

National University of Computer and Emerging Sciences, Lahore Campus



Course Name:	Database Systems	Course Code:	CS219
Degree Program:	BS(Computer Science)	Semester:	Spring 2021
Exam Duration:	3 Hours	Total Marks:	95
Paper Date:	Mon 5-Jul-2021	Weight	70%
Section:	ALL	Page(s):	10
Exam Type:	Final Exam	Total Questions:	8

Student : 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. (5 points) Consider the following schedule of three transactions T1, T2, and T3.

S: R₁(A), R₁(B), R₂(C), R₁(D), R₂(B), W₂(B), R₁(C), W₁(A), W₂(D), C₂, W₃(C), C₃, R₁(A), C₁.

Draw the serializability (precedence) graph for this schedule. State whether this schedule is (conflict) serializable or not. If the schedule is serializable, write down the equivalent serial schedule(s) otherwise explain why it is not.

Q2. (4+6= 10 points) Consider a relation schema $R(A, B, C, D, E)$, with FDs $F = \{A \rightarrow BC, C \rightarrow D, AB \rightarrow D, E \rightarrow D, BE \rightarrow AC\}$.

- a. Determine all possible keys (i.e. minimal of super key). Prove it.
- b. Compute the minimal cover for F (i.e. F_c).

Q3. (2+2+2+3= 9 points) Consider a relation schema $R(A, B, C, D, E)$, with FDs $F = \{AC \rightarrow D, AB \rightarrow C, CD \rightarrow B, A \rightarrow E\}$. Suppose $\{AB\}$ and $\{AC\}$ 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.

Q4. (6 points) Consider a relation schema $R(A, B, C, D, E)$, with FDs $F = \{AC \rightarrow D, AB \rightarrow C, CD \rightarrow B, A \rightarrow E\}$. Suppose $\{AB\}$ and $\{AC\}$ are the two possible keys of this relation. Prove or disprove the following decompositions are lossless decomposition and dependency preserving.

- a. $R_1(A, B, C)$, $R_2(B, C, D)$, and $R_3(A, E)$
 - b. $R_1(A, C, D)$, $R_2(A, B, C)$, and $R_3(A, E)$
 - c. $R_1(A, C, D)$, $R_2(B, C, D)$, and $R_3(A, E)$
-

Q5. (30 points) A renowned multi-national company has a Complaint-Management System, where different employees can post complaints and bring them to the notice of higher administration. The website has a relation Employee that contains information of all employees. The relation complaints record the complaints, its category, current status, and complaint team member investigating it.

Note that DNO is the employee's department number and CI is the ComplaintInvestigator's ID. The complaint investigator is an employee of the company, but his identity (EID) is not disclosed to the complainee.

Employee

<u>EID</u>	Ename	DNO	Gender
1	Saira	1	F
2	Zubda	2	F
3	Ali	12	M
4	Ahmad	2	M
5	Aliyar	2	M
6	Tania	3	F
7	Hamza	2	M

Category

<u>CategoryID</u>	Name	Description
1	Work Environment	...
2	Resources	...
3	Funds	...
4	Facilities	...

Complaints

<u>CID</u>	Details	EID	CategoryID	CI	Status
10	...	3	4	1	Approved
20	...	7	4	1	Decline
100	...	7	2	1	Processing
30		3	1	1	Approved
50		3	3	2	Decline
70		7	1	2	Processing
60		5	3	1	Approved
120		5	2	2	Decline
80		3	2	2	Processing

ComplaintInvestigator

<u>CI</u>	EID
1	2
3	6
2	5

Write both **SQL and Relation Algebra Queries** for the following tasks:

- Print the name of Complaint Investigators who are currently not processing any complaint.
- Print the name and dno of the female employees who have submitted complaints in the complaint-category of "Funds" and also in "Facilities".
- For each category, print the number of complaints received and also print the number of complaints approved, decline and still under processing.



Q6. (10 points)

Write the result of the following queries for the Database State given above. Also, show the intermediate tables. Explain in one sentence what these queries are doing.

a. $R1 \leftarrow \pi_{\text{CategoryID}}(\text{Category})$

$R2 \leftarrow \pi_{\text{EID, CategoryID}}(\text{Complaints})$

$R3 \leftarrow R1 \div R2$

$R4 \leftarrow ((R3 * \text{Complaints}) * \text{Employee})$

b. `SELECT E.EID`

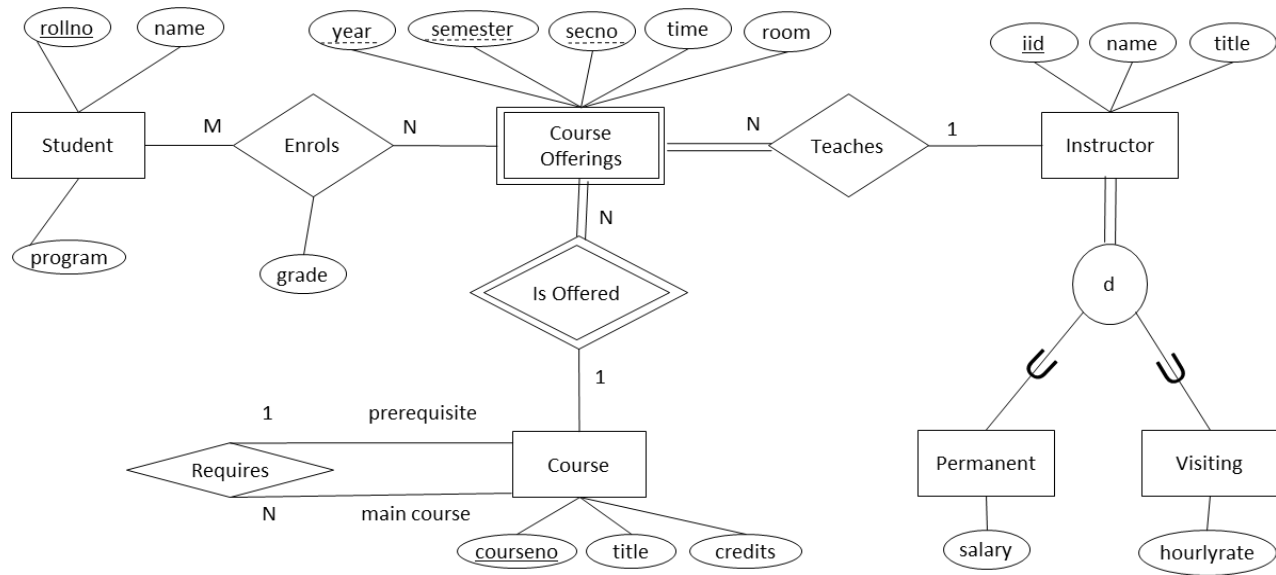
`FROM (Employee E JOIN Complaints C ON E.EID=C.EID)`

`WHERE Gender = 'M' AND DNO =2 AND`

`E.EID IN (SELECT EID FROM Complaints GROUP BY EID HAVING COUNT (*) >= 2)`

`AND NOT EXISTS (SELECT * FROM complaints WHERE status = "Approved")`

Q7. (10 points) Map the following ER/EER Diagram into a relational model and specify all constraints.



Q8. (15 points) Suppose that you are working as a database designer, and in that role you are assigned a task to develop an ER/EER Diagram for the following scenario. A research lab in UK is running several trials of a COVID Vaccine on healthy individuals (volunteers). The goal of the trial is to check whether the vaccine have side effect(s). For each of the volunteer, you are required to store their National Insurance number, name, DOB, gender, address and telephone number. Further, we keep track of illness history of each volunteer. Specifically, to maintain the history, the system will store the illness name, start date, end date, and if the illness is mild or critical. Moreover, it should be noted that a volunteer may suffer from an illness more than once. Each volunteer can enroll in maximum one trial. However, there may be volunteers who are registered but not participated in any of the trial yet. The lab has already produced vaccines for flu and other related illnesses. And for each vaccine, you are required to keep track of the vaccine's unique id, its name, temperature requirement, and its specialty. Each trial of vaccine involves exactly one vaccine given to several volunteers. Volunteers will report any issues/ side effects (if experienced) immediately. Thus for each volunteer, we need to record if they have experienced any side effect or no. A volunteer may experience single or many side effects (for instance: blood clotting, breathlessness, dry mouth, fever etc.). Each of the side effect is described and stored in standard medical terminology. Thus for each side effect, you are required to store id, name and description.

Draw an ER/EER diagram (using notation discussed in lectures) for the above scenario. Specify all constraints that should hold on the database and state any assumptions you make.
