University of Toronto at Scarborough
CSCD34SSpring 2000

Midterm Test

Duration: 90 minutes

Aids allowed: None

Make sure that your examination booklet has 10 pages (including this one). Write your answers in the spaces provided. Write legibly.

Family Name: ____________________

First Name: ____________________

Student # : ____________________

1.	________	/ 10
2.	________	/ 8
3.	________	/ 12
4.	________	/ 10
Total	________	/ 42

Question 1

[10 marks in total]

True or False: [1 mark each correct answer, -1 each incorrect answer, 0 each null answer]

1. In an E/R diagram, it is possible to have both a key constraint and a total participation constraint on the same edge.
2. For any relation r, if V and W are two arbitrary subsets of the schema of r, then it is always the case that $r \subseteq \pi_V(r) \bowtie \pi_W(r)$.
3. Natural join is a commutative operator.
4. A relation scheme with no functional dependencies has exactly one key.
5. A relation scheme that is in BCNF must be in 3NF.
6. Null values are not allowed to appear in any primary key field of an SQL table.
7. Using SQL it is impossible to delete a row from a table if there is a foreign key constraint from some other table into this one.
8. The translation methods from E/R into relational schemas described in class always produce the same number of relation schemes as the total number of entity sets and relationship sets in the E/R diagram.
9. Given relation scheme R with key X, every decomposition of R into two relation schemes of the form XY, XZ is lossless.
10. Relational division can be expressed using one or more of cartesian product, projection, selection, union, intersection, and renaming.

Question 2

[8 marks in total]

You are asked to design an aircraft maintenance database for Air Canada. The database will store information about a set of airplanes, each identified by a serial number. For each airplane we wish to store its manufacturer, model number, date of purchase, and airport where it is based. In addition, each airplane contains a set of components, such as engines, wings, etc. A component in turn may contain sub-components, and so on recursively: for example, an engine may contain a turbine assembly, which contains a fan, which contains blades.

Each component is of a certain *type*, identified by a type-identifier. For each type of component, we want to store its name and a set of suppliers from which we can buy replacement parts for components of this type. For each supplier, we store its name, address, and phone number.

Each component is uniquely identified by its type-identifier together with a part-identifier. For example, an airplane may have two engines, both having the same type-identifier but different part-identifiers.

(a) [4 marks]

Give an E/R diagram for this database. State any assumptions you make.

(b) [4 marks]
Give a set of SQL CREATE TABLE statements for the tables that result from the relational translation of your schema of part (a). Include all appropriate key and foreign key constraints. State any assumptions you make.

Question 3

[12 marks in total]

(a) [4 marks]

The schema below describes all movies, actors, and directors ever nominated for an Academy Award (Oscar). State what key constraints and referential integrity constraints can be used to enforce the following constraints on the schema below, plus any other constraints that you think are reasonable. If there are any constraints that cannot be enforced by key and referential integrity constraints, explain why.

> *Each movie has a unique title. A movie can have one or more directors, and one or more actors. Directors and actors are uniquely identified by their names. Each year, one or more movies are nominated for best movie, listed in the* `BestMovie` *relation. A movie can only be nominated in one year. Each year, one or more persons are nominated in each person category (e.g. "best actor,") listed in the* `BestPerson` *relation. A person is only nominated once for a particular movie; the same person could be nominated for several movies on the same or different years.*

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Dir[Title, Director]
Act[Title, Actor ]
BestMovie[Title, Year]
BestPerson[Category, Name, Title, Year]
```

(b) [4 marks]
Write a relational algebra expression for the query: find the movies that hogged all nominations in some year, that is: all the movies `m` and years `y` such that every person who was nominated in year `y` was nominated for movie `m`, and `m` was also nominated for best movie in year `y`.

(c) [4 marks]
Write a relational algebra expression for the query: find the most recent year when Tom Cruise was nominated for any award.

Question 4

[12 marks in total]

Consider a relation scheme R with attributes $\{A, B, C, D, E\}$ and the following functional dependencies: $A \rightarrow B$, $B \rightarrow A$, $B \rightarrow D$, and $DE \rightarrow C$.

(a) [2 marks]
Find all candidate keys.

(b) [2 marks]
Compute $(AE)^{+}$.

(c) [2 marks]
Prove that $AE \rightarrow C$ follows from the given set of functional dependencies by deriving it using the inference rules.

(d) [2 marks]
Show that R is not in BCNF.

(e) [4 marks]
Give a BCNF decomposition of R.