

# National University of Computer and Emerging Sciences, Lahore Campus



Course Name:	Database Systems	Course Code:	CS2005
Degree Program:	BS (CS/SE/DS)	Semester:	Fall 2022
Exam Duration:	3 Hours	Total Marks:	90
Paper Date:	Thu 15-Dec-2022	Weight	50%
Section:	ALL	Page(s):	12
Exam Type:	Final Exam	Total Questions:	9

**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.

CLO No.	2	3		6						Total
Q. No.	1	2	3	4	5	6	7	8	9	
Marks										

**Roll No:** \_\_\_\_\_ **Section:** \_\_\_\_\_ **Name:** \_\_\_\_\_

**Q1. (2+3+3+2= 10 points)**

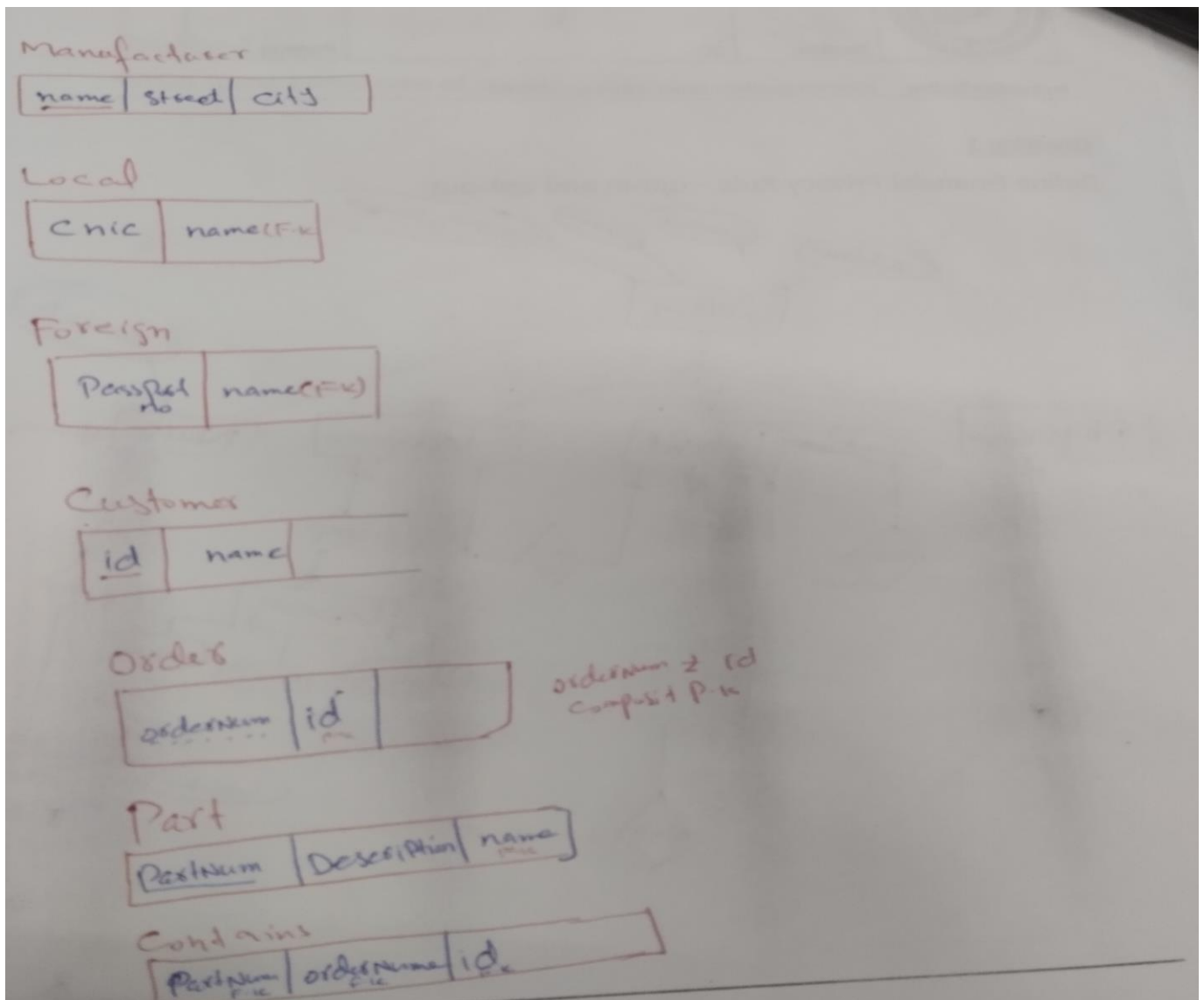
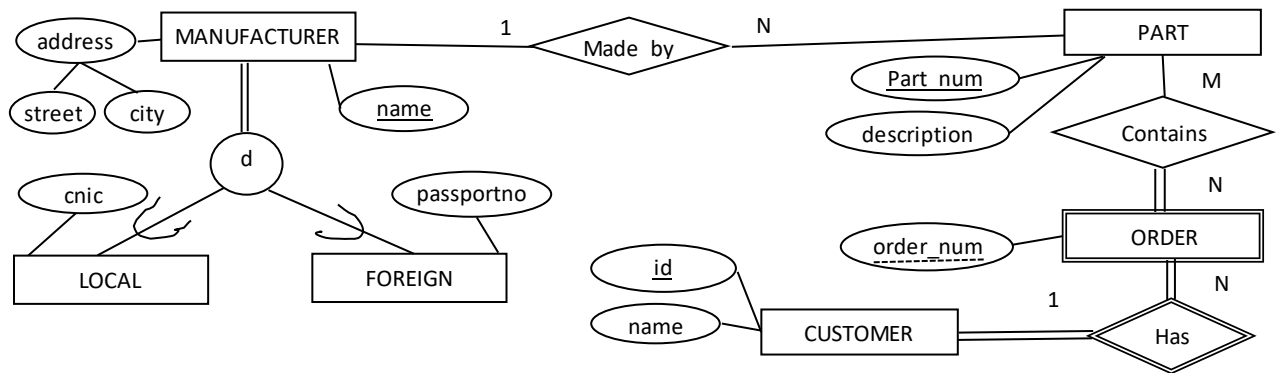
- Discuss the atomic and durable properties of transactions.
- Why concurrency control is needed, and give examples of lost update problem and dirty read problem.
- How does a category subclass differ from a regular shared subclass? Illustrate your answer with example.
- Identify the difference between user-defined and attribute-defined specializations.

**See lecture on Transection**

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Q2. (10 points) Map the following ER/EER Diagram into a relational model and specify all the constraints including primary key, foreign key, not null, and unique.



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**Q3. (10 points)** Consider the following database. The Works table records the hours an employee spends working for a department each week; the mgreno column identifies the manager of a department.

**Employee**

<u>eno</u>	ename	age
111	Isbah	35
222	Khadija	42
333	Izaan	34
444	Tahreem	32
555	Alia	50

**Works**

<u>empno</u>	<u>deptid</u>	hours	salary
111	1	20	1000
111	2	20	1000
222	1	10	500
222	2	20	1000
222	3	5	250
222	4	5	250
333	2	10	500
333	3	30	1500
444	2	20	1000
444	3	20	1000
444	4	20	1000
555	4	40	2000

**Department**

<u>did</u>	dname	mgreno	budget
1	Hardware	111	48000
2	Firmware	111	45000
3	Software	333	55000
4	Network	555	35000

For each of the following Query against the above database, show the resulting table.

a.  $R1 \leftarrow \pi_{eno}(\text{Employee}) - ((\pi_{eno}(\text{Employee}) - \pi_{mgreno}(\text{Department}))$   
 $\text{Result} \leftarrow \text{Works} \bowtie_{empno=eno} R1$

b.  $\text{SELECT did, dname, SUM(salary) AS TotalSalary}$   
 $\text{FROM department D JOIN works W ON did=deptid JOIN employee E ON empno=eno}$   
 $\text{WHERE hours} \geq 20 \quad \text{GROUP BY did, dname;}$

**Ans:**

a.

**R1**

<b>Eno</b>
111
333
555

**Result**

<b>empno</b>	<b>deptid</b>	<b>hours</b>	<b>salary</b>	<b>eno</b>
111	1	20	1000	111
111	2	20	1000	111
333	2	10	500	333
333	3	30	1500	333
555	4	40	2000	555

b.

<b>did</b>	<b>dname</b>	<b>TotalSalary</b>
1	Hardware	1000
2	Firmware	3000
3	Software	2500
4	Network	3000

**Q4. (20 points)** Write the following Queries in SQL and Relation Algebra against the above database schema given in Question#3:

- a. Retrieve the numbers, names and ages of all employees who work in both the Firmware department and the Software department.
- b. Retrieve the name and age of the manager of the department with the largest budget.

**Ans:**

a. **SELECT did, dname, age**

**FROM department D JOIN works W ON did=deptid JOIN employee E ON eno=empno WHERE dname='Firmware'**  
**INTERSECT**

**SELECT did, dname, age**

**FROM department D JOIN works W ON did=deptid JOIN employee E ON eno=empno WHERE dname='Software';**

b. **SELECT ename, age FROM employee**

**WHERE eno = (SELECT mgreno FROM department**

**WHERE budget = (SELECT MAX(budget) FROM department)**

**);**

**Convert SQL to RA**

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**Q5. (5 points)** Consider two sets of FDs, F and G,  $F = \{CD \rightarrow A, AD \rightarrow E, BD \rightarrow E, A \rightarrow D, B \rightarrow C\}$  and  $G = \{CD \rightarrow A, A \rightarrow DE, B \rightarrow C\}$ . Are F and G equivalent? Prove it.

**Both are equivalent**



**Q6.** (6+4= 10 points) Consider the relation schema  $R(A, B, C, D, E)$ , with FDs  $F = \{AB \rightarrow C, BC \rightarrow E, BD \rightarrow E, C \rightarrow B, D \rightarrow A\}$ .

- Find a minimal cover of  $F$  (i.e.  $F_c$ ). Show each step.
- Determine all possible keys (i.e. minimal of super key). Prove it.

**Ans:**

**a.**  $F_c = \{AB \rightarrow C, BC \rightarrow E, BD \rightarrow E, C \rightarrow B, D \rightarrow A\}$

**OR**  $F_c = \{AB \rightarrow C, C \rightarrow E, C \rightarrow B, D \rightarrow A\}$

**b.** Keys are  $\{BD\}$  and  $\{CD\}$ .

**Q7.** (5 points) Consider a relation schema  $R(A, B, C, D, E)$ , with FDs  $F = \{A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A\}$ . Suppose  $\{A\}$ ,  $\{BC\}$ ,  $\{CD\}$ , and  $\{E\}$  are the four possible keys of this relation. 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. List clearly complete set of BCNF schema relations with all keys and FDs and indicate which dependencies are not preserved.

**Ans: HNF= 3NF; FD3:  $B \rightarrow D$  violate BCNF.**

**BCNF relation schemas are:  $R_1(A\ B\ C\ E)$ ;  $R_2(\underline{B}\ D)$  and FD2:  $CD \rightarrow E$  is lost.**

**Q8.** (5 points) Consider a relation schema  $R(A, B, C, D)$ , with FDs  $F = \{AB \rightarrow C, C \rightarrow D, D \rightarrow A\}$ . Suppose  $\{AB\}$ ,  $\{BC\}$ , and  $\{CD\}$  are the three possible keys of this relation. State which of the following decompositions of  $R$  relation are lossless decomposition. Prove it.

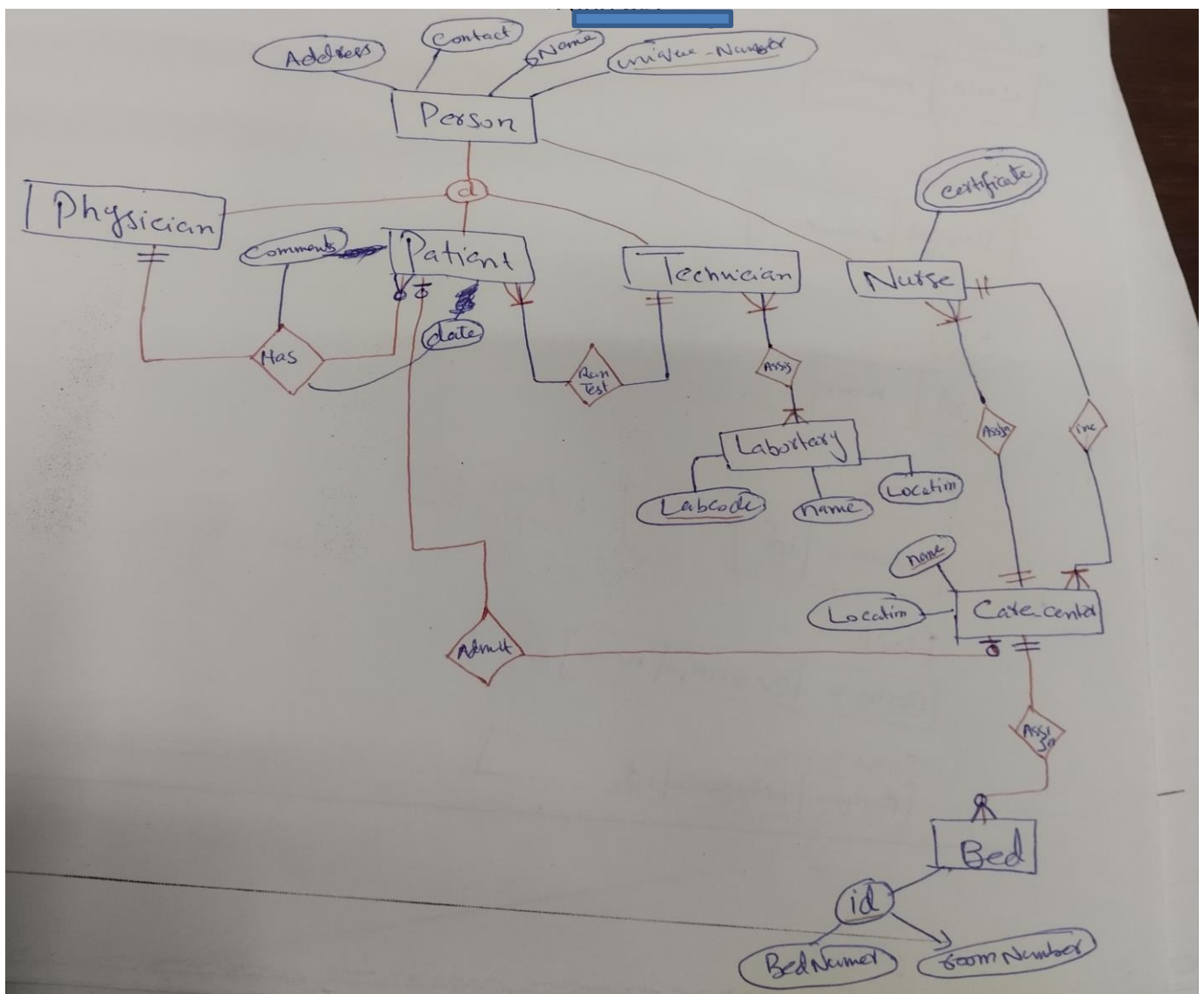
**a.**  $R_1(A, B)$ ,  $R_2(C, D)$ , and  $R_3(D, A)$

**b.**  $R_1(B, C)$ ,  $R_2(C, D)$ , and  $R_3(D, A)$

**Ans:** **a.** Not Lossless      **b.** Lossless

**Q9. (15 points)** As a large service organization, Mountain View community hospital depends on many persons for its continued success. These are physicians, patients, technicians, and nurses. Each person is given a unique number to identify them and has a name, an address, date of birth and contact. A patient has one physician responsible for him/her. The date and comments made during each session with a physician made are recorded. A Nurse is assigned to one care-centre in the hospital. Attributes of care-centre are name (identifier) and location. A nurse has the attribute certificate, which indicates his/her qualifications (RN, LPN etc). A care-centre may have one or more nurses assigned to it. Also, for each care-centre, one of the nurses assigned to that care-centre is appointed nurse in charge. A technician is assigned to one or more laboratories that are identified by a labCode, and have a name, and location. A laboratory must have at least one technician assigned to it and may have any number of technicians assigned. A technician may run one or more tests run on a patient. There may be no beds assigned to a care-centre, or a care-centre may have one or more beds assigned to it. The only attribute of bed is bed id (identifier). Bed id is a composite attribute, with components bed number and room number. A patient may be assigned to a bed if admitted in a care-centre. A bed may or may not have a patient assigned to it at a given time.

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



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