Exam II
Computer Science 420
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Lehman College
City University of New York
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NAME (Printed) ________________________________
NAME (Signed) ________________________________
E-mail ________________________________

Exam Rules

• Show all your work. Your grade will be based on the work shown.
• The exam is closed book and closed notes.
• When taking the exam, you may have with you pens or pencils, and an 8 1/2” x 11” piece of paper filled with notes, programs, etc.
• You may not use a computer or calculator.
• All books and bags must be left at the front of the classroom during this exam.
• Do not open this exams until instructed to do so.

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1. True or False:

(a) ___ Once created, database tables and schemas cannot be modified.
(b) ___ You cannot embed a query inside another query (ie a subquery) in SQL.
(c) ___ A superkey for a relation is a set of attributes that functionally determine all the attributes of the relation.
(d) ___ SQL regards relations as bags of tuples, not sets of tuples.
(e) ___ Every set is a bag.
(f) ___ Every functional dependency is a multi-valued dependency.
(g) ___ A view is a definition of how one relation (the view) may be constructed from tables stored in the database.
(h) ___ Views can be queried as if they were tables.
(i) ___ In SQL, the declarations UNIQUE and PRIMARY KEY have the same effect.
(j) ___ In SQL, the expression, \((\text{NULL AND TRUE}) \lor \text{FALSE}\) evaluates to \text{FALSE}.

2. Consider the following relational schema:

\[
\text{Name}(\text{ID}, \text{name}) \quad // \text{ID is a key} \\
\text{GPA}(\text{ID}, \text{gpa}) \quad // \text{ID is a key}
\]

(a) Write a relational algebra expression to find all students and their GPA. (That is, your answer should be a relation, with two attributes, one for the student name and one for the GPA).

(b) Write a relational algebra expression to find the names of all students with the highest GPA in the database:

3. Write a java program that prints "Hello, world" to the screen:
4. Suppose we have a relation \( R(A, B, C, D, E) \) with the following functional dependencies: \( AB \rightarrow C \), \( CD \rightarrow E \), \( C \rightarrow A \), and \( C \rightarrow D \).

   (a) What are all the keys for \( R \)?

   (b) Give an example of a functional dependency that is a BCNF violation for \( R \):

   (c) Into what two relations does this violation tell us to decompose \( R \)?

5. Suppose \( R \) and \( S \) are relations.

   (a) Suppose relations \( R \) and \( S \) have 1 tuple and 2 tuples, respectively.
   
   What is the minimum number of \( R \cup S \) could have, under the bag semantics?

   What is the minimum number of \( R \cup S \) could have, under set semantics?

   (b) Suppose relations \( R \) and \( S \) have 2 tuples and 3 tuples, respectively.
   
   What is the minimum number of \( R \cup S \) could have, under the bag semantics?

   What is the minimum number of \( R \cup S \) could have, under set semantics?

   (c) Suppose relations \( R \) and \( S \) have \( n \) tuples and \( m \) tuples,
   
   What is the minimum number of \( R \cup S \) could have, under the bag semantics?

   What is the minimum number of \( R \cup S \) could have, under set semantics?
6. Answer the questions below based on the following schema:

   companies(co_id, co_name, co_postcode, co_lastchg);
   products(pr_code, pr_desc);
   orders(ord_id, ord_company, ord_product, ord_qty, ord_placed,
           ord_delivered, ord_paid);
   diary(dy_id, dy_company, dy_timestamp, dy_type, dy_notes);

(a) Write a query that returns the product codes contained in the database:

(b) Write a query that returns the product codes and the average number ordered
    of each per order:

(c) Create a view that contains the name of each company and the total number of
    orders placed for that company:

(d) Create an index on ord_company:

(e) Write a query that select all orders that were placed in a different month from
    when the product was delivered. For example, the order is placed on 06-29-2001,
    and the product is delivered on 07-06-2001. Include in the output, the order ID,
    the product code, the date the order was placed and the date is was delivered:
7. Given two relations $R$ and $S$:

(a) Give the definition of the natural join $R \bowtie S$:

(b) Give the definition of the theta-join $R \bowtie C S$:

(c) What is the difference between $R \bowtie S$ and $R \bowtie C S$ where the condition $C$ is that $R.A = S.A$ for each attribute $A$ appearing in the schemas of both $R$ and $S$?

8. (a) Rewrite the following SQL query **without** using the INTERSECT or DIFFERENCE operators:

\[ \text{(SELECT name, address FROM MovieStar WHERE gender = 'F')} \]

\[ \text{INTERSECT} \]

\[ \text{(SELECT name, address FROM MovieExec WHERE netWorth > 10000000);} \]

(b) Show how to express the relational-algebra query

\[ \pi_L(\sigma_C(R_1 \times R_2)) \]

in SQL, where $L$ is a list of attributes and $C$ is an arbitrary condition: