

**CS585**  
**Database Systems**  
**Midterm Exam**

Name: \_\_\_\_\_

Student ID: \_\_\_\_\_

	Maximum	Received
Problem 1	10	
Problem 2	12	
Problem 3	12	
Problem 4	12	
Problem 5	15	
Problem 6	12	
Problem 7	12	
Problem 8	15	

2 hr exam. Closed book. One single sided 8.5 X 11 sheet of notes allowed.

1) 10 pts

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

\_\_\_\_\_ One can assure that a point-region quad tree for a fixed set of points is always balanced by inserting points into the tree in the optimal order.

\_\_\_\_\_ During searching an object in R-tree, one might need to search the entire database.

\_\_\_\_\_ A relationship is an association among two or more attributes.

\_\_\_\_\_ One owner entity is associated with one or more weak entities, but each weak entity has a single owner.

\_\_\_\_\_ If we compare two null values using  $<$ ,  $>$ ,  $=$ , and so on, the result is always true.

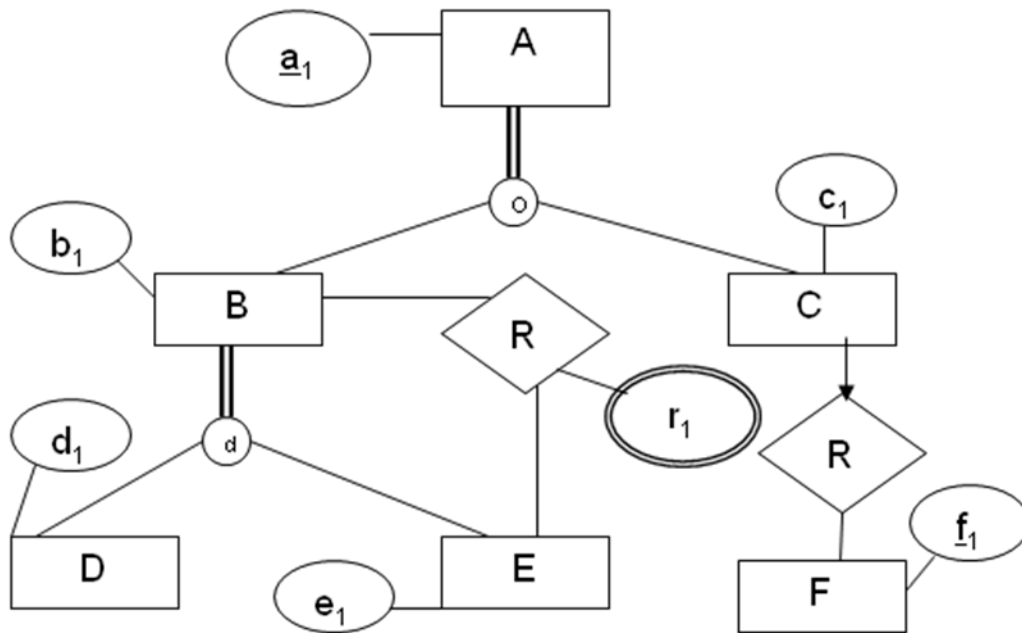
\_\_\_\_\_ Metric relationships are a subset of topological relationships in Rose algebra.

\_\_\_\_\_ One of the limitations in object oriented databases is that they cannot handle complex object models.

\_\_\_\_\_ In an object relational database, an object table is a table in which all columns of the table are of object types.

2) 12 pts

Reduce the given EER diagram to relations using pure relational model (i.e., No Object Oriented or Object Relational). Be sure to identify all primary and foreign keys.



3) 12 pts

A university database contains information about professors (identified by social security number, or SSN) and courses (identified by courseId). Professors teach courses; each of the following situations concerns the Teaches relationship set. For each situation, draw an ER diagram that describes it (assuming no further constraints hold).

a. Professors can teach the same course in several semesters, and only the most recent such offering needs to be recorded. (Assume this condition applies in all subsequent questions.

b. Every professor must teach some course.

c. Every professor teaches exactly one course (no more, no less).

d. Every professor teaches exactly one course (no more, no less), and every course must be taught by some professor.

4) 12 pts

The following questions are based on the following relational schema:

Emp (*eid*: integer, *ename*: string, *age*: integer, *salary*: real)

Works (*eid*: integer, *did*: integer)

Dept (*did*: integer, *dname*., *managerid*: integer)

Write SQL to create tables for Emp, Works, Dept such that Works have two foreign keys referring to Emp (*eid*) and Dept (*did*) respectively, and Dept has a foreign key

(*managerid*)

referring to Emp respectively. In addition, when a Dept tuple is deleted, all Works tuples referring to it should be deleted. When an Emp tuple is deleted, for all Dept tuples referring to it, the *managerid* should be set to null. Note *eid* is primary key for Emp, and *eid* and *did* together are primary key for Works. And *did* is the primary key for Dept.

5) 15 pts

Consider the relational conceptual database schema below for keeping track of course registration of students:

COURSES (Code, Title, Dept)

Registered (Code, SSN)

STUDENTS (SSN, Name, Dept, GPA)

Here, COURSES contains a tuple for each course, recording its code, title, and department providing the course. STUDENTS records the SSN, name, home department, and GPA of the students. REGISTERED keeps the relation between courses and students.

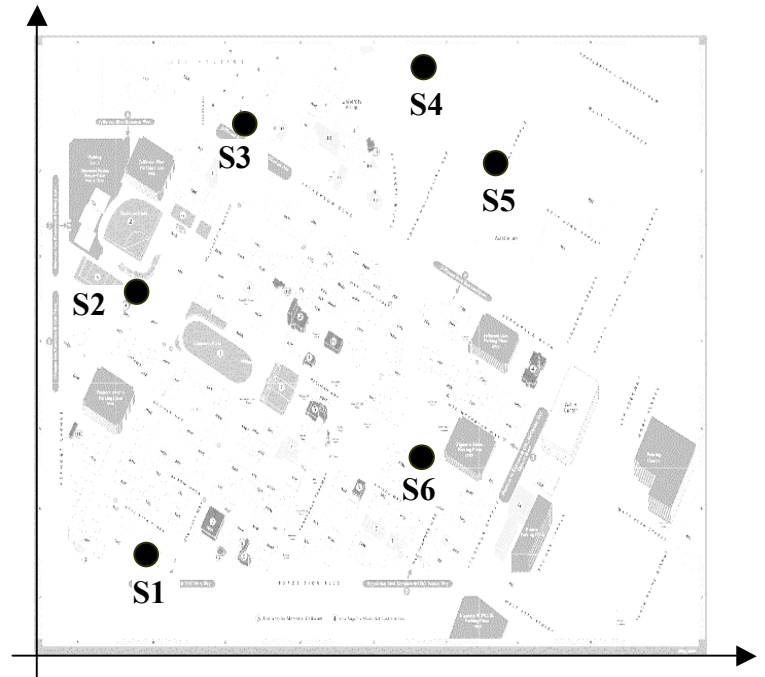
**(a)** Retrieve the name of each student who registered the course titled “Database Systems”.

**(b)** Retrieve the title of the course along with the number of students who registered this course in the descending order of registered student number.

(c) Retrieve the name of student(s) who earned the maximum GPA in the department that provides more than 30 courses.

6) 12 pts

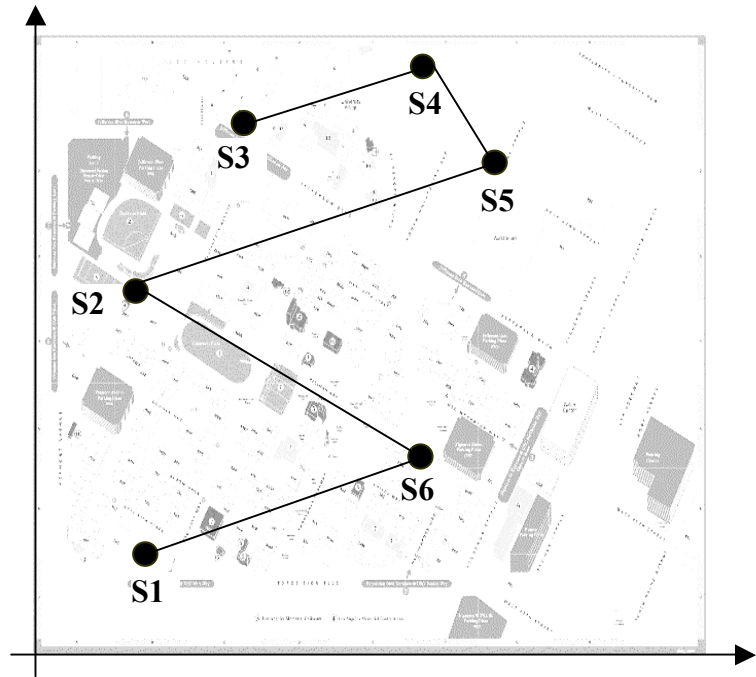
Consider the six Tram Stations shown in the following picture of USC campus.



(a) Build a PR Quadtree for these six points. (You do not need to draw the actual tree, just show the partitioning on the above figure)



- (b) A Tram starts from the first station which is S1 and after passing through all the stations stops at the last one which is S3. Construct a PM1 Quadtree for this path on the figure below.



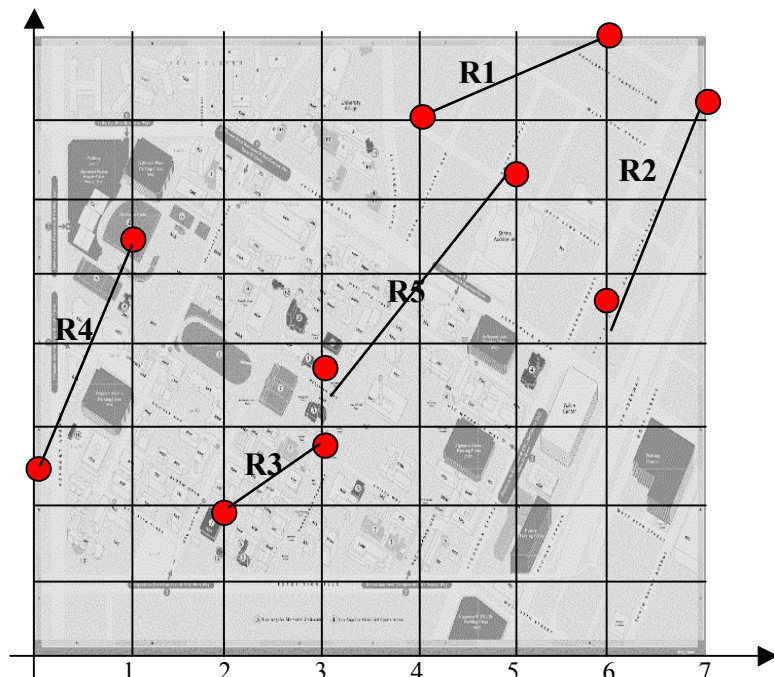
7) 12 pts

A road network is maintained in a spatial database as following:

Road ID	Road Segment
L1	(4, 7), (6, 8)
L2	(6,4), (7, 7)
L3	(2,1), (3, 2)
L4	(0, 2), (1, 5)
L5	(3, 3), (5, 6)

Assume that the roads are inserted in to the table with the ascending order of RoadID (i.e., L1, L2, L3, L4, L5). Also assume that  $(m,M)=(2,4)$ .

Draw the R-Tree index generated for the above table after each insertion. In other words, you should draw five R-Trees. Use “Quadratic” method to split the R-Tree Nodes. You need to briefly describe what happens after each step. If you need to split a node, you should clearly and completely describe which line(s) you select to become the first element of each child node, and then which lines are added to each child node and why. You could use the following chart to draw the lines.



Additional space for problem 7

8) 12 pts

Considering that we have 3 types of databases available to us (Relational, Object Relational, and Object Oriented), Complete each of the following three sentences by providing examples and reasons why.

a) A relational database may not be the best choice when...

b) An object relational database may not be the best choice when...

c) An object oriented database may not be the best choice when...

Additional space