Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Advanced Databases

Date: Friday 22nd January 2010
Time: 09.45 – 11.45

Please answer any THREE questions from the FIVE questions provided
Please use a SEPARATE answer book for Question 5

The use of electronic calculators is NOT permitted
1. The following relations are from the database of a SUBWAY Restaurant, and are the setting for this question.

   Subs (subNum, name, flavour, price, categoryNum)
   Categories (cNum, name, description)

a) Write a JDBC code fragment that is equivalent to the following PL/SQL program. You do not need to show connection to the database. State any assumptions you make.  

   declare
       cursor C1 is
       select Subs.name, Subs.flavour, Categories.name
       from Subs, Categories
       where Subs.categoryNum = Categories.cNum;

       Name Subs.name%type;
       Flavour Subs.flavour%type;
       Category Categories.name%type;

begin
    open C1;
    fetch C1 into Name, Flavour, Category;
    while C1%found loop
        dbms_output.put_line('Row Number ' ||
            C1%rowcount || ' is ' ||
            Name || ' ' || Flavour || ' ' || Category);
    end loop;
    close C1;
end

b) State 4 reasons why PL/SQL may be preferred to JDBC. 

   4 marks

c) State 4 reasons why JDBC may be preferred to PL/SQL. 

   4 marks

d) You have been told the following: “The PL/SQL will be quicker for the program in part a)”. Do you agree with this statement? 

   Discuss your opinion, using as arguments the issues that are relevant to this claim. 

   7 marks
2. This question assumes the following tables:

CREATE TABLE STUDENT – stores details about a student.

    ( REGNUM    NUMBER primary key,
    NAME       VARCHAR(20),
    COURSE     VARCHAR(10),
    DEGREECLASS VARCHAR(3)
    )

CREATE TABLE CLASSTATS – keeps the number of students in each classification degree, depending on the current state of table STUDENT.

    ( COURSE    VARCHAR(10) NOT NULL,
    CLASS      VARCHAR(3)  NOT NULL,
    NUM        NUMBER,
    CONSTRAINT pk_Course PRIMARY KEY(COURSE, CLASS)
    )

INSERT INTO CLASSTATS VALUES ('CS', '1', 15);
INSERT INTO CLASSTATS VALUES ('CS', '2-1', 20);
INSERT INTO CLASSTATS VALUES ('CS', '2-2', 30);
INSERT INTO CLASSTATS VALUES ('CS', '3', 35);
INSERT INTO CLASSTATS VALUES ('AI', '1', 2);
INSERT INTO CLASSTATS VALUES ('AI', '2-1', 10);
INSERT INTO CLASSTATS VALUES ('CSwMath', '3', 4);

a) Write a row trigger to monitor and react to a tuple insert into table STUDENT, updating table CLASSTATS accordingly. (4 marks)

b) Write a row trigger to monitor and react to a tuple update on attribute DEGREECLASS in table STUDENT, updating table CLASSTATS accordingly. (6 marks)

c) Write a statement trigger to react to any tuple delete in table STUDENT, updating table CLASSTATS accordingly. (4 marks)

d) Describe the principal differences between row and statement triggers. (6 marks)
3. a) Assuming that a persistent class `Hangar` is present in a JDO database, and it has an attribute `height`, write a JDO program that deletes all hangars with a height less than 4 from the database. You do NOT need to write the statements related to database connection, and you can assume that you have access to an initialised `PersistenceManager` object. But you DO need to include transactions and exception handling. (5 marks)

b) The following code fragment creates two Java objects.

```java
Course artificialIntelligence = new Course("Artificial Intelligence");
Student s = new Student("John", 2008, artificialIntelligence);
```

i) Provide additional code that would enable the objects to be stored on disk, assuming that each `Student` has a reference to its `Course`. You do NOT need to write the statements related to database connection, and you can assume that you have access to an initialised `PersistenceManager` object. But you DO need to include transactions and exception handling. (4 marks)

ii) In the above example, do you need to make both objects persistent explicitly? Why is this? (4 marks)

c) In JDO, any request that can be expressed as a query can also be written as a program that navigates from an extent. Discuss the pros and cons of the two approaches. (7 marks)
4. The following XML Schema is relevant to this question:

```xml
<schema xmlns="http://www.w3.org/2001/XMLSchema"
    xmlns:r="http://recipes.org"
    targetNamespace="http://recipes.org"
    elementFormDefault="qualified">

    <element name="collection">
        <complexType>
            <sequence>
                <element name="description" type="string"/>
                <element ref="r:recipe" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
        </complexType>
    </element>

    <element name="recipe">
        <complexType>
            <sequence>
                <element name="title" type="string"/>
                <element ref="r:ingredient" minOccurs="0" maxOccurs="unbounded"/>
                <element ref="r:preparation"/>
                <element name="comment" minOccurs="0" type="string"/>
                <element name="nutrition">
                    <complexType>
                        <attribute name="protein" type="r:nonNegativeDecimal" use="required"/>
                        <attribute name="carbohydrates" type="r:nonNegativeDecimal" use="required"/>
                        <attribute name="fat" type="r:nonNegativeDecimal" use="required"/>
                        <attribute name="calories" type="r:nonNegativeDecimal" use="required"/>
                        <attribute name="alcohol" type="r:nonNegativeDecimal" use="optional"/>
                    </complexType>
                </element>
            </sequence>
        </complexType>
    </element>

    <element name="preparation">
        <complexType>
            <sequence>
                <element name="step" type="string" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
        </complexType>
    </element>

</schema>
```

(Question 4 continues on the following page)
(Question 4 continues from the previous page)

a) Give an example of an XML document that validates against the above schema, which represents a recipe of your own choosing. (6 marks)

b) Construct a relational model that contains the same information as the above XML Schema. The schema should state keys and constraints where relevant, and types for all attributes. State any assumptions you make. (6 marks)

c) Illustrating your answer using the example above, state four benefits or weaknesses of the XML data representation compared with the relational model. (8 marks)
You have been asked to help with the following project. A social networking Web site wants to design a new database infrastructure to support their business. The site users can upload various multimedia objects, including photos, videos and text messages. Each photo and video can be associated with a number of tags added by the user or his/her friends.

a) Discuss the challenges in content-based retrieval of the multimedia object types used in this task. Explain why you would or would not suggest using controlled vocabularies and ontologies to support the retrieval of objects uploaded to the site. (6 marks)

b) Using the XML Schema syntax, provide a definition of an element (named my_object) that will contain a multimedia object that a user has uploaded to the site. It should contain the date of upload (as a required attribute) and a choice of three possible elements: photo (for storing a photo), video (for a video) or message (for a text message). Each photo and video element should have an element that contains the URL of the uploaded object, and a number of my_tag elements that contain user-assigned tags to the object. Each my_tag element is an empty element that has two attributes: description (a string associated with the object; required) and added_by (the name of the user who added the description; optional). The message element does not have any attributes or sub-elements. You do not need to provide other elements in the schema. (10 marks)

c) Write an XPath expression that would retrieve URLs of all videos uploaded on “20 October 2009” that have been described using word “holiday”. Assume that there is an XML schema that stores each multimedia object (<my_object>) within an element <user> that collects all objects belonging to a user, and that the entire database is stored in an <users> element. (4 marks)

END OF EXAMINATION