1. (FD’s) Find all the keys of the Relation R(ABCDE) with FD’s: D->C, CE->A, D->A, and AE->D. (15 pts)

2. (FD’s) Consider relation R(A,B,C,D,E) with functional dependencies AB->C, BC->D, CD->E, DE->A, and AE->B. Which FD’s hold on the projected relation

S(A,B,C,D)?

To answer this question, you will need to first derive all the FDs that follow from the given ones and then restrict to those that involve only the attributes in the projected relation. Explain your answers in detail. (18 pts)

3. Which of the following relations is or is NOT in Boyce-Codd Normal Form (BCNF)? Explain your answer in detail and decompose the relation, if it is not already in BCNF, into a collection of relations that are in BCNF. You also need to show the keys and FDs that hold in **EACH** new relation in each step of decomposition (20 pts)

a). R(ABCD) FD's: BD -> C ; AB -> D ; AC -> B ; BD -> A

b). R(ABCD) FD's: AC -> D ; D -> A ; D -> C ; D -> B

c). R(ABCD) FD's: C -> B ; D -> A ; C -> D ; A -> C

d). R(ABCD) FD's: BC -> A ; AD -> C ; CD -> B ; BD -> C

4. Consider the following functional dependencies that hold on R(ABCDEF):

AB-> CD, E -> C, B -> EF

Is R in 3NF? Explain your answer in detail and decompose the relation, as necessary, into a collection of relations that are in 3NF. Make sure you first find all the key(s) of R so that you will be able to tell whether an attribute is prime. (10 pts)

5. SQL exercises: (9 pts)

Design and implement a database schema for employees and their dependents.

a. For each employee, record his/her employee id, name, age, sex, and salary

b. For each dependent of an employee, record his/her name, age, and sex

c. Draw an E/R diagram, convert it into relational schema, and implement it with PostgreSQL.

d. Each relation/table must have a primary key.

e. Create at least one single-attribute index and one multi-attribute index.

(READ: <http://www.postgresql.org/docs/8.3/interactive/indexes-intro.html>

<http://www.postgresql.org/docs/8.3/interactive/indexes-multicolumn.html> )

f. Implement referential integrity constraints (if there is any) using foreign keys in PostgreSQL.

(READ: **Section 5.3.5** <https://www.postgresql.org/docs/9.2/static/ddl-constraints.html> )

***Bonus question***: (15 pts)

Draw an Entity-Relationship diagram that describes the contents of a typical online sales database. You may assume that each transaction is associated with a registered customer.

* Each transaction contains the date of purchase and a list of items purchased and their quantities. The purchase price for each item should be included as well.
* Each transaction also contains payment (e.g., credit card information) and shipping information such as the shipping method and cost.
* Each type of item has a unique identifier, a description, the quantity available, its original price, and its current price. NOTE: The purchase price can be different from the current price which is time variant.
* For each customer, assume the database contains his/her name, shipping address(es), billing address(es), credit card(s) information, and phone number. (NOTE: A customer may have more than one shipping/billing address and/or credit card.)

Your E-R diagram should show clearly attributes and keys for all entity sets, also multiplicities of relationships. Be sure to list any reasonable assumption you may have and identify any database-level constraint (e.g., candidate keys (if any) and multiplicity (e.g., 0…m, 1…m, 0/1, or 1) on the relationship).