University of Helsinki, Department of Computer Science
Introduction to Databases, 3.5.2007, H.Laine

- *Please, write the name of the course, your name and signature, and your student number or date of birth on each separate answer paper*
- *Use two separate answer paper, one for tasks 1 and 2 and the other for tasks 3 and 4*

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 π_{cardNo} (*permission*) or $\pi_{cardNo, gateNo}$ (*permission*)? Justify your answer briefly.

c) How many rows there are in the result of the join
   $control \bowtie_{control.cardNo=keycard.cardNo} keycard$?

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)

Use a separate answer paper for these tasks.

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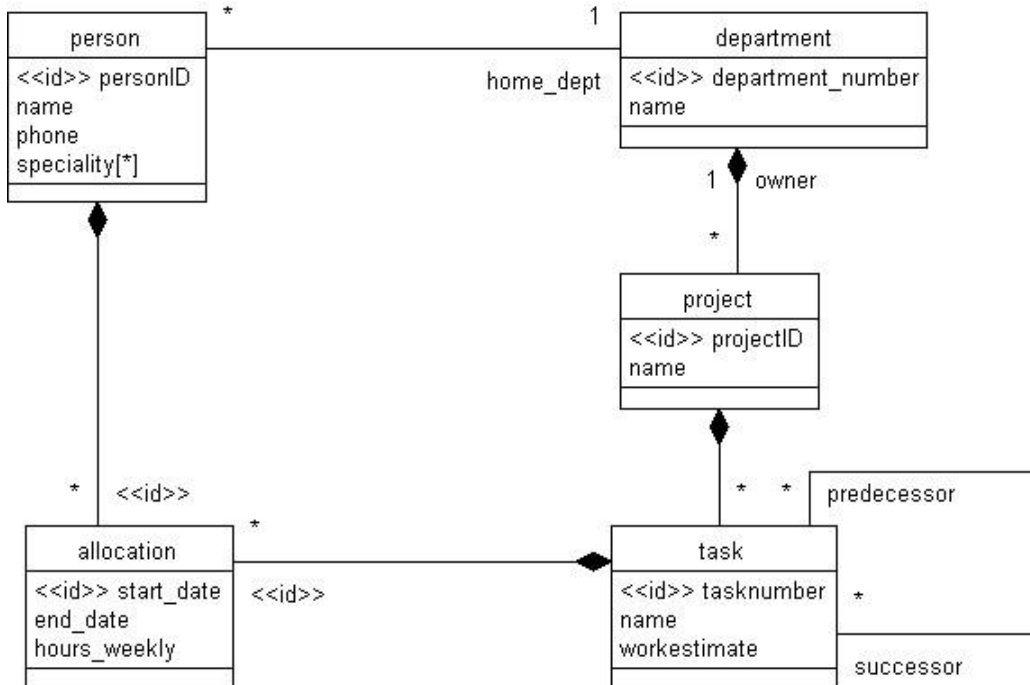
4. The following schema has been designed for storing data about hotel reservations of a small hotel chain.

```
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)

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