

# National University of Computer and Emerging Sciences, Lahore Campus



**Course:**  
**Program:**  
**Instructor:**

**Database Systems**  
**BS(Computer Science)**  
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**Course Code:** CS2005

**Practice Problem:** FDs & NFs

## Q1. [Find FDs]

List all FDs.

**R**

X	Y	Z
x1	y1	z1
x1	y1	z2
x2	y1	z1
x2	y1	z3

## Q2. [Verify FDs]

Which of the following FDs may or may not hold over schema S?

$A \rightarrow B$ , **b)**  $BC \rightarrow A$ , **c)**  $B \rightarrow C$ , **d)**  $BC \rightarrow D$ , **e)**  $CD \rightarrow B$

**S**

A	B	C	D
1	2	3	4
4	2	3	4
5	3	3	4

## Q3. [Verify FDs]

Which of the following FDs may or may not hold over schema R. Give valid reason.

**a)**  $A \rightarrow CD$ , **b)**  $B \rightarrow C$ , **c)**  $D \rightarrow E$ , **d)**  $CD \rightarrow E$ , **e)**  $E \rightarrow CA$

**R**

A	B	C	D	E	<i>Tuple#</i>
A1	B1	C1	D1	E1	1
A1	B2	C1	D1	E1	2
A2	B2	C1	D2	E3	3
A2	B3	C3	D2	E2	4

## Q4. [Prove Inference rules for FDs]

Prove or disprove the following inference rules for functional dependencies. A proof can be made either by a proof argument or by using inference rules IR1 through IR6. A disproof should be done by demonstrating a relation instance that satisfies the conditions and functional dependencies in the left hand side of the inference rule but do not satisfy the conditions or dependencies in the right hand side.

- a)  $\{W \rightarrow Y, X \rightarrow Z\} \models \{WX \rightarrow Y\}$
- b)  $\{X \rightarrow Y\}$  and  $Z$  subset-of  $Y \models \{X \rightarrow Z\}$
- c)  $\{X \rightarrow Y, X \rightarrow W, WY \rightarrow Z\} \models \{X \rightarrow Z\}$
- d)  $\{XY \rightarrow Z, Y \rightarrow W\} \models \{XW \rightarrow Z\}$
- e)  $\{X \rightarrow Z, Y \rightarrow Z\} \models \{X \rightarrow Y\}$
- f)  $\{X \rightarrow Y, XY \rightarrow Z\} \models \{X \rightarrow Z\}$

## Q5. [Closure]

Consider the following relation and compute the closure of  $\{A\}^+$ ,  $\{B\}^+$ ,  $\{C\}^+$ ,  $\{D\}^+$ , and  $\{CD\}^+$ . Show your work.

**R**

A	B	C	D
1	2	3	4
4	2	3	4
5	3	3	4

**Q6. [Closure+Key]**

Consider the relation R (A, B, C, D, E, F) and the set  $F = \{A \rightarrow B, C \rightarrow DF, AC \rightarrow E, D \rightarrow F\}$ .  
What is the KEY of this relation? Prove it.

**Q7. [Closure+Key]**

Consider the relation R (A, B, C, D, E, F, G, H, K) and the set  $F = \{A \rightarrow BC, CD \rightarrow H, CG \rightarrow AE, H \rightarrow G, B \rightarrow D, F \rightarrow G\}$ .  
Find the closure of A and BC (i.e.  $A^+$  and  $\{BC\}^+$ ).

**Q8. [Key]**

Consider the relation SALES (transno, itemno, price, qty, seller, sregion)  
and the set  $F = \{\text{transno, itemno} \rightarrow \text{qty}, \text{itemno} \rightarrow \text{price}, \text{transno} \rightarrow \text{seller}, \text{seller} \rightarrow \text{sregion}\}$ .  
What is the KEY of this relation? Prove it.

**Q9. [Key]**

Consider the relation R (A, B, C) and the set  $F = \{A \rightarrow C, C \rightarrow A\}$ .  
What is the KEY of this relation? Prove it.

**Q10. [Key]**

Given relation R(A,B,C,D,E) with dependencies  $AB \rightarrow C, CD \rightarrow E, DE \rightarrow B$   
Is AB a candidate key of this relation?  
If not, is ABD? Explain your answer.

**Q11. [Minimal Cover]**

Find the minimal cover for the following set of FDs for a relation R (A, B, C, D):  
 $F = \{A \rightarrow BC, B \rightarrow C, A \rightarrow B, AB \rightarrow C, AC \rightarrow D\}$

**Q12. [Minimal Cover]**

Find the minimal cover for the following set of FDs for a relation R (A, B, C, D, E, F):  
 $F = \{A \rightarrow BC, E \rightarrow C, D \rightarrow AEF, ABF \rightarrow BD\}$

**Q13. [Minimal Cover]**

Find the minimal cover for the following set of FDs for a relation R (A, B, C, D):  
 $F = \{C \rightarrow BD, BC \rightarrow AD\}$

**Q14. [Minimal Cover]**

Find the minimal cover for the following set of FDs for a relation R (A, B, C, D, E, G, H):  
 $F = \{AB \rightarrow C, DEG \rightarrow H, A \rightarrow C, DE \rightarrow G\}$

**Q15. [Minimal Cover]**

Consider the relation schema  $R(A, B, C, D)$ , with FDs  $F = \{AB \rightarrow CD, C \rightarrow A, AD \rightarrow C, CD \rightarrow AB, D \rightarrow B\}$ . Find a minimal cover of  $F$  (i.e.  $F_c$ ).

**Q16. [Minimal Cover]**

Consider the relation schema  $R(A, B, C, D, E, F, G, H)$  with FDs  $F = \{A \rightarrow BCD, AD \rightarrow E, EFG \rightarrow H, F \rightarrow GH\}$ . Find a minimal cover of  $F$  (i.e.  $F_c$ ).

**Q17. [Minimal Cover]**

Find two different minimal cover of  $F = \{A \rightarrow BC, B \rightarrow AC, C \rightarrow AB\}$ . Show your work. Also find all possible keys of R.

**Q18. [Minimal Cover]**

Consider the relation schema  $R(A, B, C, D, E, F)$ , with a set of FDs  $F = \{A \rightarrow BC, FC \rightarrow D, D \rightarrow B, AB \rightarrow F, F \rightarrow C, AD \rightarrow E\}$ .  
Compute the minimal cover for  $F$  (i.e.  $F_c$ ). Show your work! Also find all possible keys of R.

**Q19. [Equivalent Sets]**

Consider the following two sets of FDs. Check whether or not they are equivalent. Provide proper reason.  
 $F1 = \{A \rightarrow B, B \rightarrow C, C \rightarrow A\}$  and  $F2 = \{A \rightarrow C, C \rightarrow B, B \rightarrow A\}$ .

**Q20. [Equivalent Sets]**

Consider the following two sets of FDs. Check whether or not they are equivalent. Provide proper reason.  
 $F1 = \{A \rightarrow C, B \rightarrow C, C \rightarrow AB\}$  and  $F2 = \{A \rightarrow BC, B \rightarrow A, C \rightarrow A\}$ .

**Q21. [Equivalent Sets]**

Consider the following two sets of FDs:  
 $F = \{A \rightarrow C, AC \rightarrow D, E \rightarrow AD, E \rightarrow H\}$  and  $G = \{A \rightarrow CD, E \rightarrow AH\}$ . Check whether they are equivalent.

**Q22. [Key+NF]**

Consider the relation R (A, B, C, D, E, F) and the set  $F = \{A \rightarrow B, C \rightarrow DF, AC \rightarrow E, D \rightarrow F\}$ .

- What is the KEY of this relation? Prove it.
- What is the highest normal form of this relation? Give reason.
- If it is not in 3NF find a decomposition that is lossless and dependency preserving.

**Q23. [Key+NF]**

Consider the relation SALES (transno, itemno, price, qty, seller, sregion) and the set  $F = \{\{transno, itemno\} \rightarrow qty, itemno \rightarrow price, transno \rightarrow seller, seller \rightarrow sregion\}$ .

- What is the KEY of this relation? Prove it.
- What is the highest normal form of this relation? Give reason.
- If it is not in 3NF find a decomposition that is lossless and dependency preserving.

**Q24. [Key+NF]**

Consider the relation SCHEDULE (stdid, classno, stdname, stdmajor, classtime, room, instructor) and the set  $F = \{stdid \rightarrow \{stdname, stdmajor\}, classno \rightarrow \{classtime, room, instructor\}\}$

- What is the KEY of this relation? Prove it.
- What is the highest normal form of this relation? Give reason.
- What type of anomalies does this relation have?
- Transfer this relation to its next higher form.

**Q25. [Key+NF]**

Consider the relation PROGRAMMER TASK (prog-id, programming-package-id, programming-package-name, total-hours-worked-on-package) and the set

$F = \{ programming-package-id \rightarrow programming-package-name, \{prog-id, programming-package-id\} \rightarrow total-hours-worked-on-package \}$

- What is the KEY of this relation? Prove it.
- What is the highest normal form of this relation? Give reason.
- Transfer this relation to its next higher form.
- Can the information if the given relation be recovered?
- What operation is necessary to recover it?

**Q26. [Key+NF]**

Consider the relation TEACH (student, course, instructor) and the set  $F = \{\{student, course\} \rightarrow instructor, instructor \rightarrow course\}$ .

- What is the KEY of this relation? Prove it.
- What is the highest normal form of this relation? Give reason.
- If it is not in BCNF find a decomposition that is lossless.

**Q27. [Key+NF]**

Consider a relation R(A, B, C) and set of functional dependencies  $F = \{AB \rightarrow C, B \rightarrow A, C \rightarrow B\}$ .

Find all possible candidate keys of R. Prove it. What is the highest normal form that relation R is in? Justify your answer. Decompose it into BCNF, if it is not.

**Q28. [NF]**

Consider a relation schema R(A, B, C, D) and set of functional dependencies  $F = \{AB \rightarrow C, C \rightarrow A, D \rightarrow B, AB \rightarrow D\}$ .

$\{A,B\}$ ,  $\{B,C\}$ ,  $\{A,D\}$ , and  $\{C,D\}$  are the candidate keys of R. What is the highest normal form that relation R is in? Justify your answer. Decompose it into BCNF, if it is not.

**Q29. [Closure+Key+NF]**

Consider the relation R (A, B, C, D, E), with FDs  $\{AB \rightarrow C, C \rightarrow D, D \rightarrow B, D \rightarrow E\}$ .

- Find the closure of C and AB (i.e.  $C^+$  and  $\{AB\}^+$ ).
- Find all the keys for this relation R. (you don't need to list superkeys that are not keys.)
- Is this relation in BCNF? If your answer is yes, explain why. If your answer is no, decompose the relation into BCNF. Show your decomposition steps.

**Q30. [Key+NF]**

Consider the relation R (A, B, C, D), with FDs  $\{C \rightarrow BD, BC \rightarrow AD\}$ .

What is the highest normal form of this relation? Give reason. If it is not in BCNF find a decomposition that is lossless.

**Q31. [Key+NF]**

Consider the relation R (A, B, C, D, E, G, H), with FDs  $F = \{AB \rightarrow C, DEG \rightarrow H, A \rightarrow C, DE \rightarrow G\}$ .

What is the highest normal form of this relation? Give reason. If it is not in BCNF find a decomposition that is lossless.

**Q32. [Key+NF]**

Consider a relation with schema  $R(A, B, C, D)$ , with FDs  $F = \{BC \rightarrow A, AD \rightarrow B, CD \rightarrow B, AC \rightarrow D\}$ .

Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer. If R is not in BCNF, decompose it into a set of BCNF relations and show your steps. Indicate which dependencies if any are not preserved by the BCNF decomposition.

**Q33. [Key+NF]**

Consider the relation schema  $R(A, B, C, D)$ , with FDs  $\{AB \rightarrow C, BC \rightarrow D, CD \rightarrow A\}$ . Identify the best normal form that R

satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer. If R is not in BCNF, decompose it into a set of BCNF relations.

Indicate which dependencies if any are not preserved by the decomposition.

**Q34. [Key+NF]**

Consider the relation  $R(A, B, C, D, E)$ , with FDs  $\{AB \rightarrow C, DE \rightarrow C, B \rightarrow D\}$ . State which of the following decompositions of R relation are lossless decomposition. Justify your answer.

a.  $R1(\underline{A}, B, C)$ ,  $R2(C, \underline{D}, E)$ , and  $R3(\underline{B}, D)$ .

b.  $R1(\underline{A}, B, C)$ ,  $R2(\underline{A}, B, E)$ , and  $R3(\underline{B}, D)$ .

**Q35. [Key+NF]**

Consider a relation with schema  $R(A, B, C, D)$ , with FDs  $F = \{AB \rightarrow C, BC \rightarrow D, CD \rightarrow A\}$ .

a) We are considering to decompose R into  $R1(A, B, C)$  and  $R2(A, C, D)$ . Is this a lossless decomposition? Prove it.

b) Provide BCNF relations for this relation R. Also indicate which dependencies if any are not preserved.

c) Provide 3NF relations for this relation R.

**Q36. [Key+NF]**

Consider a relation with schema  $R(A, B, C, D, E)$ , with FDs  $F = \{AB \rightarrow C, DE \rightarrow C, B \rightarrow D\}$ .

Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer. If R is not in BCNF, decompose it into a set of BCNF relations and show your steps. Indicate which dependencies if any are not preserved by the BCNF decomposition.

**Q37. [Key+NF]**

Consider the relation  $R(A, B, C, D, E)$ , with FDs  $\{A \rightarrow BC, C \rightarrow D, E \rightarrow D, BE \rightarrow A\}$ . List all the possible keys of R. Show the intermediate steps of your derivation. Also Identify the best normal form that R satisfies. If R is not in BCNF, decompose it into a set of BCNF relations and show your steps. Indicate which dependencies if any are not preserved by the BCNF decomposition.