Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

M.Sc. in Informatics

Systems Design and Databases

Date: Wednesday 27th January 2010

Time: 14.00 – 16.00

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

1.  a) Briefly explain what a software process is.  
    b) Briefly explain the phases of the waterfall model.  
    c) Discuss the advantages and disadvantages of the waterfall model.  
    d) Consider a small retail business that is planning to set up a shop on the internet. The shop should allow customers to set up on-line accounts, place orders, make payments, and check the status of their orders as well as their accounts. The company has hired a software engineer to design and implement the computer system for the internet shop. Suppose the software engineer has decided to use the waterfall model. Outline and explain the activities that the software engineer will perform.

2.  a) What are software requirements?  
    b) Explain the main steps of the requirements engineering process.  
    c) Explain what functional and non-functional requirements are.  
    d) Explain what user and system requirements are.  
    e) Consider a small retail business that is planning to set up a shop on the internet. The shop should allow customers to set up on-line accounts, place orders, make payments, and check the status of their orders as well as their accounts. The company has hired a software engineer to design and implement the computer system for the internet. Identify and explain the main user, system, functional and non-functional requirements for this system.
SECTION B
Answer TWO questions from this section

3. a) The following relation has been used to describe part of an Estate Agency database that stores details of properties for sale and contact information for clients:

Properties(ID, city, street, price, name, telephone)

The first four attributes (ID, city, street and price) describe a property, while the last two refer to a customer (their name and telephone number) interested in viewing it. Functional dependencies in this relation are as follows:

ID → ID, city, street, price; name → name, telephone; telephone → telephone, name.

Since there is partial dependency of the attributes on the key to the table, this relation suffers from the redundant repetition of data. Provide an example to illustrate that. In addition, give two examples of update operations that illustrate the update anomalies (e.g. insertion, modification, deletion) that derive from the redundant repetition of data in this relation. (6 marks)

b) 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.

(14 marks)
4. 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 university library:

LIBRARY(libno, libname, location, rooms)
BOOK(bookno, title, pages, authno (fk))
AUTHOR(authno, authname)
COPY(copyno, libno (fk), bookno (fk), cost)
LOAN(copyno (fk), borrowerno (fk), due_date)
BORROWER(borrowerno, name, age)

Most attribute names are self-explanatory. In the LIBRARY and BOOK tables, the rooms and pages attributes refer to the number of rooms in a library and to the number of pages in a book, respectively. The cost attribute in the COPY table refers to how much the library paid for the copy of a book. Attributes followed by (fk) are foreign keys, and underlined attributes are primary keys. Some features of the schema are:

• Each book has only one author recorded in the database.

• Each book has a distinct book number, known as ISBN, that is represented at the schema by the bookno attribute.

• It is important to differentiate between a BOOK and a COPY of a book. For instance, the book (Fundamentals of Database Systems, ISBN 0201542633) has several copies available within the same or different libraries (e.g., 3 copies at John Rylands, 2 at the SCS library, etc.). The system assumes that each copy has a distinct copy number (copyno attribute) that uniquely identifies the copy independently of the library where it is situated.

Provide SQL expressions for the following tasks:

i) Retrieve the names of libraries that have more than 3 rooms. (1 mark)

ii) Retrieve the names of borrowers who need to return books by “10 May 2010”. (2 marks)

iii) Retrieve the names of borrowers who have no books on loan. (2.5 marks)

iv) Retrieve the names and locations of libraries that have books written by the author whose name is "Codd". (2.5 marks)

v) Retrieve the names of borrowers who have more than 3 books currently on loan. (3 marks)

vi) Create an SQL view that contains the borrower name, due_date and copyno of all books borrowed by senior citizens (i.e., age > 65). (3 marks)
5. a) When mapping an EER schema to a relational schema, class/sub-class hierarchies can be mapped in several different ways. For the following example, give a suitable mapping, and discuss its advantages and disadvantages. (6 marks)


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

```plaintext
class Student
(extent students key student_id)
{
  attribute string name;
  attribute int student_id;
  attribute int year;
  attribute string school;
  attribute string programme;
  attribute date birthdate;
  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, code and year. (6 marks)

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

- retrieve the names and programmes of all students in the second and third years;
- 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. (8 marks)

END OF EXAMINATION