Experiment 1.4

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Semester: 5th
Date of Performance: 10 Sep 2025
Subject Name: ADBMS
Subject Code: 23CSP-333

1. **Problem Title:** Functional Dependency And Keys.
2. **Problem Description:** In relational databases, keys are established based on functional dependencies (FDs). A super key refers to any group of one or more attributes that can uniquely identify a tuple in a relation. Specifically, if a set of attributes XXX functionally determines all the attributes in the relation (X→RX \to RX→R), then XXX is considered a super key. Among super keys, candidate keys are the minimal ones—no subset of these keys can still uniquely identify all attributes in the relation. One candidate key is chosen as the primary key, which acts as the primary identifier for tuples in the relation. When a key consists of multiple attributes, it's known as a composite key. This happens when the combination of those attributes can uniquely determine all other attributes, but no single attribute in the set can do so alone. In summary, super keys ensure uniqueness, candidate keys are the minimal super keys, the primary key is the chosen candidate key, and composite keys are formed by combining multiple attributes.
3. **Questions:**
   a. Consider a relation R having attributes as R(ABCD), functional dependencies are given below: **AB->C, C->D, D->A.** Identify the set of candidate keys possible in relation R. List all the set of prime and non prime attributes.
   Ans)

Given: R(A,B,C, D); ***FD:*** AB->C, C->D, D->A.

AB+ = ABCD
BC+ = CBDA
DB+ = DBAC

Ckeys = {AB,BC,DB} PA={A,B,C,D} NPA={}
Normalisation: 3NF because (X is a super key or candidate key OR Y is a prime attribute) (If all attributes comes out to be prime – R is in 3NF).

b. Relation R(ABCDE) having functional dependencies as: A->D, B->A, BC->D, AC>BE. Identify the set of candidate keys possible in relation R. List all the set of prime and non prime attributes.

Ans)

Given: R(A,B,C, D, E); ***FD:*** A->D, B->A, BC->D, AC->BE.

CA+ = DCABE

CB+ = CBADE

Ckeys = {CA,CB} PA={A,C,D} NPA={B}

Normalisation: 1NF because (X is a subset of candidate key AND Y is non-prime attribute) – then R is not in 2NF.

c. Consider a relation R having attributes as R(ABCDE), functional dependencies are given below: B->A, A->C, BC->D, AC->BE. Identify the set of candidate keys possible in relation R. List all the set of prime and non prime attributes.

Ans)

Given: R(A,B,C, D, E); ***FD:*** B->A, A->C, BC->D, AC->BE.

A+ = DCABE

B+ = CBADE

Ckeys = {A,B} PA={A,B} NPA={C,D,E}

Normalisation: BCNF or 3.5NF because (All the FD in X is super key or candidate key).

d. Consider a relation R having attributes as R(ABCDEF), functional dependencies are given below: A->BCD, BC->DE, B->D, D->A. Identify the set of candidate keys possible in relation R. List all the set of prime and non prime attributes.

Ans)

Given: R(A,B,C, D, E, F); ***FD:*** A->BCD, BC->DE, B->D, D->A

FB+ = BDACEF

FD+ = DABCEF

Ckeys = {FB,FD} PA={A,D,F,B} NPA={C,E}

Normalisation: 1NF because (X is a subset of candidate key AND Y is non-prime attribute) – then R is not in 2NF.

e. Designing a student database involves certain dependencies which are listed below: X ->Y, WZ ->X, WZ ->Y, Y ->W,Y ->X, Y ->Z. The task here is to remove all the redundant FDs for efficient working of the student database management system.

Ans)

Given: R(W, X, Y, Z); ***FD:*** X ->Y, WZ ->X, WZ ->Y, Y ->W,Y ->X, Y ->Z.

Redundant: WZ ->X, WZ ->Y

Since X -> Y so we can write WZ ->Y.

FD': X ->Y, WZ ->Y, Y ->W, Y ->X, Y ->Z.

X+ = YWXZ

Y+ = WXZY

WZ+ = WZYX **Ckeys**

= {X,Y,WZ} PA={X,Y,WZ} NPA={ }

Normalisation: BCNF because (All the FD in X is super key or candidate key).

f. Debix Pvt Ltd needs to maintain database having dependent attributes ABCDEF. These attributes are functionally dependent on each other for which functionally dependency set F given as: **{A -> BC, D -> E, BC -> D, A -> D}** Consider a universal relation R1(A, B, C, D, E, F) with functional dependency set F, also all attributes are simple and take atomic values only. Find the highest normal form along with the candidate keys with prime and non-prime attribute.

Ans)

Given: R(A,B,C,D,E,F); ***FD:*** A -> BC, D -> E, BC -> D, A -> D**. AF+**
= AFDBCE

Ckeys = {AF} PA={A,F} NPA={B,C,D,E }

Normalisation: 1NF because (X is a subset of candidate key AND Y is non-prime attribute) – then R is not in 2NF.