which viewers are subscribed to which viewing platforms.

Write the following queries over D:

1. Write a query in **relational algebra** that computes the platforms that do not have any movie with some rating given by their subscribed viewers that is less than 4.
2. Write a query in **SQL** that computes which viewers subscribed to the platform "`Netflix`" have an average rating for the movies they reviewed less than 3.
3. Write a query in **SQL** that computes the platforms that do not have any movie for which the average rating given by their subscribed viewers is less than 4.

Problem 4 [10%] The following conceptual schema S models the contracts between a department, a responsible manager, and a client of a service company: for each service contract, the relevant information is: *(1)* the fee charged to the client for the basic service, and *(2)* the extra cost charged to the client for each additional product delivered under the contract (the same cost for all products). Following a change decided by the company, the requirements are revised: *(i)* each department may not enter into more than 5 contracts, and *(ii)* for each contract, the different products delivered under that contract should also be modeled, and the extra cost will no longer be unique for all products, but its value may vary among such products. Show the conceptual schema resulting from the revision of schema S so as to comply with the new requirements.