Information and Database Management Systems I (CIS 4301)
(Fall 2016)

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Homework 5

Name: 
UFID: 
Email Address: 

Pledge (Must be signed according to UF Honor Code)

On my honor, I have neither given nor received unauthorized aid in doing this assignment.

______________________________________________________________________________
Signature

For scoring use only:

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Exercise 1 (Normal Forms) [26 points]

1. Consider the relation Part (part, manufacturer, seller, price) with the following functional dependencies:

   part → manufacturer;
   part, seller → price.

   (a) Keeping in mind the FDs, make an instance of this relation that has redundant information. [2 points]

   (b) If we apply the decomposition step from BCNF decomposition, what attributes would each of the new relations have? [2 points]

   (c) Project the FDs onto each of the new relations. [2 points]

   (d) Put the same data as in part (a) into your new schema. Is there any redundancy? [2 points]

2. Consider the following functional dependencies over the attribute set ABCDEFGH:

   A → E, BE → D, AD → BE, BDH → E, AC → E, F → A, E → B, D → H, BG → F, CD → A

   (a) Find a minimal cover for this set of functional dependencies. [3 points]

   (b) Decompose the relation ABCDEFGH into a lossless 3NF schema. [3 points]

   (c) Check whether your answer to (b) is in BCNF. If not, decompose it into a lossless BCNF schema. [3 points]

3. Consider a relation schema R with attributes ABCDEF GH with functional dependencies S:

   \[ S = \{ B \rightarrow CD, BF \rightarrow H, C \rightarrow AG, CEH \rightarrow F, CH \rightarrow B \} \]

   (a) Which of these functional dependencies violate BCNF? [3 points]

   (b) Employ the BCNF decomposition algorithm to obtain a lossless decomposition of R into a collection of relations that are in BCNF. Make sure it is clear which relations are in the final decomposition and project the dependencies onto each relation in that final decomposition. [3 points]

   (c) Is your decomposition dependency-preserving? Explain your answer. [3 points]
Exercise 2 (Functional Dependencies and Normal Forms) [25 points]

1. consider the relational schema \( R = \{A, B, C, D, E, F, G, H\} \) and the set of functional dependencies \( FD: \)
   \[ A \rightarrow B, B \rightarrow C, AD \rightarrow CEF, BE \rightarrow FG, CF \rightarrow GH, G \rightarrow H \]

   (a) Which of the following is a canonical cover of the FD? Choose all that apply. [2 points]
   A. The given FDs are a canonical cover.
   B. \( \{A \rightarrow B, B \rightarrow C, AD \rightarrow E, AD \rightarrow F, BE \rightarrow F, BE \rightarrow G, CF \rightarrow G, G \rightarrow H\} \)
   C. \( \{A \rightarrow B, B \rightarrow C, AD \rightarrow E, BE \rightarrow F, CF \rightarrow G, G \rightarrow H\} \)
   D. \( \{A \rightarrow B, B \rightarrow C, AD \rightarrow E, AD \rightarrow F, BE \rightarrow G, CF \rightarrow G, G \rightarrow H\} \)
   E. None of the above; the canonical cover is _______________

(b) Which of the following functional dependencies can be deduced? Choose all that apply. [2 points]
   A. \( A \rightarrow C \)
   B. \( AE \rightarrow F \)
   C. \( CE \rightarrow F \)
   D. \( BDE \rightarrow AG \)

(c) True or False: The attribute closure \( \{B\}^+ \) is \( \{B, C, F\} \). [1 point]

(d) True or False: The attribute closure \( \{AD\}^+ \) is \( \{A, B, C, D, E, F, G\} \). [1 point]

(e) True or False: ABD is a candidate key of R. [1 point]

2. Consider the relation \( S(ABCDE) \). Let the following functional dependencies be defined over the relation \( S: \)
   \[ A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A \]

   (a) Identify whether this relationship in 3NF and BCNF? [2 points]

   (b) Provide the projection of FDs for the subset of attributes \( \{ABD\} \). [2 points]

   (c) Give a BCNF decomposition of \( S \) that is lossless. [2 points]

   (d) Is your BCNF decomposition dependency preserving? [2 points]

   (e) Give a 3NF decomposition of \( S \) that is lossless and dependency preserving. [2 points]
3. Suppose we have a relation schema $R(A, B, C, D, E, F, G)$ and a set of functional dependencies $F = \{BCD \rightarrow A, BC \rightarrow E, A \rightarrow F, F \rightarrow G, C \rightarrow D, A \rightarrow G, A \rightarrow B\}$. Decompose $R$ into 3NF. Show all steps and argue precisely. Is this decomposition also in BCNF? If so, why. If not, why not? [8 points]
Exercise 3 (Triggers) [26 points]

Considering the following tables in a database:

```
CREATE TABLE EMP(
    EMPNO      NUMBER(4) NOT NULL,
    ENAME      VARCHAR2(10),
    JOB        VARCHAR2(9),
    MGR        NUMBER(4),
    HIREDATE   DATE,
    SAL        NUMBER(7, 2),
    COMM       NUMBER(7, 2),
    DEPTNO     NUMBER(2));

CREATE TABLE DEPT(
    DEPTNO     NUMBER(2),
    MGRNO      NUMBER(2),
    DNAME      VARCHAR2(14),
    LOC        VARCHAR2(13));

CREATE TABLE BONUS(
    ENAME      VARCHAR2(10),
    JOB        VARCHAR2(9),
    SAL        NUMBER,
    COMM       NUMBER);

CREATE TABLE SALGRADE(
    GRADE      NUMBER,
    LOSAL      NUMBER,
    HISAL      NUMBER);

CREATE TABLE GRADENUM(
    GRADE      NUMBER,
    NUM        NUMBER,
    HIGH       NUMBER);
```

1. Add a constraint to table 'EMP' that checks whether 'DEPTNO' refers to column 'DEPTNO' in table 'DEPT'. The constraint should also guarantee that once a department in the 'DEPT' table is deleted, the employee records of that department in table 'EMP' are also deleted. [3 points]

2. Create a constraint that checks the attribute 'SAL' of table 'EMP' whether the salary of employees is higher than 2000 and lower than 10000. Also, create a primary key constraint on the empno and create a constraint on the ename to be unique. [3 points]
3. Create a trigger that displays the employees' average salary, before an employee's record in table 'EMP' is updated or before new employee’s record is inserted. [5 points]

4. Create a trigger that sets the value of 'COMM' in table 'EMP' equal to the value of 'COMM' in 'BONUS' for employees whose bonus record is updated in table 'BONUS'. If the employee is not in the 'EMP' table, insert a new record into the 'EMP' table with that employee's name, set 'EMPNO' to the current highest 'EMPNO' + 1, and leave the other columns as null. [5 points]

5. Create a trigger that does the following: If a department’s deptno is updated then update the employees’ depno also who works for the department. [5 points]

6. Create a trigger that does the following: When the employees’ salary is modified (less than before or more than 20%), then display the error message. [5 points]
**Exercise 4 (Function, Block and Procedure)** [23 points]

We assume the same database schema as in Exercise 4.

1. Create a function that calculates the summation of all employees' salaries of a given department.
   
   input: PDNAME: department name
   return: SUM_SAL: summation of all employees' salaries

   Then write an anonymous block to call your function and output the result. [6 points]

2. Write a block which updates the 'EMP' table. If an employee's salary is less than 3000, then increase his salary by 5 percent, and output the employee’s name, original salary and new salary. Make use of the cursor concept. [5 points]

3. Create a procedure that takes department number and changes the manager for the department to the employee in the department with highest salary. [6 points]

4. Write a procedure which first groups the salaries of employees. If one's salary falls into a salary boundary bounded by 'LOSAL' and 'HISAL' in table 'SALGRADE', then we consider this employee in the group of this 'GRADE'. Then insert records to table 'GRADENUM', set 'NUM' as the number of employees whose salary fall into its boundary. If 'NUM' > 3, set 'HIGH' = 1, otherwise, set 'HIGH' = 0. [6 points]