1. A passage control system uses personal key cards. A card is controlled each time when one wants to pass a gate. Each control is registered as a record in table control. If the passage is denied, the reason for the denial is also registered. This reason might be, for example, a missing permission or that the number of the card could not be read. Only the persons listed in table grantor are allowed to grant permissions. Notation A->B indicated that column A is a foreign key that refers to table B. Primary keys are underlined. This system uses the following tables:

- **person** (personID, name, address, task, employeeSince, employeeUpto), 200 rows
- **keycard** (cardNo, dateAdmitted, owner->person, validFrom, expirationDate), 300 rows
- **gate** (gateNo, location), 20 rows
- **control** (cardNo->keycard, whenControlled, gateNo->gate, passageAllowed, reason), 600000 rows (for about one year)
- **permission** (permissionNo, gateNo->gate, cardNo->keycard, startingDate, endingDate, typeOfPermission, whoAdmitted->person), 2000 rows
- **grantor** (gateNo->gate, grantor->person), 60 rows

   a) Is the difference keycard – person possible and, if it is, how many rows there are in the result of the operation.

   b) Which relation has more rows \( \pi \text{ cardNo} (\text{permission}) \) or \( \pi \text{ cardNo, gateNo} (\text{permission}) \)? Justify your answer briefly.

   c) How many rows there are in the result of the join \( \text{control} \bowtie\text{keycard} \)?

   d) Columns gateNo and whenControlled form the key of table control. Could the composition of columns cardNo and whenControlled be used as the primary key as well? Justify your answer briefly.

   e) Row (gateNo:12, grantor: 12345) is deleted from table grantor. What other changes should be done in the database to preserve the referential integrity? (10p)

2. Express the following queries in SQL on the database of task 1. Specify a proper order for each result.

   a) Prepare a list of gates that have no permissions granted on them.

   b) List all the persons to whom Matti Meikäläinen has granted permissions on gate 18.

   c) For each gate list the gate number, location and the amount of currently valid permissions.

   d) Who has the most of valid permissions and how many? (16p)

*Turn the paper for tasks 3 and 4 (give their answer on a separate paper)*
3. The following diagram models the information content of a simple project management system. Design the relational database schema for this database. Express the schema using the technique of task 1. Mark the primary and the foreign keys. (9p)

4. The following schema has been designed for storing data about hotel reservations of a small hotel chain.

reservation(reservation_number, arrival_date, nights_to_stay, customer_name, customer_credit_card_no, number_of_persons, room_type, hotel_identifier, hotel_name, hotel_address)

a) Explain what would the following functional dependency mean, in practice:
   hotel_identifier -> arrival_date

b) Express as a functional dependency the rule ‘a credit card may be used to secure only one reservation on the same date’.

c) Let us assume that the following functional dependencies are valid:
   reservation_number -> arrival_date
   reservation_number -> nights_to_stay
   reservation_number -> customer_credit_card_no
   reservation_number -> number_of_persons
   reservation_number -> hotel_identifier
   reservation_number -> room_type
   customer_credit_card_no -> customer_name
   hotel_identifier -> hotel_name
   hotel_identifier -> hotel_address

   Is the table in Boyce–Codd normal form. Justify your answer briefly. (10p)

Turn for tasks 1 and 2 (use a separate answer paper for them)