CS3431: B-term, 2011
Homework 3: Functional Dependency and Normalization

Due Date: Nov. 22, 2011 (8:00AM))

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*? Prove your answer (Prove it is a minimal key in the relation).

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:

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.

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.

2. **(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.

Problem 4 [10 Points]

Consider the attribute set R = (A, B, C, D) and the FD set = $\{AB \rightarrow C, AC \rightarrow B, B \rightarrow D, BCD \rightarrow A\}$.

Compute the canonical cover for the given set of dependencies and identify which attributes and/or FDs can be removed.

Grading:
The maximum grade is 100 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 (8:00AM), or submit electronically via blackboard.wpi.edu website.