Experiment – 1.4

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Aim: To analyze given relations with functional dependencies, determine candidate keys, classify prime and non-prime attributes, remove redundant dependencies, and identify the highest normal form of the relation schemas.

Objective: The objective of this work is to analyze functional dependencies in given relations to determine candidate keys and classify attributes as prime or non-prime. It also focuses on minimizing functional dependencies by removing redundancy and evaluating the highest normal form achieved by each relation. Through this, the study aims to enhance understanding of normalization concepts for efficient and reliable database design.

Q1Question:
For relation R(A,B,C,D) with FDs {AB→C, C→D, D→A}, find candidate keys, prime and non-prime attributes. Also state the highest normal form.

Dependencies: AB→C, C→D, D→A

Solution:

- Candidate Keys: **AB, BC, BD**
- Prime Attributes: **A, B, C, D**
- Non-Prime Attributes: **Ø**

Explanation:
AB+ = {A,B,C,D}, BC+ = {B,C,D,A}, BD+ = {B,D,A,C}. All attributes are prime.

Highest Normal Form = **3NF** (C→D violates BCNF but is allowed in 3NF since D is prime).

Q2Question:
For relation R(A,B,C,D,E) with FDs {A→D, B→A, BC→D, AC→BE}, find candidate keys, prime and non-prime attributes. Also state the highest normal form.

Dependencies: A→D, B→A, BC→D, AC→BE

Solution:
- Candidate Keys: **AC, BC**
- Prime Attributes: **A, B, C**
- Non-Prime Attributes: **D, E**

Explanation:
AC+ = {A,B,C,D,E}, BC+ = {B,C,A,D,E}. Both are keys. Non-primes {D,E} depend only on part of key (A), so violates 2NF.

Highest Normal Form = **1NF**.

Q3Question:
For relation R(A,B,C,D,E) with FDs {B→A, A→C, BC→D, AC→BE}, find candidate keys, prime and non-prime attributes. Also state the highest normal form.

Dependencies: B→A, A→C, BC→D, AC→BE

Solution:
- Candidate Keys: **A, B**
- Prime Attributes: **A, B**
- Non-Prime Attributes: **C, D, E**

Explanation:
A+ = {A,C,B,E,D}, B+ = {B,A,C,D,E}. Both generate full set. Since all LHS are keys, no violations.

Highest Normal Form = **BCNF**.

Q4Question:
For relation R(A,B,C,D,E,F) with FDs {A→BCD, BC→DE, B→D, D→A}, find candidate keys, prime and non-prime attributes. Also state the highest normal form.

Dependencies: A→BCD, BC→DE, B→D, D→A

Solution:
- Candidate Keys: **AF, BF, DF**
- Prime Attributes: **A, B, D, F**
- Non-Prime Attributes: **C, E**

Explanation:
A+ = {A,B,C,D,E}, missing F → AF is key. Similarly BF and DF. Partial dependencies (A→C,E) mean it fails 2NF.

Highest Normal Form = **1NF**.

Q5Question:
For relation R(W,X,Y,Z) with FDs {X→Y, WZ→X, WZ→Y, Y→W, Y→X, Y→Z}, find candidate keys, prime and non-prime attributes, minimal cover, and highest normal form.

Dependencies: X→Y, WZ→X, WZ→Y, Y→W, Y→X, Y→Z

Solution:
- Minimal Cover: **{X→Y, WZ→X, Y→W, Y→Z}**
- Candidate Keys: **X, Y, WZ**
- Prime Attributes: **W, X, Y, Z**
- Non-Prime Attributes: **∅**
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Explanation:
Y+ = {Y,W,X,Z}, X+ = {X,Y,W,Z}, WZ+ = {W,Z,X,Y}. All attributes are prime.

Highest Normal Form = **BCNF** (all FDs have LHS as key).

Q6Question:
For relation R1(A,B,C,D,E,F) with FDs {A→BC, A→D, BC→D, D→E}, find candidate keys, prime and non-prime attributes. Also state the highest normal form.

Dependencies: A→BC, A→D, BC→D, D→E

Solution:

- Candidate Key: **AF**
- Prime Attributes: **A, F**
- Non-Prime Attributes: **B, C, D, E**

Explanation:

A+ = {A,B,C,D,E}, missing F → AF is key. Non-primes depend only on part of key, violating
2NF.
Highest Normal Form = **1NF**.

Learning Outcomes

After completing these questions, students will be able to:

1. Apply closure method to find candidate keys.
2. Differentiate prime and non-prime attributes in a relation.
3. Detect and eliminate redundant functional dependencies.
4. Identify the highest normal form of a given relation schema.
5. Improve conceptual clarity of normalization for efficient database design.