

**CS3431: B-Term, 2013**  
**Homework 3: Functional Dependency and Normalization**

**Due Date:** Dec. 16, 2013 (3:00 PM)

**Problem 1 [15 Points]**

Consider a relation with schema  $R(A, B, C, D)$  and FD's:  $AB \rightarrow C$ ,  $C \rightarrow D$ , and  $D \rightarrow A$ .

1. **(5 Points)** Report **five** nontrivial FD's that can be derived from the given FD's.
2. **(5 Points)** Find the attribute closure for the following attribute sets:  $\{AD\}$ ,  $\{C\}$ ,  $\{AB\}$
3. **(5 Points)** What are all the candidate keys of  $R$ ?

**Problem 2 [50 Points]**

For each relational schema given below and its corresponding functional dependencies (FDs):

- $R(A, B, C, D)$ :  $AB \rightarrow C$ ,  $C \rightarrow D$  and  $D \rightarrow A$
- $R(A, B, C, D)$ :  $AB \rightarrow C$ ,  $BC \rightarrow D$  and  $CD \rightarrow A$  and  $AD \rightarrow B$
- $R(A, B, C, D, E)$ :  $AB \rightarrow C$ ,  $C \rightarrow D$ ,  $D \rightarrow B$  and  $D \rightarrow E$

answer the following questions (for each of the above three cases separately):

1. **(10 Points)** find all candidate keys of the relation.
2. **(10 Points)** Given the keys you defined in the previous step, find the functional dependencies (from the given ones) that violate BCNF.
3. **(10 Points)** Decompose the relations to satisfy BCNF. Specify which FD is used to make the decomposition. If there is multi-step decomposition, then indicate each step along with which FD used for the decomposition.
4. **(10 Points)** Given the keys you defined in Step 1, find the functional dependencies (from the given ones) that violate 3NF.
5. **(10 Points)** Decompose the relations to satisfy 3NF. Specify which FD is used to make the decomposition. If there is multi-step decomposition, then indicate each step along with which FD used for the decomposition.

Department	Surname	FirstName	Address
Sales	Eastland	Fred	6 High Street
Purchasing	Eastland	Fred	6 High Street
Accounts	Watson	Ethel	27 Acacia Avenue
Personnel	Eastland	Sydney	27 Acacia Avenue

Table 1: Relation for Problem 3

### Problem 3 [25 Points]

Consider the relation in Table 1.

- (10 Points) Indicate whether each of the following decompositions is **Lossy** or **Lossless** and state why?
  - Department* and *Surname* are in one relation and *Surname*, *FirstName*, and *Address* are in another relation.
  - Department*, *FirstName*, and *Surname* are in one relation and *FirstName*, and *Address* are in another relation.
- (15 Points) From the data in Table 1, identify the set of functional dependencies that hold. Then, specify which of the following decompositions preserve the dependencies and state why?
  - Department*, *FirstName*, and *Surname* are in one relation and *Surname*, and *Address* are in another relation.
  - Department*, *FirstName*, and *Surname* are in one relation and *Surname*, *FirstName*, and *Address* are in another relation.

**Grading:**

The maximum grade is 90 Points. Late submissions follow the rules stated on the website.

**Deliverables:**

Each student should deliver a report containing the required solution.

**Submission:**

Submit a hardcopy in the beginning of the class (3:00PM), or submit electronically via [blackboard.wpi.edu](http://blackboard.wpi.edu) website (Electronic submission is recommended).