Name	NetID

CS411: Database Systems **Spring 2016**

Midterm, March 4

- READ THESE INSTRUCTIONS CAREFULLY BEFORE YOU START. DO NOT turn this page UNTIL the proctor instructs you to.
- First: write your name and NetID at the top of this sheet.
- The exam lasts for 75 minutes, i.e., from 9–10.15am.
- We will not answer any questions during the exam. If you need to make any assumptions for any of the questions, please feel free to do so and then clarify the assumption in your answer.
- The examination contains both objective type (True/False) and long answer questions. There are 10 objective type questions, and 4 long answer questions. All questions are compulsory.
- For the objective type questions, **please circle the right answer, and provide a short description justifying your choice**. If you need extra space for any calculations, feel free to use the back side of each page. Each of the objective type questions is worth 2 points.
- For the long answer questions, please answer in the space provided; if you need more space, feel free to use the back side of each page. You should not need more space, and we will not provide more space, so please use your space wisely. Show all necessary steps as part of your calculation to get partial credit.
- The maximum score you can obtain is $20 + 20 + 10 + 24 + 26 = 100$.
- You must stop writing when time is called by the proctors.
- **Cheating: No.**

Question	1	2	3	4	5	Total
Points						

Objective-Type Questions - 20 points

Please **circle** the right answer, and provide a short 1–2 line description justifying your choice.

1. [2] It is possible for weak entity sets to have non-supporting relationships with other entity sets.

   True False

2. [2] A weak entity set can never be part of a many-to-many relationship.

   True False

3. [2] For a relation $R(A, B)$ with two tuples, at least one among i) $A \rightarrow B$ or ii) $B \rightarrow A$ must always hold.

   True False

4. [2] The projection operation is faster in set semantics compared to bag semantics.

   True False

5. [2] The following formula is valid under bag semantics: $(R \cup S) - T = (R - T) \cup (S - T)$. If yes, prove it and if no, provide a counter-example.

   True False

6. [2] If X^+ contains all the attributes of the relation, then X must be a superkey.
   True False

7. [2] Any table with two attributes must be in BCNF.
   True False

8. [2] 3NF is dependency-preserving, lossless, and minimizes redundancy when compared to BCNF.
   True False

9. [2] An E-R diagram with m entities and n relationships will always translate to at least $m + n$ tables in the relational model.
   True False

10. [2] An attribute declared as UNIQUE can have NULL as its value.
    True False

Database Design - 20 points

1. [10] You are to design a database for an insurance company. The data will include:

   - Information about customers (SSN, name, address and phone number)
   - Information about insured cars (model, vehicleID and insurance rate)
   - Information about claims made on insured cars (claimID, claim date, settlement date and amount of settlement)
   - An insured car can have multiple insurance claims
   - You may assume that all insured cars are owned by a single customer, but you should allow a customer to own several cars

   Specify an E/R design for your database. Please state any additional assumptions you make in your design. Don't forget to underline key attributes for entity sets and include arrowheads indicating the multiplicity of relationship sets. If there are weak entity sets or "is-a" relationships, make sure to notate them appropriately.

2. [10] Convert the E/R diagram from question 1 to a relational schema. Merge relations where appropriate. Please show the relational schema before and after the merge, if any. Make sure to underline key/s in each relation.

Armstrong's Axioms - 10 points

Derive the following rules using Armstrong's axioms:

1. [5] Combining rule: $X \to Y, X \to Z \implies X \to YZ$

2. [5] Splitting rule: $X \to YZ \implies X \to Y$

Functional Dependencies and Normal Forms - 24 points

Consider a relation $R(A, B, C, D, E)$ with the following functional dependencies:

$AB \rightarrow C$

$BC \rightarrow D$

$CD \rightarrow E$

$DE \rightarrow A$

1. [6] Specify all minimal keys for R among the following: $\{AB, BC, CD, ED, ABD, BDE, BCE\}$.

2. [4] Which of the given functional dependencies (FDs) are Boyce-Codd Normal Form (BCNF) violations?

3. [7] Using our algorithm for BCNF decomposition, give a decomposition of R into BCNF based on the FDs.

4. [7] Can the algorithm produce a different decomposition into BCNF? If so, provide the corresponding decomposition. Otherwise write "no different decomposition".

Relational Algebra and SQL - 26 points

Consider the following relational database schema:

lives (name, street, city)

works (name, company, salary)

located (company, city)

manages (managee-name, manager-name)

You may make the following assumptions for this problem:

(a) The first attribute is a key for each relation (i.e., lives.name, works.name, located.company, and manages.managee-name are keys).

(b) Every person in the works relation also appears in the lives relation, but not necessarily vice-versa (i.e., no one works without living, but people may live without working).

Specify a relational algebra expression for each of the following queries:

1. [5] Find the names, streets, and cities of all people who work for IBM and earn more than 30,000.

2. [5] Find the names of all managers who work in Seattle.

Specify the following queries using SQL:

1. [8] Find the names of all people who work for IBM, and do not manage anyone.

2. [8] Find the names of all people who live and work in different cities.