# BSCCS2001: Practice Solutions
Week 5

1. Consider the following [MCQ: 2 points]
$X = \{A \to BC, B \to A, C \to A\}$
$Y = \{A \to B, B \to C, C \to A\}$

- ◯ $X$ covers $Y$
- ◯ $Y$ covers $X$
- ◯ $X$ and $Y$ are equivalent
- √ All the above

**Solution:** Let us check $X$ covers $Y$, every functional dependency in $Y$ logically implies in $X$.
FDs in $Y$ : $A \to B$, $B \to C$, $C \to A$
check for $A \to B$,
$A^+ \to ABC$ $\{A \to BC \text{ in } X\}$
Check for $B \to C$
$B^+ \to BAC$, $\{A \to BC, B \to A \text{ in } X\}$
Check for $C \to A$
$C^+ \to CAB$ $\{C \to A, A \to BC \text{ in } X\}$
**Therefore, $X$ covers $Y$**
Let us now check, If $Y$ covers $X$
FDs in $X$: $A \to BC$, $B \to A$, $C \to A$
Check for $A \to BC$
$A^+ \to ABC$ $\{A \to B,\ B \to C \text{ in } Y\}$
Check for $B \to A$
$B^+ \to BCA$ $\{B \to C,\ C \to A \text{ in } Y\}$
Check for $C \to A$
$C^+ \to A$ $\{C \to A \text{ in } X\}$
**Therefore, $Y$ covers $X$**
**Since, both $X$ & $Y$ covers each other, so they are equivalent $X \equiv Y$**

2. Consider relation **R**$(A,B,C,D,E,F)$ with the following functional dependencies:

$$\mathcal{F} = \{AB \rightarrow C, AC \rightarrow E, EF \rightarrow D, AB \rightarrow F\}$$

[MSQ: 2 points]

Which among the following is true about $R$?

- ◯ *R1(D, E, F), R2(A, B, C, E, F)* is a lossy decomposition of $R$.
- √ *R1(A, B, D), R2(C, E, F)* is a lossy decomposition of $R$.
- ◯ *R1(A, D, E, C), R2(B, E, C)* is a lossless decomposition of $R$.
- √ *R1(D, E, A, B), R2(C, F, B)* is a lossy decomposition of $R$.

**Solution:**

This problem will be solved in the *Solve With the Instructor* session.

3. Consider relation **T20WC** defined as **W***(Team, Ranking, Captain, Points, Players)* with the following functional dependencies:

$$\mathcal{F} = \{Team, Ranking \rightarrow Captain, Ranking \rightarrow Players, Captain \rightarrow Points\}$$

Then, which of the following is true ? [MCQ:2points]

- ◯ *W1(Team, Ranking, Captain)*, *W2(Captain, Points)* is a lossless-join decomposition.
- √ *W1(Team, Ranking, Captain)*, *W2(Points, Players)* is a lossy-join decomposition
- ◯ *W1(Team, Ranking, Captain)*, *W2(Ranking, Points, Players)* is a lossless-join decomposition.
- ◯ None of the above

**Solution:**
Option 1 : *W1(Team, Ranking, Captain)*, *W2(Captain, Points)*
$W1 \cup W2 \neq W$
Thus, it is lossy join decomposition.
Option 2 : *W1(Team, Ranking, Captain)*, *W2(Points, Players)*
$W1 \cup W2 = W$
$W1 \cap W2 = \phi$
Thus, it is lossy join decomposition. So, option 2 is correct
Option 3 : *W1(Team, Ranking, Captain)*, *W2(Ranking, Points, Players)*
$W1 \cup W2 = W$
$W1 \cap W2 = Ranking$
$Ranking^{+} \rightarrow Ranking, Players$
*Ranking* is not superkey for any relation. Hence, we can't determine $W1$ and $W2$ from it. So, it is lossy decomposition.

# Numerical Answer Type

4. Consider the relation **Book***(Author, Publisher, Pages, Ratings, Type)* having the following functional dependencies : [NAT: 2 points]
   $\mathcal{F}$= $\{$ $Author \rightarrow Publisher, Pages$
   $Publisher \rightarrow Ratings$
   $Pages, Ratings \rightarrow Type$
   $Type \rightarrow Author$ $\}$
   What is the maximum number of candidate keys for **Book**?

   Ans : 4

   **Solution:** By estimating the closure of all combination of attributes, it can be observed that the closure of the following attributes produces all other attributes:
   $Author, Type, (Publisher, Pages), (Pages, Ratings)$.
   Hence, these 4 are the candidate keys.

5. In a relation **R**$(A,\ B,\ C,\ D,\ E)$, each attribute is a candidate key. Then, what is the maximum number of super keys possible for **R**?

[NAT: 2 points]

Ans: 31

**Solution:** Consider a relation $R(A_1, A_2, A_3.....A_n)$, then maximum number of super keys are $2^n$-1. (If Each attribute of a relation is candidate key)
Here, n = 5, so, the number of super keys for a given relation $R$ is 31.

6. Which among the following is/are the use(s) of finding closure of attributes? [MSQ: 2 points]

    ◯ Find if an attribute or set of attributes is a superkey.

    ◯ Compute the canonical cover of a given set of functional dependencies

    ◯ Test if a specific functional dependency holds

    ◯ Compute the closure of a given set of functional dependencies

    √ All the above

**Solution:** The solution follows from the lectures.

7. Let $\mathbf{R}(A, B, C, D, E)$ be a relation with the following functional dependencies:

$$\mathcal{F} = \{A \rightarrow C, A \rightarrow B, C \rightarrow D, BC \rightarrow E\}$$

[MCQ: 2 points]

Then,

- ◯ $\mathcal{F}^+ = \{A \rightarrow C, A \rightarrow B, C \rightarrow D, BC \rightarrow E\}$
- ◯ $\mathcal{F}^+ = \{A \rightarrow C, A \rightarrow B, C \rightarrow D, A \rightarrow D, BC \rightarrow E\}$
- ◯ $\mathcal{F}^+ = \{A \rightarrow BC, C \rightarrow D, BC \rightarrow E\}$
- √ $\mathcal{F}^+ = \{C \rightarrow D, BC \rightarrow E, A \rightarrow BCDE\}$

**Solution:** This problem will be solved in the *Solve With the Instructor* session.

8. Let $\mathbf{R}(A, B, C, D, E)$ be a relation with the following functional dependencies:

[MCQ: 2 points]

$\mathcal{F} = \{A \rightarrow B, C \rightarrow D, BD \rightarrow E\}$
Then, which of the following functional dependencies can be derived from $\mathcal{F}$ using Armstrong's Axioms?

- √ $AC \rightarrow E$
- ◯ $BE \rightarrow D$
- ◯ $B \rightarrow A$
- ◯ $C \rightarrow E$

**Solution:**
$A \rightarrow B$
$AC \rightarrow BC$ {Augmentation}
$C \rightarrow D$
$BC \rightarrow BD$ {Augmentation}
$BD \rightarrow E$
$AC \rightarrow E$ {Transitivity}

9. Choose the correct canonical cover of the set of functional dependencies $\mathcal{F}$ that occur in a relation $\mathbf{R}(A, B, C, D)$, where

$$\mathcal{F} = \{A \to BC, AB \to C, A \to D, D \to C\}$$

[MCQ: 2 points]

- ○ $A \to BC, AB \to C$
- ○ $A \to BC, AB \to C, A \to D$
- √ $A \to B, A \to D, D \to C$
- ○ $A \to B, B \to C, A \to D$

**Solution:** Given $A \to BC, AB \to C, A \to D, D \to C$.
$A \to D, D \to C \Rightarrow A \to C$
That is, in the FD $A \to BC$, $A \to C$ is redundant.
Hence we can remove $A \to C$ from $A \to BC$.

$$\mathcal{F} = \{A \to B, AB \to C, A \to D, D \to C\}$$

Since $A \to C$ is a stronger constraint than $AB \to C$ and since $A \to C$ can be derived from $A \to D, D \to C$, we can remove $AB \to C$ from $\mathcal{F}$.
Therefore

$$\mathcal{F} = \{A \to B, A \to D, D \to C\}$$

10. Choose the set of FDs equivalent to:

$$A \to BC, B \to CE, C \to ED$$

[MSQ: 2 points]

- $\surd$ $A \to BE, B \to CD, C \to ED$
- ◯ $A \to B, B \to D, C \to E$
- $\surd$ $A \to B, B \to C, C \to ED$
- ◯ $A \to B, B \to C, C \to D, D \to A$

**Solution:**

This problem will be solved in the *Solve With the Instructor* session.

11. Given the relation **hospital** and its decomposition into **hosp1** and **hosp2** as shown in Figure 1, choose the correct set of options. [MCQ: 2 points]

hospital

| hospitalNum | patientNum | doctorID |
|---|---|---|
| H0001 | P0001 | D0001 |
| H0002 | P0002 | D0002 |
| H0003 | P0001 | D0003 |

hosp1

| hospitalNum | patientNum |
|---|---|
| H0001 | P0001 |
| H0002 | P0002 |
| H0003 | P0001 |

hosp2

| patientNum | doctorID |
|---|---|
| P0001 | D0001 |
| P0002 | D0002 |
| P0001 | D0003 |

Figure 1: Decomposition of **hospital** relation

- ◯ The given decompostion is lossless and the natural join of **hosp1** and **hosp2** has 5 rows.
- ◯ The given decompostion is lossless and the natural join of **hosp1** and **hosp2** has 3 rows.
- √ The given decompostion is lossy and the natural join of **hosp1** and **hosp2** has 5 rows.
- ◯ The given decompostion is lossy and the natural join of **hosp1** and **hosp2** has 3 rows.

**Solution:**

hospital

| hospitalNum | patientNum | doctorID |
|---|---|---|
| H0001 | P0001 | D0001 |
| H0002 | P0002 | D0002 |
| H0003 | P0001 | D0003 |
| H0001 | P0001 | D0003 |
| H0003 | P0001 | D0001 |

Figure 2: Natural join of **hosp1** and **hosp2**

12. Consider a relation $R(A, B, C, D, E)$ having the following functional dependencies:

$$\mathcal{F} = \{A \rightarrow BCD, D \rightarrow E, C \rightarrow D\}$$

Which among the following are lossy decompositions? [MSQ: 2 points]

- ◯ $R_1(A, B, C), R_2(B, C, D), R_3(C, D, E)$
- ◯ $R_1(A, B, C), R_2(A, C, D), R_3(A, D, E)$
- √ $R_1(A, B, C), R_2(A, C), R_3(A, D)$
- ◯ $R_1(A, B, C, D), R_2(A, C, D, E)$

**Solution:**

This problem will be solved in the *Solve With the Instructor* session.