

CMPS277 Principles of Database Systems Fall 2007  
**Homework Assignment 1**

Due in class on October 11, 2007

1. Show that every rule-based conjunctive query is satisfiable. In other words, for every rule-based conjunctive query  $Q$  that is specified over a relational database schema  $\mathcal{R}$ , there is an instance  $I$  of  $\mathcal{R}$  such that  $Q(I)$  is non-empty.
2. Let  $R$  be a binary relation scheme with attributes  $A$  and  $B$  and let  $S$  be a unary relation scheme with attribute  $C$ . Prove or disprove that  $\Pi_A(R \times S) = \Pi_A(R)$ .
3. Let  $Q_1$  and  $Q_2$  be the following two queries:

$$Q_1(y, z) : \neg R(x, y), R(x, z)$$

$$Q_2(x, y) : \neg R(x, y)$$

Show that  $Q_1$  is not equivalent to  $Q_2$ . In other words, show that either  $Q_1 \not\subseteq Q_2$  or  $Q_2 \not\subseteq Q_1$ .

4. (a) Define what it means for a query to be *monotone*.  
(b) Let  $R_1$  and  $R_2$  be two identical relation schemes and let  $r_1$  and  $r_2$  be the relations of  $R_1$  and  $R_2$  respectively. The difference of  $r_1$  and  $r_2$ , denoted as  $r_1 - r_2$ , is defined to be the set of tuples that exists in  $r_1$  but do not exist in  $r_2$ . Prove that the difference of  $r_1$  and  $r_2$  cannot be expressed with the SPCU algebra. (*Hint: Show that every SPCU query is monotone but the query  $r_1 - r_2$  is not a monotone query.*)