UNIVERSITY OF BIRMINGHAM

School of Computer Science

First Year – MSc Computer Science
First Year – MSc Financial Engineering

06 21923

Fundamentals: Databases

Summer Examinations 2013

Time allowed: 1 hr 30 min

[Answer Question ONE and TWO out of remaining THREE Questions]

[Answer THIS Question]

1. Suppose a database is required to contain a table for an entity type called Cities with attributes that include:

   Name
   CountryId
   IsCapital
   HasCathedral
   Population
   HeightAboveSea.

   The attributes IsCapital and HasCathedral are BOOLEAN and say whether or not the city is the country's capital and whether or not the city contains a cathedral.

   The Name attribute has STRING values.

   Suppose there is also a Countries entity type with attributes that include:

   CountryId
   Population.

   The Population attributes in both tables are INTEGER-valued.

   FIRST DO THE FOLLOWING:

   (a) Specify a reasonable primary key (PK) for the Cities entity type, and clearly state any assumption or other consideration on which your choice of PK rests. You may use existing attributes and/or add one or more new attributes. [3%]

   THEN PROVIDE SQL queries for the following tasks:

   (b) Creating the Cities table (assuming the Countries table has already been created). [5%]

   (c) Displaying (in any order) the PK values of the cities that are a capital or have a cathedral (or both). The display should NOT contain information other than the PKs. For example, it should not contain cities' populations or heights. [6%]

(d) Doing the same as in (b) except that now there should be ONE additional column in which each value is one of three possible string values :"capital", "cathedral", "both". The first of these values ("capital") is to be used when the city is a capital but does not have a cathedral. The second value ("cathedral") is to be used when the city has a cathedral but is not a capital. The third value ("both") is to be used when the city both has a cathedral and is a capital. [9%]

(e) Displaying in descending alphabetical order the names of the countries whose population is bigger than 3 times the maximum population of the cities in that country. You may assume that all the countries in the Countries table are also represented in the Cities table. [Hint: first write a query for the task of creating a table showing for each country the maximum population of its cities. Partial credit will be given for this subsidiary task even if you do not do the whole task.] [9%]

[Answer TWO out of the remaining Three Questions]

2. (a) Does the nature of the Cities and Countries tables specified in Question 1 capture the fact that a country has one and only one capital city? If so, explain how. If not, specify a variant approach (possibly with somewhat different tables) that does adequately capture that fact. [8%]

(b) Suppose now that we wanted to represent the presence of many types of major religious building in cities, not just the presence of cathedrals. For example, we want to represent the presence of mosques, synagogues and analogous types of building from other major world religions. Assume that there are many such types of building (at least twenty, say) and that in principle a city might have all of them, BUT that a city usually only has a minority of them, if any. Specify a good way of changing or adding to the arrangement in Question 1, and explain why you think your design is good. [9%]

(c) Suppose that there is an M:N relationship R between two entity types E and F, and that we tried to represent R in the logical design without using a bridging table. What problems would arise? [9%]

(d) A method was recommended in the module for representing a 1-1 symmetric relationship such as marriage. Explain how to modify the method to allow people to be married to different people at different times. Provide an ERD fragment that helps explain the method. (You can use any ERD style or your own variant, but you should STATE which style(s) you are using or modifying, and should EXPLAIN any modifications.) [8%]

3. [NOTE: In each part of this question you can provide examples, and some credit will be awarded for these, but you should also make accurate general statements to the extent that you can.]

   (a) Does every entity type have at least one candidate key? Justify your answer. [8%]

   (b) In what way are certain types of key involved in the notion of a transitive dependency? [8%]

   (c) What is Second Normal Form (2NF), and how can it be achieved in an ERM that is not yet in this form throughout? You may assume that it is in 1NF throughout. [9%]

   (d) Explain as clearly and precisely as you can why Third Normal Form (3NF) is desirable. [9%]

4. (a) This is about the Cities and Countries tables in Question 1. Provide a relational algebra expression whose value is the set of city PK values for cities whose population is less than one tenth of the population of the country that the city is in. (You may wish to construct an SQL query first, but credit can only be given for the relational algebra expression.) [9%]

   (b) Explain the sense in which a table representing an entity type involves a mathematical relation. You may assume that the entity type has at least two attributes. [9%]

   (c) Suppose the relationship between a Painters entity type and a Paintings entity type is 1:M. Now consider the mathematical relation S from painters to paintings induced by this relationship at a given moment, and the inverse relation T from paintings to painters. State, with justifications, whether S is functional and/or total, and whether it is a function. Do the same for T. [8%]

   (d) In what way are Cartesian products of sets relevant to the joining of tables? [You can provide examples, and some credit will be awarded for these, but you should also make an accurate general statement to the extent that you can.] [8%]