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National University of Computer and Emerging Sciences, Lahore Campus

Course:	Database Systems	Course Code:	CS2005
Program:	BS(CS/DS/SE)	Semester:	Fall 2023
Duration:	60 Minutes	Total Marks:	25
Paper Date:	Fri 10-Nov-2023	Weight	15%
Section:	ALL	Page(s):	5
Exam:	Midterm-2 - SOLUTION	Total Questions:	5

Instruction/Notes: A scratch sheet can be used for rough work; however, all the questions and steps are to be shown on the question paper. No extra/rough sheets should be submitted with question paper. You will not get any credit if you do not show proper working, reasoning, and steps as asked in the question statements.

Q1. *(5 points)* Consider a relation R (A, B, C, D, E), with the set of FDs F= {AB → C, BC → D, AD → B}. What are the keys of this relation? Prove it.

Ans: Keys are {ABE}, {ADE}.

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Q2. *(5 points)* Consider the relation schema R (A, B, C, D, E, H), with FDs F= {A → B, C → D, E → H, AB → C, A → D}. Find a minimal cover of *F* (i.e. F_c).

Ans: F_c = {A → BC, C → D, E → H}

{A → B, C → D, E → H, AB → C, ~~A → D~~}

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Q3. *(5 points)* Consider two sets of FDs, F and G, F = {A → B, C → D, E → H, AB → D, AB → C} and G = {A → BC, C → D, E → H}. Are F and G equivalent? Prove it.

Ans: F covers G and G covers F, so they are eqauivalent set.

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Q4. *(5 points)* Consider the relation R (A, B. C, D, E), with FDs {BD→E, A→C}. State which of the following decompositions of R relation are lossless decomposition. Prove it.

a. R1(A, B, D), R2(B, D, E), and R3(A, C).

b. R1(A, B, C), R2(B, D, E), and R3(A, C).

Ans:

(a) Lossless Decomposition:

R1(A, B, D), R2(B, D, E), and R3(A, C)

Following two lossless conditions are true:

Condition1: R1∩R2 → R2-R1 (i.e., BD→E) and

Condition2: R1∩R3 → R3-R1 (i.e., A→C)

(b) Not Lossless Decomposition:

R1(A, B, C), R2(B, D, E), and R3(A, C)

Only one lossless conditions is true:

Condition1: R1∩R3 → R3-R1 (i.e., A→C)

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Q5. *(5 points)* Consider the relation schema R (A, B, C, D, E), with FDs F= {CE → D, D → B, C → A}. Key of relation R is {CE}. 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.

Ans: HNF=1NF; Relation R violate 2NF due to partial FD3: C→A,
2NF Schema is R1(B, C, D, E), R2(A, C); All FDs are preserved.

3NF Schema: *R1 violate 3NF due to FD2: D→B,*
3NF Schema is R11(C, D, E), R12(B, D), R2(A, C); All FDs are preserved.

BCNF Schema: 3NF Schema is also in BCNF (i.e., Further decomposition is not required).