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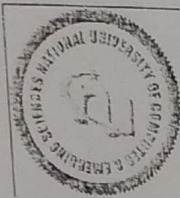# National University of Computer and Emerging Sciences, Lahore Campus

Course Name:	Database Systems	Course Code:	CS2005
Degree Program:	BS(Computer Science)	Semester:	Spring 2022
Exam Duration:	60 Minutes	Total Marks:	25
Paper Date:	Mon 09-May-2022	Weight	15%
Section:	ALL	Page(s):	5
Exam Type:	Midterm-2	Total Questions:	5

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Instruction/Notes: Scratch sheet can be used for rough work however, all the questions and steps are to be shown on 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 question statements.

Q1. *(5 points)* Consider a relation R (A, B, C, D, E, H, K, L), with the set of FDs F= {A → BL, B → CE, D → BK, K→ D}. What are the keys of this relation? Prove it.

$A \rightarrow B$ $A \rightarrow L$ $B \rightarrow C$ $B \rightarrow E$ $D \rightarrow B$ $D \rightarrow K$ $K \rightarrow D$

essential attributes $= A, H$

maybe $= B, D, K$

non essential $= L, C, E$

5

$AH^+ = \{A, H, B, L, C, E\}$ not key

$AHD^+ = \{A, H, D, B, L, C, E, K\} \rightarrow$ candidate key

$AHK^+ = \{A, H, K, B, L, C, E, D\} \rightarrow$ candidate key

$AHB^+ = \{A, H, B, L, C, E\emptyset, \cancel{K}\} \rightarrow \overset{not}{candidate\ key}$

candidate keys $= \{(A,H,D), (A,H,K), (A,H,B)\}$

= \{(AHD), (AHK), \cancel{(AHB)}\}$

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

Step 1 $A \rightarrow BC, A \rightarrow C, B \rightarrow C, B \rightarrow E, A \rightarrow E, AC \rightarrow H, D \rightarrow B$

Step 2   Remove redundancies on LHS.

$$AC \rightarrow H \qquad C^+ = \{C, \}$$
$$A^+ = \{A, B, C, E, \} \therefore C, A \text{ both necessary.}$$

No redundancies on left

Step 3   Remove redundancies on right.

$A \rightarrow B, \qquad A^+ = \{A, C, E, H\}$ not redundant

$A \rightarrow C, \qquad A^+ = \{A, B, C, E, H\} \rightarrow \boxed{\text{redundant}}$

$B \rightarrow C, \qquad B^+ = \{B; E, \}$ not redundant

$B \rightarrow E, \qquad B^+ = \{B, C, \}$ not redundant

$A \rightarrow E, \qquad A^+ = \{A, B, C, E, H\} \rightarrow \boxed{\text{redundant}}$

$AC \rightarrow H, \qquad AC^+ = \{A, C, B, E, \}$ not redundant

$D \rightarrow B, \qquad D^+ = \{D, B\}$ not redundant

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redundant depencies = $A \rightarrow C, A \rightarrow E$

F_c =minimal cover: $(A \rightarrow B, B \rightarrow C, B \rightarrow E, AC \rightarrow H, D \rightarrow B)$

Q3. (5 points) Consider a relation R (A, B, C, D), with the set of FDs F = {A → B, B → C, C → D, D → A}. Show the relation state that must hold all these FDs.

A	B	C	D
1	4	5	2
2	3	6	1
2	3	6	1

5

Q4. (5 points) Consider the relation R (A, B. C, D, E), with FDs {AC→B, DE→B, C→E}. Key is {ACD}. State which of the following decompositions of R relation are lossless decomposition. Prove it.
   a. R1(A, C, B), R2(A, C, D), and R3(C, E).
   b. R1(A, C, B), R2(B, D, E), and R3(C, E).

ⓐ $\left(R_1 \underset{AC}{\bowtie} R_2 \right) \underset{C}{\bowtie} R_3$

R_1 and R_2 can be joined using AC which is the candidate key for R_1.
Then this table can be joined with R_3 based on C.

So this is lossless decomposition.   5

ⓑ $\left(R_1 \underset{C}{\bowtie} R_3 \right) \underset{?}{\bowtie} R_2$

This is not lossless decomposition.
There is no common (candidate) key
between $(R_1 \bowtie R_3)$ and R_2. to join them

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Q5. *(5 points)* Consider the relation schema R (A, B, C, D, E, H), with FDs F= {AB → C, CD → AE, E → H}. Keys are {ABD} and {BCD}. 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.

$AB \rightarrow C$ $CD \rightarrow AE$ $E \rightarrow H$

$AB \rightarrow C$ $CD \rightarrow A$ $CD \rightarrow E$ $E \rightarrow H$

Prime attributes = A, B, D, C

Non Prime = E, H

Highest NF = 1NF.

→ Check 1NF = yes   (no multivalued attributes)

→ check 2NF = no.

     Partial dependency exists: $CD \rightarrow A$

                                     $CD \rightarrow E$

     (hence cannot be in 2NF, so 1NF).

~~exter~~

• Removing Partial dependencies :

   R1(A,B,C), ~~R2(A,CD)~~ R3 (C,D,E,H)

Now it is in 2NF.

→ check 3NF = no.   Transitive dependency exists in R3

                                  $(CD \rightarrow E \quad E \rightarrow H)$

• Removing Transitive dependency:

   R1(A,B,C)   R2 (A,C,D)   R3 (C,D,E)   R4 (E,H)

        ~~(ABD)~~ ~~(BCD)~~ ~~(ACD)~~ ~~(C,D,E)~~ ~~(E,H)~~

→ check BCNF = yes. Left sides are super keys.

     Final BCNF =   R1 (A,B,C) R2(A,C,D) R3 (C,D,E) R4(EH)

     Lost dependency = None