Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Advanced Databases

Tuesday 15th January 2008     Time: 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
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. Use a prepared statement for the insert. State any assumptions you make. (12 marks)

```java
DECLARE
    CURSOR c1 is
        SELECT ename, empno, sal FROM emp
        ORDER BY sal DESC;  -- start with highest paid employee
    my_ename VARCHAR2(10);
    my_empno NUMBER(4);
    my_sal   NUMBER(7);
BEGIN
    OPEN c1;
    FOR i IN 1..5 LOOP
        FETCH c1 INTO my_ename, my_empno, my_sal;
        EXIT WHEN c1%NOTFOUND;  /* in case the number requested */
        /* is more than the total */
        /* number of employees */
        INSERT INTO temp VALUES (my_sal, my_empno, my_ename);
    END LOOP;
    CLOSE c1;
END;
```

b) Discuss the benefits (or otherwise) of using prepared statements for the above example. (2 marks)

c) State 3 reasons why PL/SQL may be preferred in a project to JDBC, and 3 reasons why JDBC may be preferred to PL/SQL. (6 marks)
2. This question assumes the following tables:

```sql
CREATE TABLE SAL – The salary of an employee
  (NAME VARCHAR2(20) primary key,
   SAL NUMBER(7,2),
   JOB VARCHAR2(9)
  )
;

CREATE TABLE SALGRADE – The salary range of a job
  (JOB VARCHAR2(9) primary key,
   MINSAL NUMBER(7,2),
   MAXSAL NUMBER(7,2)
  )
;
```

<table>
<thead>
<tr>
<th>JOB</th>
<th>MINSAL</th>
<th>MAXSAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLERK</td>
<td>800</td>
<td>1300</td>
</tr>
<tr>
<td>ANALYST</td>
<td>3000</td>
<td>3500</td>
</tr>
<tr>
<td>SALESMAN</td>
<td>1250</td>
<td>1600</td>
</tr>
<tr>
<td>MANAGER</td>
<td>2450</td>
<td>2975</td>
</tr>
<tr>
<td>PRESIDENT</td>
<td>5000</td>
<td>5500</td>
</tr>
</tbody>
</table>

a) Write row triggers that enforce the following integrity constraint given an update to the JOB attribute of existing tuples in SAL: the salary of someone with a specific job must remain within the salary range for that job, as specified in the table SALGRADE. You should provide triggers that enforce the constraint using two alternative techniques:

i) The update is blocked. (4 marks)

ii) A compensating action is taken that changes the valid salary range for a job in the table SALGRADE. (4 marks)

b) Write a statement trigger that blocks changes of any type to SALGRADE that allow any JOB to have a salary higher than that for the minimum salary of the PRESIDENT. (5 marks)

c) Describe the principal differences between row and statement triggers, and discuss when each is likely to be most appropriate for integrity checking, with reference to the above example. (7 marks)
3.  

a) Assuming the presence of a persistent class `Product` that has an attribute `price`, write a JDO program that deletes all products with a price less than 150 from the database. You need not show connection to the database, and can assume that you have access to an initialised `PersistenceManager`, but should include transactions and exception handling. (10 marks)

b) Given that the following code fragment creates two Java objects, provide additional code that would enable the objects to be stored on disk, assuming that each `Product` has a reference to its `Manufacturer`. You need not show connection to the database, and can assume that you have access to an initialised `PersistenceManager`, but should include transactions. (4 marks)

```
Manufacturer apple = new Manufacturer("Apple");
Product ipod = new Product(apple, "iPod", "Now with video", 49.99);
```

The above example does not need to make both objects persistent explicitly; why is this? (2 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. (4 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)

a) Give an example of an XML document that validates against the above schema. (7 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. (7 marks)

c) Write XQuery queries that retrieve:
   i) The productName of every item with a USPrice less than 100. (3 marks)
   ii) The name of every person to whom a Lawnmower is to be shipped. (3 marks)

5. A city museum plans to develop a multimedia database that will store an art collection that includes digitalised music, films, videos, paintings, novels, stores, etc. The main aim of the database is to support content-based information retrieval. The database designer decided to implement content descriptions through a short textual summary and an open, i.e. uncontrolled, set of keywords assigned manually to each piece of art in the database.

a) Describe the main challenges in content-based information retrieval in the context of multimedia DBs. What are the disadvantages of using textual descriptions as meta-data? (6 marks)

b) Discuss the pros and cons of using open-ended sets of keywords for content descriptions, and compare it with controlled vocabularies and ontologies. Provide an example to support your discussion. (6 marks)

c) Explain the advantages of using XML for storing semi-structured and multimedia data. Using the XML Schema syntax, describe the two elements (textSummary and keywords) you would need to use to implement the suggested design. There should be at least one keyword, and each of them can have two optional attributes: the name of the person who added it and the date when this was done. You do not need to provide other elements in the schema. (8 marks)

END OF EXAMINATION