UCLA
Computer Science Department
Winter 2021

Instructor: J. Cho

CS143 Midterm: 1 Hour 50 minutes

Student Name: ______________________________________

Student ID: ____

(IMPORTANT PLEASE READ **):**

- The exam is *closed book* and *closed notes*. You may use *one double-sided cheat-sheets*. You can use a calculator.
- *Simplicity and clarity of your solutions will count.* You may get as few as 0 point for a problem if your solution is far more complicated than necessary, or if we cannot understand your solution.
- If you need to make any assumption to solve a question, *please write down your assumptions*. To get partial credits, you may want to write down how you arrived at your answer step by step.
- If a question asks for a numeric answer, you don't have to calculate. You may just write down a numeric expression.
- Please, write your answers neatly.

Problem	**Score**	
1	25	
2	30	
3	15	
4	15	
5	15	
Total	100	

1.
    1. Min: r (when $S \subseteq R$), Max: $r + s$ (when $R \cap S =$)
    2. Min: 0 (when all R.B values are different from S.B values), Max: $r \times s$ (when all R.B = S.B = b)
    3. Min: 0, Max: s. This expression is equivalent to $\pi_B(R) \cap \pi_B(S)$
    4. Min: r, Max: r. R $\bowtie$ R is always R
    5. Min: 0 (when A=B for every tuple in R), Max: r (when A≠B for every tuple in R)

2.
    1. No. Consider $R = \{(1, 2)\}, S = \{(1, 3)\}$
    2. Yes
    3. Yes
    4. Yes
    5. No. Consider $R = \{(1, 0), (2, 0)\}$.
    6. No. Consider $R = \{(2, 1), (3, 1)\}$.

3. $\pi_{R.A,R.B}(\sigma_{R.A=S.A \wedge R.B=S.B}(R \times S))$

4. {(1,3), (2, NULL)}. 'NULL = NULL' is Unknown, so when the WHERE clause condition is applied, the R tuple (1,1) will join with S tuples {(1, 3), (1, NULL)} and the R tuple (1,2) will join with S tuple (2, NULL). Then after GROUP BY A, S.B, we have two groups ((1,1), {(1,3), (1,NULL)}) and ((1,2), {(2, NULL)}), and the result of AVG(C) will be 3 and NULL for each group, respectively.

5.
    1. False (double lines is at least, not at most).
    2. True (Each state has one mayor)
    3. True (state.name, city.name) is the key of a City, so city.name must be unique within a state
    4. True (state name is the key of State entity set)
    5. False (No such constraint is implied by the given ER model)