

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 application related to loans granted by a bank to persons. Of each *loan*, we are interested in the code (identifier), the amount, the initial interest rate, and the person who holds the loan. Each loan is of one of the following two types: overdraft and mortgage. Of each *overdraft*, we are interested in the date it was granted, the purpose for which it was requested, and the changes in the interest rate that were applied to it, knowing that this interest rate cannot change more than once per month. Of each *mortgage*, we are interested in the year in which it began and in its duration. Some mortgages are *for the first home* and of these we are interested in the discount applied to the interest rate, if any. Of each *person* holding a loan, we are interested in the social security number (identifier), the date of birth, and the sex. Of each such person who is a *public employee* we are also interested in the profession. Finally, consider that each person cannot hold more than two mortgages and each public employee cannot hold more than one first-home mortgage.

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) loans are always accessed by choosing to access either mortgages or overdrafts, never both; (ii) whenever we access a loan, we always want to know whether it is a first-home loan or not and if so we always want to know the interest rate discount, if any.

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. [10%] the restructured relational schema (again with constraints).

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

Problem 3 [18%] Consider the relation `Deposit`(code, customer, month, year, amount), which stores deposits that a customer makes on their bank account, with the identification code of the deposit (primary key), the customer holding the account, the month and year in which the deposit was made, and the amount in Euros of the deposit.

1. Express *in SQL* a query that, given a month M of a year Y (e.g., June 2023), returns for each customer the balance of the account in month M of year Y . Notice that the balance is the sum of all deposits made by that customer up to month M of year Y .
2. Express *in SQL* a query that, for each customer and for each year, returns the month(s) in which the maximum amount for that year was deposited.
3. Express *in relational algebra* a query that, for each customer, returns the month(s) in which the customer has made at least two deposits with the same amount (where obviously a month is identified by the month number and the year).

Problem 4 [10%] Consider the relational database shown below and answer the following questions.

1. Which are the key constraints that are satisfied in the relation R (i.e., which are the keys of R)?
2. Which are the superkey constraints that are satisfied in the relation R (i.e., which are the superkeys of R)?
3. Which are the foreign key constraints that are satisfied in the database?

R				S
A	B	C	D	E
6	6	6	1	5
4	null	3	2	6
6	6	5	3	7
5	6	6	4	