

**INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**  
**ROORKEE – 247667**  
**Database Management Systems (CSN-351)**

**Sheet: 3**

**Total Marks: 100**

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**Instructions:**

- The deadline for assignment submission is **20 October till 11:59 PM**.
- If there is any similarity between the two students' submissions, both will be awarded **zero marks**. So, it's the student's responsibility not to share the submission with other students.
- Each late submission will receive a 15% penalty per day for up to 2 days. No submission will be accepted after the 2<sup>nd</sup> late day.
- You must **handwrite** your solutions; please scan the hard copy and convert it into a PDF with your name and enrolment number. Your name and roll number should be clearly written on the top of the first page.
- Please do not email us your submissions.
- Your submission must be uploaded to the Microsoft team.
- Also, Make sure that you are uploading the **correct file**. Please double-check your submitted file, and update your submission if required. We are not responsible if you get zero or fewer marks for uploading the wrong/older file.

**Que. 1:** Consider a schema with two relations,  $R(A, B)$  and  $S(B, C)$ , where all values are integers. Make no assumptions about keys. Consider the following three relational algebra expressions:

a.  $\pi_{A,C}(R \bowtie \sigma_{B=1} S)$

b.  $\pi_A(\sigma_{B=1} R) \times \pi_C(\sigma_{B=1} S)$

c.  $\pi_{A,C}(\pi_A R \times \sigma_{B=1} S)$

Two of the three expressions are equivalent (i.e., produce the same answer on all databases), while one of them can produce a different answer. Which query can produce a different answer? Give the simplest database instance you can think of where a different answer is produced.

[10 Marks]

**Que. 2:** Consider a relation  $R(A, B)$  that contains  $r$  tuples, and a relation  $S(B, C)$  that contains  $s$  tuples; assume  $r > 0$  and  $s > 0$ . Make no assumptions about keys. For each of the following relational algebra expressions, state in terms of  $r$  and  $s$  the minimum and maximum number of tuples that could be in the result of the expression.

a.  $R \cup \rho_{S(A,B)} S$

b.  $\pi_{A,C}(R \bowtie S)$

c.  $\pi_B R - (\pi_B R - \pi_B S)$

d.  $(R \bowtie R) \bowtie R$

e.  $\sigma_{A>B} R \cup \sigma_{A<B} R$

[10 Marks]

**Que.3:** Consider a database with the following schema:

Person ( name, age, gender )      name is a key

Frequents ( name, pizzeria )      (name, pizzeria) is a key

Eats ( name, pizza )      (name, pizza) is a key

Serves ( pizzeria, pizza, price )      (pizzeria, pizza) is a key

Write relational algebra expressions for the following queries:

- Find all pizzerias frequented by at least one person under the age of 18.
- Find the names of all females who eat either mushroom or pepperoni pizza (or both).
- Find the names of all females who eat both mushroom and pepperoni pizza.
- Find all pizzerias that serve at least one pizza that Amy eats for less than \$10.00.
- Find all pizzerias that are frequented by only females or only males.
- For each person, find all pizzas the person eats that are not served by any pizzeria the person frequents. Return all such person (name) / pizza pairs.

[30 Marks]

**Que 4:** Consider the following relations:

Student(snum: integer, sname: string, major: string, level: string, age: integer)

Class(name: string, meets at: string, room: string, fid: integer)

Enrolled(snum: integer, cname: string)

Faculty(fid: integer, fname: string, deptid: integer)

The meaning of these relations is straightforward; for example, Enrolled has one record per student-class pair such that the student is enrolled in the class.

Write the following queries in SQL. No duplicates should be printed in any of the Answers.

1. Find the names of students not enrolled in any class.
2. Find the age of the oldest student who is either a History major or enrolled in a course taught by I. Teach.
3. Find the names of all classes that either meet in room R128 or have five or more students enrolled.
4. Find the names of all students who are enrolled in two classes that meet at the same time.
5. Find the names of faculty members who teach in every room in which some class is taught.
6. Find the names of faculty members for whom the combined enrollment of the courses that they teach is less than five.
7. For each level, print the level and the average age of students for that level.
8. For all levels except JR, print the level and the average age of students for that level.
9. For each faculty member that has taught classes only in room R128, print the faculty member's name and the total number of classes she or he has taught.
10. Find the names of students enrolled in the maximum number of classes.

[50 Marks]