Please look over the entire exam first, 
Select easy questions first, don’t panic, 
Relax, and good luck!
Problem 1: (10 points)

Indicate whether each of the following statement is true or false (T/F):

___ 1. Entity Integrity Constraint: no two tuples can have the same combination of values for all their attributes.

___ 2. Foreign-key cannot be NULL.

___ 3. All ternary relationship can be reduced to two or three binary relationships.

___ 4. Primary key is only unique across the relation, but Object Identity (OID) is a unique system-wide identifier.

___ 5. R⁺-Tree has less insertion cost than R-Tree.

___ 6. In Total + overlap specialization, super-class cannot have primary key.

___ 7. PM1 quad-tree is data-independent

   SQL related question:

___ 8. An expression in group-qualification must have a single value per group.

___ 9. A view is just a relation, but we store a definition, rather than a set of tuples.

___ 10. New tuple cannot be inserted in a view that has an aggregate inside.
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Problem 2: (20 points)
(a) Reduce given ER diagram to relation using pure relational model. Be sure to identify all primary and foreign keys.
(b) Reduce given ER diagram to relation using pure relational model. Be sure to identify all primary and foreign keys. (B and C are weak entities and they have b1 and c1 as their discriminators, respectively)
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Problem 3: (10 points)
(a) Consider the case, that a seller wants to put all expensive items on sale. Does the following SQL statement achieve the goal? If not, write the correct statement.

   Update Items
   Set price=0.8*price
   Where price> (select avg(price) from Items)
(b) Consider the case, that the school of engineering decides to print a list of CS student names. Does the following SQL statement achieve the goal? If not, write the correct statement.

```
Select s.name
From student s
Where s.teacherName=(select t.name
    From teacher t
    Where t.department="CS")
```
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Problem 4: (30 points)
Consider the following ER diagram and its reduction.
CREATE ROW TYPE Address_Type (  
    street VARCHAR(15), city VARCHAR(15),  
    zip VARCHAR(10));

CREATE TABLE customers (  
    ssn CHAR(10) PRIMARY KEY,  
    name VARCHAR(15), phone CHAR(20),  
    age INTEGER, address Address_Type);

CREATE TABLE CDs (  
    CDID INTEGER PRIMARY KEY,  
    title VARCHAR(30), releaseDate DATE,  
    genre CHAR(1), artist VARCHAR(15));

CREATE TABLE orders (  
    orderID INTEGER PRIMARY KEY,  
    ssn CHAR(10), storeID INTEGER,  
    orderDate DATE,  
    FOREIGN KEY (cssn) REFERENCES customers (ssn),  
    FOREIGN KEY (storeID) REFERENCES stores (storeID));

CREATE TABLE stores (  
    storeID INTEGER PRIMARY KEY,  
    storeName VARCHAR(15), webAddress VARCHAR(20),  
    mailAddress Address_Type);

CREATE TABLE store_items (  
    storeID INTEGER, CDID INTEGER,  
    quantity INTEGER, price INTEGER,  
    PRIMARY KEY (storeID, CDID),  
    FOREIGN KEY (storeID) REFERENCES stores (storeID),  
    FOREIGN KEY (CDID) REFERENCES cds (CDID));

CREATE TABLE order_items (  
    orderID INTEGER, storeID INTEGER,  
    CDID INTEGER, quantity INTEGER,  
    PRIMARY KEY (orderID, CDID),  
    FOREIGN KEY (orderID) REFERENCES orders (orderID),  
    FOREIGN KEY (storeID, CDID) REFERENCES store_items (storeID, CDID));
a) Write a SQL statement to find the name of stores that have less than 300 cds.

b) Complete the following SQL statement to find the name of the cds that has been ordered by no one younger than 18 in “Los Angeles” city:

```sql
SELECT CDs.title FROM CDs
WHERE ........ ( SELECT order_items.CDID FROM order_items, orders, customers
    WHERE order_items.orderID = orders.orderID
    AND orders.ssn = customers.ssn
    AND .........................
    AND ..........................
    AND ..........................
    AND ..........................);
```
c) Describe what the following SQL statement does?

```
SELECT s.storeName, SUM(si.price * oi.quantity) Total_Value
FROM store_items si, order_items oi, stores s
WHERE s.storeID = si.storeID
AND oi.storeID = s.storeID
AND oi.CDID = si.CDID
GROUP BY s.storeName
HAVING SUM(si.price * oi.quantity) >= ALL (
    SELECT SUM(si1.price * oi1.quantity)
    FROM store_items si1, order_items oi1, stores s1
    WHERE s1.storeID = si1.storeID
    AND oi1.storeID = s1.storeID
    AND oi1.CDID = si1.CDID
    GROUP BY s1.storeName
);
```
d) Describe what the following SQL statement does?

```sql
SELECT s.storeID, oi.CDID, SUM(oi.quantity)
FROM order_items oi, stores s
WHERE s.storeID = oi.storeID
GROUP BY s.storeID, oi.CDID
HAVING SUM(oi.quantity) >= ALL (
    SELECT SUM(oi2.quantity)
    FROM order_items oi2
    WHERE oi2.storeID = oi.storeID
    GROUP BY oi2.storeID, oi2.CDID
    HAVING SUM(oi2.quantity) < SOME (
        SELECT SUM(oi1.quantity)
        FROM order_items oi1
        WHERE oi1.storeID = oi2.storeID
        GROUP BY oi1.storeID, oi1.CDID
    )
)
```
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Problem 5: (10 points)

Consider the following object-oriented concepts:

a) Specialization  
b) Single Inheritance  
c) Multiple Inheritance  
d) Repeated Inheritance  
e) Overloading  
f) Overriding  
g) Abstraction

Now consider the following statements, which are provided to create a database using an object-relational model. For each sentence specify which of above concepts are applied:

<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CREATE ROW TYPE A (a1 Integer, a2 Integer);</td>
</tr>
<tr>
<td>2</td>
<td>CREATE ROW TYPE B (b1 Integer);</td>
</tr>
<tr>
<td>3</td>
<td>CREATE ROW TYPE C (c1 A, c2 Integer) UNDER B;</td>
</tr>
<tr>
<td>4</td>
<td>CREATE ROW TYPE D (d1 A, d2 Integer) UNDER B;</td>
</tr>
<tr>
<td>5</td>
<td>CREATE ROW TYPE E (e1 A, e2 Integer) UNDER D;</td>
</tr>
<tr>
<td>6</td>
<td>CREATE FUNCTION F (f1 B) RETURNS Integer;</td>
</tr>
<tr>
<td>7</td>
<td>CREATE FUNCTION F (f1 C) RETURNS Integer;</td>
</tr>
<tr>
<td>8</td>
<td>CREATE FUNCTION F (f1 A) RETURNS Integer;</td>
</tr>
<tr>
<td></td>
<td>CREATE TABLE TD USING D;</td>
</tr>
<tr>
<td></td>
<td>CREATE TABLE TE USING E;</td>
</tr>
<tr>
<td>9</td>
<td>SELECT TD.d2, TE.e2 FROM TD, TE WHERE TD.d1 = TE.e1;</td>
</tr>
<tr>
<td>10</td>
<td>SELECT e1, e2 FROM TE ORDER BY e1;</td>
</tr>
</tbody>
</table>
Problem 6: (10 points)

Assume the following table for the position of some of the buildings in Los Angeles is stored in a database with spatial support.

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Shape</th>
<th>Spatial Data</th>
</tr>
</thead>
</table>
| 1  | Staples Center   | Circle  | origin: (13, 20)
|     |                  |         | radius: 10                           |
| 2  | Pershing Square | Square  | center: (37.5, 50)
|     |                  |         | length: 8                            |
| 3  | Bonaventure Hotel| Octagon | (13, 70)
|     |                  |         | (15.2, 68.2)                         |
|     |                  |         | (19, 68.2)                           |
|     |                  |         | (21, 70)                             |
|     |                  |         | (21, 72.8)                           |
|     |                  |         | (19, 74.8)                           |
|     |                  |         | (15.2, 74.8)                         |
|     |                  |         | (13, 72.8)                           |
| 4  | Library Tower   | Circle  | origin: (55, 70)
|     |                  |         | radius: 3                            |
| 5  | Arco Towers     | Square  | center: (15.5, 52.5)
|     |                  |         | length: 5                            |

Assume that the rows are inserted into the table as they appear above. Also, assume that \((m, M) = (2, 4)\).

a) Draw resulting R-Tree index for the above table. Please note that you need to draw the corresponding index after each insertion. In other words, you should draw five R-Trees here. (For the first four trees, you could get 1 point for each correct one. For the 5th tree, you could earn 6-point reward if the answer is correct. Please use “Quadratic” method to split the node.)
b) In order to search some object in R-Tree, you might have to go through several rectangles or the whole database. Why? How could $R^+$-Tree solve this problem? (3 points)

c) Please describe one common drawback for R-Tree and $R^+$-Tree. (2 points)
Problem 7: (10 points)

In this problem, you would need to have the knowledge of Quad Tree:

a) Please draw the resulting index of the following region by using Region QuadTree.
b) Assume the following table for the position of some of streets in Los Angeles in stored in a database with spatial support. Assume the streets are inserted in to the database based on the alphabetical order (from A to Z). Please decompose the following region based on the criteria of PM1 Quadtree.