Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Advanced Databases

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

Please answer any THREE Questions from the FIVE questions provided
This is a CLOSED book examination

The use of electronic calculators is NOT permitted
Please answer any THREE Questions from the FIVE questions provided

The following schema and instructions are assumed for both Questions 1 and 2.

CREATE TABLE AIRPLANE
    ( Reg NUMBER (7) primary key,
      Capacity NUMBER (3),
      Weight NUMBER (3,2),
      Height NUMBER (2,2),
      HangNumber NUMBER (2)
    );

CREATE TABLE HANGAR
    ( HangNumber NUMBER (2) primary key,
      HangCapacity NUMBER (2),
      Location VARCHAR2 (10),
      HeightRoof NUMBER (2,2)
    );

INSERT INTO HANGAR VALUES (01, 40, 'South of Terminal 1', 4.5);
INSERT INTO HANGAR VALUES (02, 80, 'Southeast of Terminal 2', 6.0);
INSERT INTO HANGAR VALUES (03, 20, 'North of Terminal 1', 4.0);

1. 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 Reg, Height, Location
        FROM Airplane, Hangar
        WHERE HangNumber = 01 and
            Airplane.HangNumber = Hangar.HangNumber;

    Reg Airplane.Reg%type;
    Height Airplane.Height%type;
    Location Hangar.Location%type;
begin
    open C1;
    fetch C1 into Reg, Height, Location;
    while C1%found loop
        dbms_output.put_line(
            'Row Number '|| C1%rowcount ||
            ' is '|| Reg||' '|| Height ||
            ' '|| Location);
        fetch C1 into Reg, Height, Location;
    end loop;
    close C1;
end;
```

(8 marks)
(Question 1 continues from the previous page)

b) You have been told that “The PL/SQL will be quicker in this case”. Discuss whether or not you agree with this statement, indicating what issues are relevant to the claim. (4 marks)

c) State 4 reasons why PL/SQL may be preferred in a project to JDBC, and 4 reasons why JDBC may be preferred to PL/SQL. (8 marks)

2. a) Write a trigger that enforces the following integrity constraint given insert or update changes to AIRPLANE: an airplane cannot be stored in a hangar whose roof height is lower than the specified height for the airplane model. (6 marks)

b) Write a trigger that blocks updates to HANGAR that would cause the constraint from (a) to be violated for existing tuples in AIRPLANE. (6 marks)

c) If the trigger in b), instead of blocking updates, was to seek to maintain the constraint by executing compensating updates, what would some possible options be? (2 marks)

d) If the above constraints were to be enforced over a database that did not support triggers, how might they be implemented? Discuss the pros and cons of different implementation options. (6 marks)

3. There are two databases, a relational database and a JDO database. Both store data on Personal Records, their unique national insurance numbers (NINs), names and addresses. For both of the databases:

a) Write a program fragment that, given the NIN and the address of a person, updates the person’s record with the given NIN to the given address. The relational database should be accessed using JDBC. State any assumptions you make. You need not include exception handling. (6 marks)

b) Write another program fragment for the situation in a) assuming you are dealing with an object database using JDO. State any assumptions you make. You need not include exception handling. (6 marks)

c) Compare your solutions provided in (a and b). Discuss where the different approaches seem to provide the better constructs for programmers, and whether or not the specific pros and cons you observe are likely to be common in JDBC/JDO programs. (8 marks)
4. The following XML Schema is relevant to this question:

```xml
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    targetNamespace="http://tempuri.org/po.xsd"
    xmlns="http://tempuri.org/po.xsd" elementFormDefault="qualified">

    <xs:element name="purchaseOrder" type="PurchaseOrderType"/>

    <xs:complexType name="PurchaseOrderType">
        <xs:sequence>
            <xs:element name="shipTo" type="USAddress"/>
            <xs:element name="billTo" type="USAddress"/>
            <xs:element name="items" type="Items"/>
        </xs:sequence>
        <xs:attribute name="orderDate" type="xs:date"/>
    </xs:complexType>

    <xs:complexType name="USAddress">
        <xs:sequence>
            <xs:element name="name" type="xs:string"/>
            <xs:element name="street" type="xs:string"/>
            <xs:element name="city" type="xs:string"/>
            <xs:element name="state" type="xs:string"/>
            <xs:element name="zip" type="xs:decimal"/>
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="Items">
        <xs:sequence>
            <xs:element name="item" minOccurs="0" maxOccurs="unbounded">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="productName" type="xs:string"/>
                        <xs:element name="quantity">
                            <xs:simpleType>
                                <xs:restriction base="xs:positiveInteger">
                                    <xs:maxExclusive value="100"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                        <xs:element name="USPrice" type="xs:decimal"/>
                        <xs:element name="shipDate" type="xs:date" minOccurs="0"/>
                    </xs:sequence>
                    <xs:attribute name="partNum" type="xs:string" use="required"/>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>

</xs:schema>
```

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

5. You have been asked to help with the following project. A university hospital wants to build a database with digital X-ray images of wrist fractures. Each image will be associated with a description from an experienced consultant to support student training. Some consultants prefer to provide a short textual report, while others prefer to select a set of descriptions from an ontology of wrist fractures that has been created to support the task.

a) Discuss the storage options for digital X-ray images in relational and XML database systems.

b) What are the advantages and disadvantages of using ontological descriptions as meta-data?

c) Using the XML Schema syntax, provide a definition of a relevant element (named description, containing a choice of elements report and ontoTerms) that you would use to support the description task as described above. You do not need to provide other elements in the schema.

d) Discuss querying approaches that could be implemented to support student training, considering using meta-data and image similarities. As an example for the former, write an XQuery expression that would retrieve all images where a patient’s fracture has been described using the ontology term “Scaphoid Fracture” (assume that there is an XML schema that stores each X-ray image in an <image> element with an <description> element inside it, and that the entire database is stored in an <images> element).