Homework Assignment 2  
(due Monday, February 6, 2012)

- Read Sections 5.1, 5.2, 6.1, 6.2, 6.3, 6.4 of the textbook and the notes on “Logic and Database Queries” posted at the Lectures Notes page of the course webpages and also found at http://www.cs.rice.edu/~tlogic/Database/all-lectures.pdf

- Exercise 5.1.1, Exercise 5.1.4 parts a), b), and g) only; Exercise 5.1.5 part a) only; Exercise 6.2.1 parts c) and d) only;

**Problem 1:** In this problem the attributes of both $R$ and $S$ are $A, B, C$.

1. Give an example of two relations $R$ and $S$ such that under set semantics

   \[
   \pi_{A,B}(R - S) \neq \pi_{A,B}(R) - \pi_{A,B}(S).
   \]

2. Give an example of two relations $R$ and $S$ such that under set semantics

   \[
   \pi_{A,B}(R) \cap \pi_{A,B}(S) \neq \pi_{A,B}(R \cap S).
   \]

**Problem 2:** Recall the *beer drinkers* database consisting of information about drinkers, beers, and bars telling which drinkers like which beers, which drinkers frequent which bars, and which bars serve which beers and at what prices. In the previous homework assignment you had to give an appropriate relational database schema for this database.

1. Give relational algebra expressions for the following queries:

   (a) “List all bars that serve at least one beer that Joe Mug likes.”

   (b) “List all bars that serve every beer that Joe Mug likes.”

2. Give relational calculus expressions for the above two queries

3. Give SQL expressions for the above queries.

**Problem 3:** This problem is about the semijoin $R \bowtie S$ of two relations $R$ and $S$, which is the relation consisting of all tuples in $R$ that “contribute” to the join $R \bowtie S$. Semijoins play a useful role in database query processing and optimization.

More precisely, the semijoin $R \bowtie S$ of two relations $R$ and $S$ is the relation consisting of all tuples $t$ in $R$ such that there is at least one tuple in $S$ that agrees with $t$ in all attributes that $R$ and $S$ have in common.

Assume now that the attributes of $R$ are $A, B, C$ and the attributes of $S$ are $B, C, D$. Give a relational algebra expression and an SQL expression for $R \bowtie S$.

**Problem 4.** As in the first homework assignment, assume that an airline maintains a FLIGHTS database that includes a table called DIRECT with two attributes FROM and TO containing information about direct flights between two cities. Give an SQL expression for the relation AT-MOST-TWO consisting of all pairs $(c, d)$ of cities such that one can travel from city $c$ to city $d$ with at most two intermediate stops.