Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Database Systems

Date: Monday 19th May 2008
Time: 14:00 – 16:00

Please answer THREE questions from the FIVE provided

This is a CLOSED book examination

The use of electronic calculators is NOT permitted.
1. a) Explain the difference between a super key and a candidate key in a relation, and the role of a primary key. Use an example to illustrate your answer. (6 marks)

   b) Explain possible integrity violations in a relational schema after an update operation. Consider the following relations from a database containing information about modules, lecturers and timetables:

   Module(ModuleID, ModuleName, Credits)
   Lecturer(LecturerID, LecturerName, Position, Department)
   Timetable(ModuleID, ModuleName, LecturerID, LecturerName, Time)

   A module may be taught by different lecturers, and in various time slots. Does the above design suffer from the problem of possible update integrity violations? Explain your answer. (7 marks)

c) Explain the need for object-oriented and XML databases. Support your views with discussion on emerging developments in the area and with a comparison to relational databases. Provide a critical comparison between object-oriented and XML databases. (7 marks)

2. a) Explain the notion of weak entity sets in an ER schema and give an example. (5 marks)

   b) Design an EER diagram for a library database system described below:

   - The database should store library items. Each library item has a title and a unique identification number (ID). It also has a publisher who has a unique name and a web address (URL, also unique). A library item is published by a single publisher, and can be either a magazine, a journal, a book, or a conference proceedings. A magazine has a date of publication and a type (e.g. weekly magazine, quarterly magazine). A journal has a volume and a number. A book has at least one author. A conference proceedings has a location, a date, and at least one editor.

   - The model should also represent borrowers, i.e. people who borrow library items. Each borrower is assigned a unique identifier (BID) by the library and has a name and an address.

   - When a borrower checks out a library item, both the check-out date and the latest return date are assigned to this transaction. If a borrower is a student, then s/he can keep a library item for at most three months; if s/he is a lecturer, s/he can keep it for six months; otherwise, s/he can keep it for one month only.

   (Question 2 continues on the following page)
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- Borrowers can reserve a library item (if it is not available), and the
database should store the date when the reservation was made. Each
library item can be reserved by several borrowers (reservations are
satisfied in a first-come-first-serve order).

Make sure that you specify the primary keys, cardinality constraints, participation
constraints, and constraints on generalization/specialization (if any). Also, justify
your design decisions and specify any additional assumptions that you have
made. (15 marks)

3. a) Explain the three types of database systems that can be used to store, manage and
query XML data. What are the advantages of native XML databases? (6 marks)

b) Map the ER diagram shown below into a relational schema, explaining the
process that you have followed. Indicate primary key and foreign keys for each
relation and show the dependencies between relations.

![ER Diagram]

(14 marks)
4. a) Consider the following relational schema for an airline database system.

FLIGHTS (flight-num, departure-city, destination-city)
DEPARTURES (flight-num, flight-date, plane-type)
PASSENGERS (passenger-id, name, address, preferred-meal, preferred-seat-location)
BOOKINGS (passenger-id, flight-num, flight-date, seat-number)

Provide SQL expressions for the query/update situations below:

- Find the names of all passengers preferring “aisle” seats.
- Count the number of passengers in the database.
- Create a view MAN747FLIGHTS consisting of the flight number, flight date and destination city of all flights departing from “Manchester” in a plane of type “747”.
- Find flight numbers and flight dates for flights with fewer than 50 seats booked.
- Delete all bookings for the passenger with passenger-id = “pa121”.

(11 marks)

b) Given the relation R with attributes A, B, C, D, E, F and the following original set F of functional dependencies:

\[ F = \{ A \rightarrow \{ B, C \}, \quad \{ C, D \} \rightarrow \{ E, F \}, \quad B \rightarrow E \} \]

Provide three other non-trivial functional dependencies that can be derived from F. Describe which inference rule you used to derive each functional dependency.

(9 marks)
5. a) Discuss the concept of a transaction in a database system. Describe the model used by JDBC to communicate with a database and implement database application transactions. (6 marks)

b) The following ODL (Object Definition Language) definitions form a partial model of an object database:

```odl
class Module
  (extent modules key code)
  {
    attribute string name;
    attribute string code;
    relationship <Academic> is_taught_by inverse Academic:: teaches;
    relationship set <Student> is_taken_by inverse Student:: takes;
    ...
  }

class Academic
  (extent academics key staff_number)
  {
    attribute string name;
    attribute int staff_number;
    attribute string position;
    attribute string school;
    relationship set <Module> teaches inverse Module:: is_taught_by;
    ...
  }
```

Using the ODL, define an example class `Student` that contains three attributes (`name, student_id` and `year`) and one relationship (`takes`, describing the modules taken by a student). Using the OQL (Object Query Language), define a view `get_academics(school)` that retrieves all academics who work in a given school. Using the view, write an OQL statement that returns the number of academics in the School of Computer Science (assuming that there is a corresponding persistent object named `CS`). Finally, write an OQL query that retrieves a list of students ordered by their name, who take a module taught by a staff from the School of Computer Science. (14 marks)

END OF EXAMINATION