CS338—Computer Applications in Business: Databases
Assignment 3 (Fall 2003)
Due: November 27, 2003 in class

Question 1. Relational Algebra.

Let $R(a, b)$, $S(a, b)$ be two relations with attributes ranging over integers. Prove or provide a counterexample for the following claims:

- $\sigma_{a=1}(R - S) = \sigma_{a=1}(R) - \sigma_{a=1}(s)$
- $\pi_{\{a\}}(R - S) = \pi_{\{a\}}(R) - \pi_{\{a\}}(S)$

You can assume both R and S are sets.

Question 2. Functional Dependencies.

Suppose we have following three tuples, $(1, 2, 3)$, $(4, 2, 3)$, and $(5, 3, 3)$, that comprize a (legal) instance of a relation $R(A, B, C)$.

- Which of the following dependencies, $A \to B$, $BC \to A$, and $B \to C$, hold over R?
- Can you identify any other dependencies that hold in R?

Question 3. Reasoning with FDs.

Show each of the following:

- The *augmentation axiom*, $X \to Y \Rightarrow XZ \to YZ$, is sound;
- If in a relation R the functional dependencies $X \to A$ and $X \to B$ hold, then $X \to AB$ also holds.

Question 4. FDs and Normal Forms.

Suppose instead we have the following database for the investment company, organized as a single relation U with the following attributes: B (broker), O (office of a broker), I (investor), S (stock), Q (quantity of stock owned by an investor), and D (dividend paid by a stock). In addition we know the following functional dependencies hold: $S \to D$, $I \to B$, $IS \to Q$, and $B \to O$.

- How many candidate keys does U have? (justify your answer).
- Find a lossless-join decomposition of U into BCNF.
- Find a lossless-join dependency-preserving decomposition of U into 3NF.

Submit: written solution to all questions. Be precise and concise. It is recommended that you spend some time organizing your answer, rather than writing down ideas in the order they occur to you. The conciseness and organization of your answers will be taken into consideration in the grading.