Worksheet 4

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Semester: 5TH **Date of Performance:08/09/25**
Subject Name: ADBMS **Subject Code:23CSP-333**

FUNCTIONAL DEPENDENCIES -

Q1. 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.

Sol: -
B is missing on the right-side of given functional dependencies, so it is sure that it must be the part of every candidate key.
Closures: -
$AB^+ = \{A, B, C, D\} \rightarrow$ AB is a key.

$BC^+ = \{A, B, C, D\} \rightarrow$ BC is a key.

$BD^+ = \{A, B, C, D\} \rightarrow$ BD is a key.

Candidate keys: - (BA, BC, BD)

Prime attributes: - A, B, C, D

Non-prime attributes: -
None

Normal Form: 3NF

Q2. 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.

Sol: -

C is missing on right-side so it must be a part of every candidate key.

Closures-

AC+= {A, B, C, D, E} ⇒ **AC** is a key

BC+= A, B, C, D, E} ⇒ **BC** is a key

Candidate keys: - (AC, BC)

Prime Attributes: - A, B, C

Non-prime Attributes: - D, E

Normal Form: 1NF

Q3. 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.

Sol: -

Closures -

A+= {A, C, B, E, D} = {A, B, C, D, E}. ⇒ **A** is a key

B+={A, B, C, D, E} ⇒ **B** is a key

Any superset of A or B is a super key but not minimal. No other single attribute has a closure of all attributes (e.g. C+C^+C+ doesn't expand). So, there are no other candidate keys.

Candidate keys: - (A, B)

Prime attributes: - A, B

Non-prime attributes: - C, D,
E

Normal Form: BCNF

Q4. 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.

Sol: -

Closures-

AF+= {A, B, C, D, E, F ⇒ **AF** is a key.

BF+= {A, B, C, D, E, F} ⇒ **BF** is a key.

DF+= {A, B, C, D, E, F} ⇒ **DF** is a key.

Check minimality: none of A, B, or D alone determine F; F alone does not determine the rest. Thus AF, BF and DF are minimal (no proper subset is a key).

Candidate Keys: - (AF, BF, DF)

Prime attributes: - A, B, D, F

Non-prime attributes: - C, E

Normal form: - 1 NF

5. Designing a student database involves certain dependencies which are listed below: X ->Y
WZ ->X
WZ ->Y
Y ->W
Y ->X
Y ->Z
Identify the set of candidate keys possible in student database. List all the set of prime and non prime attributes.

Sol: -

Closures: -

X+= {X, Y, W, Z} ⇒ X determines all attributes.

Y+= {Y, W, X, Z} ⇒ **Y** determines all attributes.

WZ+= {W, Z, X, Y} ⇒ **WZ** determines all attributes.

Singletons W+ and Z+ do **not** expand to all attributes (no FD gives others from W or Z alone), so W and Z are not keys individually.
WZ is a key and minimal because neither WWW nor ZZZ alone is a key.

Candidate keys: - (X, Y, WZ)

Prime attributes: - X, Y, W, Z

Normal Form: BCNF

6. 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.

Sol: -

A does **not** appear on any RHS → A cannot be determined by other attributes → **A must be in every candidate key**.
F does **not** appear on any RHS → F cannot be determined by other attributes → **F must be in every candidate key**.
So every candidate key must include both **A** and **F**.

Closures: -

- A+= {A, B, C, D, E}, A+ does not include FFF.
- AF+= A+∪{F} = {A, B, C, D, E, F}. Hence AF determines all attributes → AF is a super key.

Minimality: neither AAA alone nor FFF alone is a key, so AF is minimal.

No other minimal combination can omit either A or F (both are required), so AF is the only candidate key.

Candidate key: -(AF)

Prime attributes: -A, F

Non-prime attributes: -
B,C, D, E

Normal Form: - 1NF