CIS560 – Database System Concepts   Name:_____

Homework Assignment 4 [20 points] – due September 27 at 11:59PM

1. [3 points] Consider the relation `PatientOf` and the functional dependencies below. Describe, with examples, how redundancy, update, and delete anomalies can arise.

   ```
   PatientOf (patient_no, name, address, doctor_no, since)

   patient_no → name, address
   patient_no, doctor_no → since
   ```

2. [3 points] Consider a relation with attributes R(A, B, C, D, E) that satisfies the following functional dependencies:

   ```
   AB → D
   AC → E
   BC → D
   D  → A
   E  → B
   ```

   Find all the keys that contain the attribute A.

3. [2 points] Use the definition of functional dependencies to prove that if functional dependencies

$A_1, \ldots, A_n \rightarrow B_1, \ldots, B_m$ and $C_1, \ldots, C_k \rightarrow D_1, \ldots, D_j$ hold,

then functional dependency

$A_1, \ldots, A_n, C_1, \ldots, C_k \rightarrow B_1, \ldots, B_m, D_1, \ldots, D_j$ also holds.

In the above functional dependency, we should remove one copy of any attribute that appears among both the A's and C's, and among both the B's and D's.

4. [4 points – 2 points for finding the decomposition, 2 points for identifying keys]
   Consider a relation R(A, B, C, D, E) with the following functional dependencies:
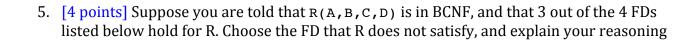
```
A   → B
A   → C
BC  → A
D   → E
```

Decompose the relation R into a collection of Boyce-Codd Normal Form (BCNF) relations. For each step, show the relation that you are decomposing and the violation of BCNF that you are using during that decomposition step. Indicate clearly your end result: the relations, their attributes, and their keys.

5. [4 points] Suppose you are told that `R(A,B,C,D)` is in BCNF, and that 3 out of the 4 FDs listed below hold for R. Choose the FD that R does not satisfy, and explain your reasoning

```
1:  A   → BCD
2:  BC  → A
3:  CD  → B
4:  D   → C
```

6. [4 points] Some of your old high-school friends have opened a new restaurant, and it has become so wildly successful that they need a computer to keep track of dinner reservations. Not knowing all that much about databases, they have created a single table to hold reservation information:

```
RESERVATION (Date, Time, Name, Phone, VIP)
```

Some customers have only made a single reservation, but many of them have multiple reservations in the table. No two customers have the same name and phone number, but some different customers have either the same name or same phone number. VIP is a boolean - true value indicates the very best customers, who receive extra special service.

a. [2 points] What are the possible key(s) and superkeys(s) for this relation? Justify your answer in terms of functional dependencies and closures.

b. [2 points] Identify any "bad" functional dependencies in the RESERVATION table and use them to decompose it into relations that are BCNF. Are all the functional dependencies preserved? Explain.