EXPERIMENT - 4

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1. **Consider a relation R having attributes as R(ABCD), functional dependencies are given below:s**
   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:

Closure of {A, B}:
(AB)+ = {A, B} → {A, B, C} → {A, B, C, D}
Therefore, {A, B} is a candidate key.

Closure of {B, C}:
(BC)+ = {B, C} → {B, C, D} → {A, B, C, D}
Therefore, {B, C} is a candidate key.

Closure of {B, D}:
(BD)+ = {B, D} → {A, B, D} → {A, B, C, D}
Therefore, {B, D} is a candidate key.

Candidate Keys: {A, B}, {B, C}, {B, D}
Prime Attributes: {A, B, C, D}
Non-Prime Attributes: None

2. **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:

Closure of {A, C}:
(AC)+ = {A, C} → {A, C, B, E} → {A, B, C, D, E}
Therefore, {A, C} is a candidate key.

Closure of {B, C}:
(BC)+ = {B, C} → {B, C, D} → {A, B, C, D} → {A, B, C, D, E}
Therefore, {B, C} is a candidate key.

Check singletons and smaller sets (quick):
A+ = {A, D}
B+ = {B, A, D}
C+ = {C}
D+ = {D}
E+ = {E}
None are keys.

Candidate keys: {A, C}, {B, C}
Prime attributes (appear in some key): {A, B, C}
Non-prime attributes: {D, E}

3. **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:

Closure of {A}:
(A)+ = {A} -> {A, C} -> {A, C, B, E} -> {A, B, C, D, E}
Therefore, {A} is a candidate key.

Closure of {B}:
(B)+ = {B} -> {B, A} -> {B, A, C} -> {B, A, C, E} -> {A, B, C, D, E}
Therefore, {B} is a candidate key.

Quick check of other singletons:
C+ = {C}
D+ = {D}
E+ = {E}
None are keys.

Candidate keys: {A}, {B}
Prime attributes: {A, B}
Non-prime attributes: {C, D, E}

4. **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:

Relation R(A,B,C,D,E). FDs: A → B C D, BC → D E, B → D, D → A

Closure of {A}:
(A)+ = {A} → {A, B, C, D} → {A, B, C, D, E}
Therefore, {A} is a candidate key.

Closure of {B}:
(B)+ = {B} → {B, D} → {A, B, C, D} → {A, B, C, D, E}
Therefore, {B} is a candidate key.

Closure of {D}:
(D)+ = {D} → {A, D, B, C} → {A, B, C, D, E}
Therefore, {D} is a candidate key.

(For reference) Closure of {B, C}:
(BC)+ = {B, C} → {B, C, D, E} → {A, B, C, D, E}
⇒ {B, C} is a superkey but not minimal (B alone is a key).

Candidate keys: {A}, {B}, {D}
Prime attributes (appear in some key): {A, B, D}
Non-prime attributes: {C, E}

5. **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:

Step 1 — ensure single attribute on RHS
(All FDs already have single RHS; no splitting needed.)

Step 2 — remove redundant FDs

1. Test Y → X for redundancy:
   Compute (Y)+ using other FDs (exclude Y → X):
   (Y)+ = {Y} → {Y, W} (by Y → W) → {Y, W, Z} (by Y → Z) → {Y, W, Z, X} (by WZ → X)
   X ∈ (Y)+ even without Y → X ⇒ Y → X is redundant → remove it.

2. Test WZ → Y for redundancy:
   Compute (WZ)+ using other FDs (exclude WZ → Y):
   (WZ)+ = {W, Z} → {W, Z, X} (by WZ → X) → {W, Z, X, Y} (by X → Y)
   Y ∈ (WZ)+ even without WZ → Y ⇒ WZ → Y is redundant → remove it.
3. Re-check remaining FDs for redundancy / extraneous LHS attributes:
   Remaining FDs: X → Y, WZ → X, Y → W, Y → Z.
   - None of X → Y, WZ → X, Y → W, Y → Z is implied by the others.
   - For WZ → X, test W (or Z) extraneous: (Z)+ = {Z} and (W)+ = {W} — neither gives X, so both W and Z are needed.

Final minimal set of FDs
X → Y
WZ → X
Y → W
Y → Z

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.

Ans:

Step 1 — Closures

- A+ = {A} → {A, B, C} → {A, B, C, D} → {A, B, C, D, E}
  A+ = {A, B, C, D, E} (F missing)
- (A,F)+ = {A, F} → {A, B, C, D, E, F}
  (A,F)+ = all attributes ⇒ {A, F} is a key.

Observation:

• A never appears on RHS ⇒ A must be in every key.

• F never appears on RHS ⇒ any key must include F.
⇒ every key must contain A and F. Since AF is a key and minimal, AF is the only candidate key.

Step 2 — Prime / Non-prime

- Candidate key(s): {A, F}
- Prime attributes (in some key): {A, F}
- Non-prime attributes: {B, C, D, E}

Step 3 — Highest Normal Form

- 1NF: satisfied (atomic attributes).
- 2NF: fails because A → B,C,D (A is proper subset of candidate key AF) gives partial dependency of non-prime attrs on part of the key.
- Therefore highest NF = 1NF.

Final:

- Candidate key: {A, F}
- Prime attributes: {A, F}
- Non-prime attributes: {B, C, D, E}
- Highest normal form: 1NF (not in 2NF due to A → B,C,D).