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| **National University of Computer and Emerging Sciences, Lahore Campus** | | | | |
| C:\Users\saif\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\final design.jpg | **Course Name:** | **Database Systems** | **Course Code:** | **CS2005** |
| **Degree Program:** | **BS(Computer Science)** | **Semester:** | **Fall 2021** |
| **Exam Duration:** | **60 Minutes** | **Total Marks:** | **26** |
| **Paper Date:** | **Wed 01-Dec-2021** | **Weight** | **15%** |
| **Section:** | **ALL** | **Page(s):** | **5** |
| **Exam Type:** | **Midterm-2** | **Total Questions:** | **4** |
| **Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Roll No:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Section:** \_\_\_\_\_\_\_\_ | | | | |
| **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.** *(4 points)* Prove or disprove the following inference rules for functional dependencies.

**a.** {B → AD, AE → BC} ⇒ AE → D

**b.** {B → AD, D → C, E → C} ⇒ AB → C

**Ans:**

**a) Proof:** {B → AD, AE → BC} ⇒ AE → D

**1- B → AD (given)**

**2- AE → BC (given)**

**3- AE → B (using IR4-decomposition rule on 2)**

**4- B → D (using IR4-decomposition rule on 1)**

**5- AE → D (using IR3-trasitive rule on 3 & 4)**

**b) Proof:** {B → AD, D → C, E → C} ⇒ AB → C

**1- B → AD (given)**

**2- D → C (given)**

**3- E → C (given)**

**4- B → D (using IR4-decomposition rule on 1)**

**5- B → C (using IR3-trasitive rule on 4 & 2)**

**6- AB → C (using IR2-augmentation rule on 5 to augment A on LHS)**

**Q2.** *(4+5= 9 points)* Consider a relation schema *R (A, B, C, D, E)*, with FDs *F = {B→AD, D→C, AB→C, E→C, AE→BD}*.

1. Determine all possible keys (i.e. minimal of super key). Prove it.
2. Compute the minimal cover for F (i.e. Fc).

**Ans: Keys are {AE} & {BE};**

**Fc = {B→AD, D→C, ~~AB→C~~, E→C, AE→B~~D~~} OR**

**Fc = {B→AD, D→C, E→C, AE→B}**

**Q3.** *(4 points)* Consider a relation schema *R (A, B, C, D, E)*, with FDs *F = {CD→A, BE→A, D→B}*. Suppose *{CDE}* is the possible key of this relation R. Prove or disprove the following decompositions are lossless decomposition. Provide valid reason.

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

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

**Ans:**

***a)******Lossless:***R1(A, C, D), R2(C, D, E), and R3(B, D) (R1 ⋈CD R2) ⋈D R3

***b)******Not Lossless:***R1(A, C, D), R2(A, B, E), and R3(B, D) (R1 ⋈D R3) ⋈??? R2 (i.e. R2 cannot be join with any other relation)

**Q4.** *(2+2+2+3= 9 points)* Consider a relation schema *R (A, B, C, D, E, F)*, with FDs *G = {CD→A, BD→C, AC→B, D→E, E→F}*. Suppose *{BD}* and *{CD}* are the two possible keys of this relation. Show all steps, working, and reasoning to answer the following questions.

**a.** Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer.

**b.** Decompose the relation R into a 2NF schema, if it is not in 2NF. *(Remove 2NF violations only, in this part)*

**c.** Check whether your answer to part **(b)** is in 3NF. If not, decompose it into a 3NF schema.

**d.** Check whether your answer to part **(c)** is in BCNF. If not, decompose it into a BCNF schema. List clearly complete set of BCNF schema relations with all keys and FDs and also indicate which dependencies if any are not preserved.

**Ans:**

**a) HNF= 1NF; because FD4: D*→*E is partial FD that violate 2NF condition.**

**b) 2NF Schema: R1(A, B, C, D) with FD1, FD2, FD3, and keys {BD} & {CD}**

**R2(A, E, F) with FD4: A*→*E & FD5: E*→*F**

**c) FD5: E*→*F in R2 relation, violate 3NF condition.**

**3NF Schema: R1(A, B, C, D) with FD1, FD2, FD3, and keys {BD} & {CD}**

**R21(A, E) with FD4: A*→*E**

**R22(E, F) with FD5: E*→*F**

**d) FD3: AC→B in R1 relation, violate BCNF condition.**

**BCNF Schema: R11(A, C, D) with FD1: CD→A**

**R12(A, B, C) with FD3: AC→B**

**R21(A, E) with FD4: A*→*E**

**R22(E, F) with FD5: E*→*F**

**FD2: BD→C is not preserved.**