Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE
M.Sc. in Informatics

Systems Design and Databases

Friday 30th January 2009
09:45 – 11:45

Please answer ONE question from SECTION A and TWO questions from SECTION B

Use a SEPARATE answer book for each section

The use of electronic calculators is NOT permitted.
SECTION A
Answer ONE question from this section

A1. a) Briefly explain what a software process is. (4 marks)
    b) Briefly explain the phases of the waterfall model. (4 marks)
    c) Discuss the advantages and disadvantages of the waterfall model. (4 marks)
    d) Consider a shop that is planning to set up a system for managing sales over the counter in the shop as well as controlling its stock. Suppose the software engineer has decided to use the waterfall model. Outline and explain the activities that the software engineer will perform. (8 marks)

A2. a) What are software requirements? (4 marks)
    b) Explain the main steps of the requirements engineering process. (4 marks)
    c) Explain what functional and non-functional requirements are. (2 marks)
    d) Explain what user and system requirements are. (2 marks)
    e) Consider a shop that is planning to set up a system for managing sales over the counter in the shop as well as controlling its stock. Identify and explain the main user, system, functional and non-functional requirements for this system. (8 marks)
B1. a) Explain possible integrity violations in a relational schema after a delete operation and possible remedy actions taken by a database management system (DBMS).

Consider the following relations from a database containing information about courses and students (primary keys are underlined, and Course_ID in the Takes relation is a foreign key referring to the Course relation):

\[
\begin{align*}
\text{Course} & \quad (\text{Course\_ID}, \text{semester}, \text{lecturer}) \\
\text{Takes} & \quad (\text{Student\_ID}, \text{Course\_ID}, \text{semester}, \text{grade})
\end{align*}
\]

Does the above design suffer from the problem of possible integrity violations after a delete operation? Which action would you ask a DBMS to perform in order to remedy any potential integrity violation in this case? (6 marks)

b) Explain the concept of overlapping subclasses in the enhanced entity-relationship (EER) model. (3 marks)

Map the EER 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 them. (11 marks)
B2.  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) Consider the following relational schema for a private hospital database system (primary keys are underlined):

   PATIENT (PId, PName, HealthPlan)
   CASE (Caseld, PId, CDate)
   TREATMENT (Caseld, Dname, TDate, Disease)
   PRESCRIPTION (PrId, Caseld, PDate, Drug, Amount, Approved)

The PATIENT table stores information on patients (a unique identifier, name and type of their health plan, which can be ‘A’, ‘B’, ‘C’ or ‘D’). The CASE table records specific injury/problem cases (the same patient can have multiple cases). The TREATMENT table stores patient treatment information such as doctor name (DName), treatment date (TDate) and Disease with which the patient is being diagnosed. As part of a treatment, a patient can have multiple prescriptions (recorded in the PRESCRIPTION table). If the Approved flag is null, the status of the prescription is pending; 'Y' means that the prescription has been approved and 'N' that the prescription is denied.

Provide SQL expressions for the following tasks:

- Retrieve the names of patients who have a health plan 'B'.
- Retrieve the names of doctors who treated patients whose prescriptions were denied.
- Retrieve the names of doctors who have treated at least three different patients.
- Retrieve the names of patients along with the total number of prescriptions they have received.
- Create the CASE table.
- Set the Approved flag to ‘Y’ for all patients with health plan ‘D’. (14 marks)
B3.  

a) Explain the three-level ANSI/SPARC database architecture. Give an example of a database system that has multiple external schemas. (6 marks)

b) Consider the following ODL (Object Definition Language) definition:

```
class Student
  (extent students key student_id)
  {
    attribute string name;
    attribute int student_id;
    attribute int year;
    attribute string school;
    attribute date birthdate;
    attribute enum Gender{M, F} sex;
    relationship set<Module> takes inverse Module::is_taken_by;
  }
```

i) Explain the idea of referential integrity and compare how it is maintained in the relational and object-oriented (OO) data models. Provide an OO example by defining a class Module with a relationship (is_taken_by) referring to a set of students that take a given module. The Module class should also contain attributes name and code. (7 marks)

ii) Using Student and Module classes, write OQL (Object Query Language) statements for the following tasks:

- return the total number of students in the School of Computer Science who take the module with code COMP67321;
- retrieve the names of modules that are taken only by the students from the School of Computer Science. (7 marks)