
Name:

SSN:

Directions:

- ☐ The test has 5 questions, each worth as indicated, there is a total of 20 points.
 - ☐ Read the question carefully and answer only what is asked
 - ☐ Provide justification for your arguments!
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1. (2 points) Suppose that we have a relation $R(P,Q,R)$ with a multivalued dependency $P \twoheadrightarrow Q$. If we know that (p_1, q_1, r_1) and (p_2, q_2, r_2) are in the current instance of R , what other tuples do we know must also be in R .

2. (2 points) Consider a relation schema $R(X,Y,Z,P)$ with the functional dependencies:
 $X \rightarrow Y$, $Y \rightarrow P$ and $Y \rightarrow Z$

- a) Which of the above functional dependencies violates the 3NF condition?
Why? And, why not?
- b) Based on the results of a) decide whether R is in 3NF or not.

3. (3 points) Consider the relation schema $R(X,Y,Z,P)$ with the multivalued dependency (MD) $XY \twoheadrightarrow Z$ and the functional dependency $Y \rightarrow Z$.
- Derive one multivalued dependency from the functional dependency!
 - Find all MDs from the given MDs and the MDs from (a) that violate the 4NF condition!
 - Is R in 4NF?
 - Decompose R into 4NF relations!

4. (3 points) Suppose that we have two relations

P	Q	T
1	2	3
6	7	8
9	7	8

Relation Z

S	T	U
2	3	4
7	8	10
2	3	5

Relation V

- a) Compute the natural join of Z and V: $Z \bowtie V$
b) Compute the theta join of V and Z with the condition $P < U$: $V \bowtie_{P < U} Z$

5. (5 points) Suppose that we have the following relational database schemas

Product(maker, model)

PC(model, speed, ram, hd, cd, price)

Laptop(model, speed, ram, hd, screen, price)

Printer(model, color, type, price)

with the assumption that a model number is unique over all manufacturer and product types. This means that the above four relations have *model* as one of their keys.

In what follows, “a computer” is understood as either a PC or a laptop.

Write expression of relational algebra for the following queries:

- a) Which manufacturers produce PC and also produce laptop?
- b) Which manufactures produce computer with the speed 120?
- c) List all the products produced by manufacturer ‘A’!
- d) Find those pairs of PC models that have both the same speed and RAM. A pair should be listed only once!
- e) Which tuples belong to the result of the following expression:

$$\pi_{\text{model,maker}}(\sigma_{\text{ram}>64}(\text{PC}) \cup \sigma_{\text{ram}>64}(\text{Laptop})) ?$$

6. (5 points) Suppose that we have the following relational database schemas

Product(maker, model)

PC(model, speed, ram, hd, cd, price)

Laptop(model, speed, ram, hd, screen, price)

Printer(model, color, type, price)

with the same assumption as in the previous question.

Write SQL queries for the following queries:

- a) Which manufacturers produce PC and also produce laptop?
- b) Which manufactures produce computer with the speed 120?
- c) List all the products produced by manufacturer 'A'!
- d) Find those pairs of PC models that have both the same speed and RAM. A pair should be listed only once!
- e) Find the fastest computer produced by manufacturer 'A'!