Assignment #1: Part I — Foundations

Due date: Tuesday Oct 14 at 6PM (in the appropriate assignment box),
Value: 10% of final marks.

HINT: Look at the solutions for the posted homeworks, and look at the examples in the book.

In this assignment you are going to solve several (slightly modified) exercises from our text book. The topic of these exercises is mainly conceptual and logical database design, and SQL queries.

1. **(Exercises 2.6 and 3.16) – 50%**. SITE frequent fliers have been complaining to Ottawa Airport officials about the poor organization at the Airport. As a result, the officials decided that all information related to the airport should be organized using a DBMS, and you have to design a database for this purpose. Your first task is to organize the information about all the airplanes stationed and maintained at the airport. The following is the relevant information:

   - Every airplane has a registration number, and is of a specific model.
   - The airport accommodates a number of airplane models, and each model is identified by a model number (e.g. B-747), as well as a capacity and weight.
   - A number of technicians work at the airport. For each of them, store his/her name, SIN, address, phone number, and salary.
   - Each technician is an expert on one or more plane model(s), and his expertise may overlap with that of other technicians. This information about technicians must also be recorded.
   - Traffic controllers have an annual medical examination. For each of them, store the date of the most recent examination.
   - All airport employees (including technicians) belong to a union. Store the union membership of each employee. You can assume that each employee is uniquely identified by a SIN.
   - The airport has a number of tests that are used periodically to ensure that airplanes are still airworthy. Each test has a Federal Aviation Administration (FAA) test number, a name, and a maximum possible score.
   - The FAA requires the airport to keep track of each time a given airplane is tested by a given technician using a given test. For each testing event, the information needed is the date, the number of hours the technician spent doing the test, and the score the airplane received on the test.

   Based on the information given above, do the following.

   (a) Draw an ER diagram for the airport database. Doing so, indicate the various attributes of each entity and relationship set; also specify the key and participation constraints for each relationship set. Specify any necessary overlap constraints. Your ER diagram should contain no more than 6 entity sets, and no more than 3 relationship sets.

   (b) Translate your ER diagram into a relational database schema by showing the SQL statements needed to create the relations, using only key and null constraints. Any constraint

from the ER diagram that you cannot capture in your SQL statements must be documented.

(c) Assume the additional constraint that only a technician who is expert on a plane model can conduct a test on that particular model. Express this using the CHECK statement.

2. **(Exercise 5.8) – 30%**: Consider the following relations with the obvious meaning:

$Student(\underline{snum : \texttt{int}}, sname : \texttt{string}, major : \texttt{string}, level : \texttt{string}, age : \texttt{int})$

$Class(\underline{cname : \texttt{string}}, meetsat : \texttt{time}, room : \texttt{string}, fid : \texttt{int})$

$Enrolled(\underline{snum : \texttt{int}, cname : \texttt{string}})$

$Faculty(\underline{fid : \texttt{int}}, fname : \texttt{string}, deptid : \texttt{int})$

Based on this schema, formulate the following queries **both** in relational algebra and in (domain) relational calculus:

(a) Find the snums of students who are enrolled in exactly two classes.

(b) Find the snums of students taking all classes.

(c) Find the snums of students taking all classes taught by Minsky.

(d) Find the names of faculty members teaching classes in rooms STE0131, but not in room STE5201.

(e) Find the names of faculty members teaching classes in rooms STE0131 or STE5201.

Also, express the following integrity constraints in SQL, unless it is implied by the appropriate primary and foreign key constraints that can be expressed on the schema above.

(a) Every faculty member must teach at least two courses.

(b) Two classes cannot meet in the same room at the same time.

(c) Each room can only accommodate one class.

(d) Every class has an enrolment of at least 10 students and at most 100 students.

(e) Every student must be enrolled in CSI3317.

Finally, express the following queries in SQL.

(a) For each class, find the total number of enrolment for that class.

(b) Find the names of students who have not enrolled in csi5311. (Use a nested query)

(c) Find the average age of students who are older than 21 for each level that contains at least 10 such students.

3. **(Exercise 5.10) – 20%**: Consider the following relations with the obvious meaning:

$Employee(\underline{eid : \texttt{int}}, ename : \texttt{string}, age : \texttt{int}, sal : \texttt{real})$

$Works(\underline{eid : \texttt{int}, did : \texttt{int}}, duration : \texttt{int})$

$Dept(\underline{did : \texttt{int}}, budget : \texttt{real}, managerid : \texttt{int})$

Based on this schema, write SQL ICs (domain, key, foreign key, or CHECK; or assertions) or SQL triggers to ensure that the following (independent) requirements are true of the instances of given database schema.

(a) No employee can make more than 1000$.

(b) The total duration of all appointments for an employee must not exceed 365.

(c) Whenever a manager is given a salary raise, her manager's salary must increase to be at least as much in case the employee's salary would go over the manager's salary.