Databases
Homework #2
Due on September 30, 2011

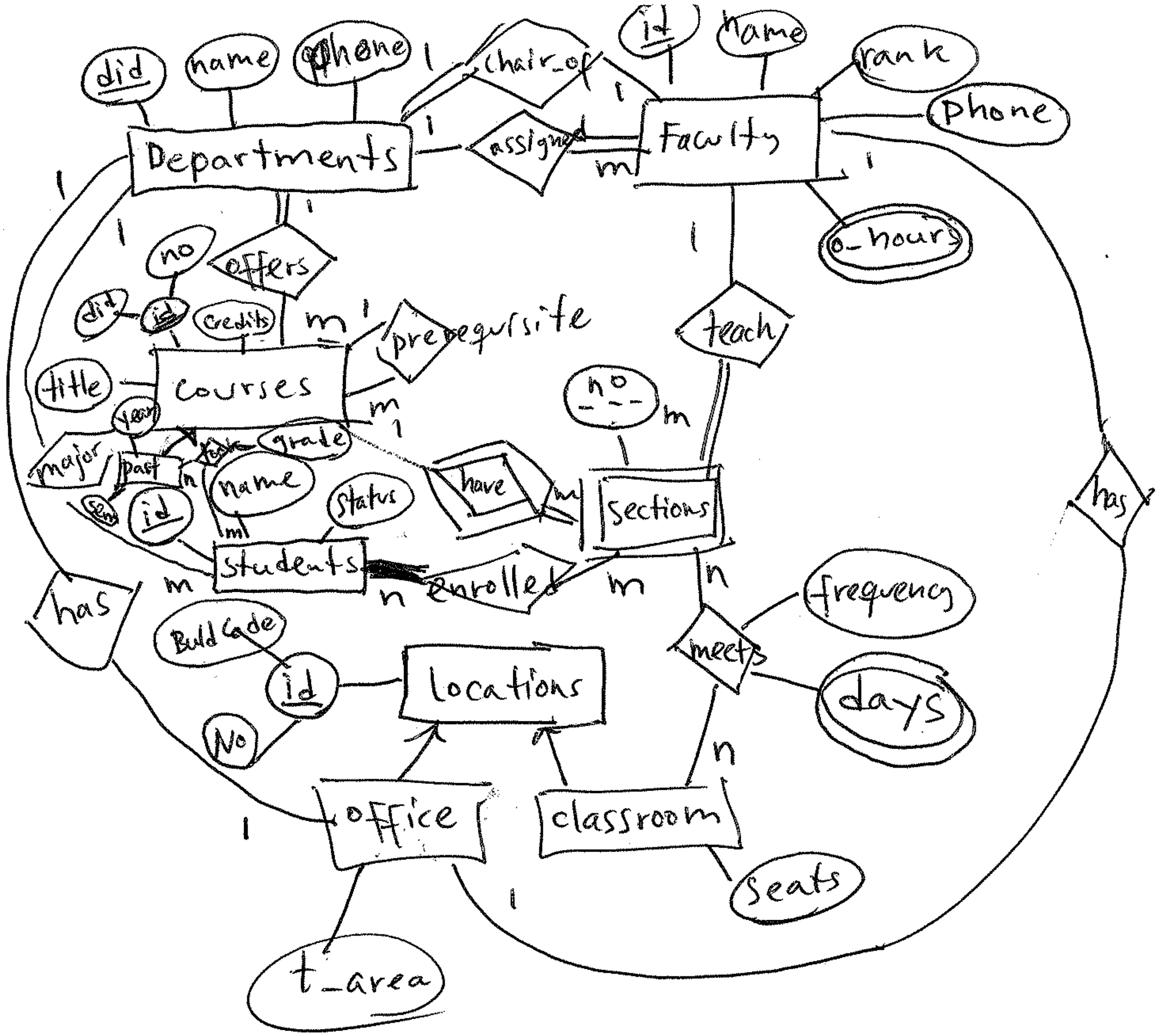
Consider the following mini-world of a university. There are academic departments. Each department is identified by a 4-letter code, and has a name, a chairperson, an office and a 4-digit telephone extension. Each department offers a set of courses. Each course is identified by the department code and a 3 digit number, and has a title and number of credits; each course may require any number of prerequisite courses. Certain courses are currently offered; an offering of a course is called a section. Sections of the same course are distinguished by a 2 digit section number (01, 02, etc.). Each section is taught by a particular faculty, and meets between 1 and 3 times a week at a particular classroom and in a particular day-time slot (different weekly meetings may be at different classrooms and in different time slots). Each faculty is assigned to a single department, is identified by a 9-character university identification code, and has a name, a rank (assistant professor, associate professor, professor, etc), an office with a telephone extension and a set of office hours. The chairperson of a department is always assigned to that department. Each student is identified by a 9-character university identification code, and has a name, a major department, and an academic status (e.g., undergraduate, graduate, non-degree). Each student is currently enrolled in a number of sections, totaling between 0 and 18 credits. For each course that the student had taken in the past, a letter grade is available. Locations consist of a 3 letter building code and a 3 digit room number, and they are labeled as classrooms or offices. Classrooms have number of seats, offices have total area.

Problem 1: *(15 points)* Design a general hierarchical database model for this mini-world. Provide a diagram showing the records with appropriate fields in a tree structure.

Problem 2: *(45 points)* Design an entity-relationship database for this min-world. Give a diagram, showing the entity sets, the relationship sets and the attributes. Distinguish between weak and strong entity sets. Indicate the primary keys or partial keys of all entity sets and the mapping cardinalities of all relationship sets (use cardinality limits notation).
Consider using the complete set of features described in class with the exception of multi attributes and derived attributes. In addition (separate from your dia-gram): (1) Indicate which part of the description you have not been able to represent in your design. (2) For each binary relationship set in the diagram, indicate whether its constraint is one-to-one, many-to-one, or many-to-many, and whether any of its two components is a total participation constraint.

Problem 3: *(40 points)* Convert the entity-relationship design to a scheme for a relational database.
List all relation schemes. For each relation scheme state the name of the relation, the names of the attributes, the data types, the primary keys and the foreign keys.

Submit a hard copy of your assignment on the due date, and label each of your answers as problem1, problem 2 E-R diagram, problem 2.1, problem 2.2, or problem 3.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Information unable to represent in the E-R

4-letter code for did
4-digit phone extension
3-digit number for course
2-digit no of section
domain of frequency in meets
9-char for fid
domain for rank in faculty
9-char for sid
domain for status
min, max total no of credits
3-digit room number

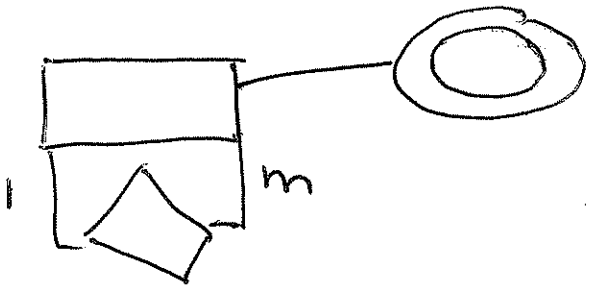
Last Name Queredo First Name _____

Files and Databases
Quiz 2

1. *(10 points)* List all four types of integrity constraints

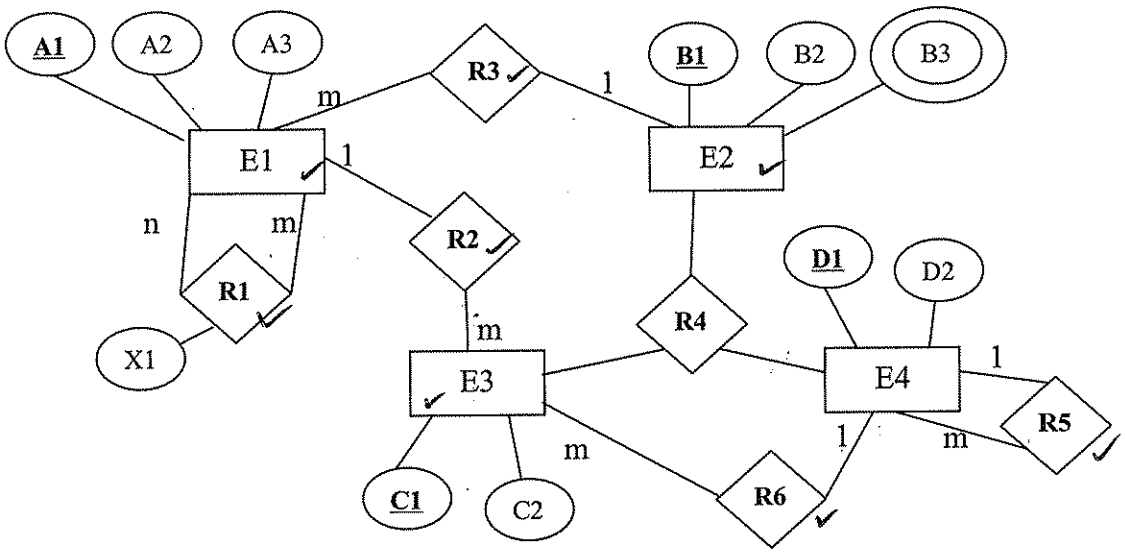
primary key
foreign key
general domain

2. *(20 points)* Give an example of a unary relationship with a one-to-many connectivity and at least one multi-valued attribute



3. *(70 points)* Transform the following E-R diagram into a set of relations

Possible Relation	Attributes (underline primary key, circle foreign keys)
✓ E1	A1, A2, A3, (B1)
✓ E2	B1, B2
✓ E3	C1, C2, (A1), (D1)
✓ E4	D1, D2, (D1_R5)
✓ R1	(A1), (A1_R1), X1
✓ R2	
✓ R3	
R4	(C1), (B1), (D1)
✓ R5	
✓ R6	
✓ E2_B3	(B1), B3



Query 8: List the sid of those students with the highest GPA

$t1 \leftarrow$ students

$t2 \leftarrow$ students

$$t3 \leftarrow \Pi_{t1.sid}\left(t1 \bowtie_{t1.gpa < t2.gpa} t2\right)$$

$$\text{answer} \leftarrow \Pi_{sid}(\text{students}) - t3$$

Division $\div$ / /

A

sno	pno
S1	P1
S1	P2
S1	P3
S1	P4
S2	P1
S2	P2
S3	P2
S4	P2
S4	P4

B1

pno
P2

B2

pno
P2
P4

B3

Pno
P1
P2
P4

B4

pno
P1
P2
P3
P4

Compatibility

A / B1 possible if B1 $\in$ A

is possible A/B1 ? yes

is possible B1/A ? no

$A/B1 = \frac{sno \ \cancel{pno}}{\cancel{pno}}$

A/B1

sno
S1
S2
S3
S4

A/B2

sno
S1
S4

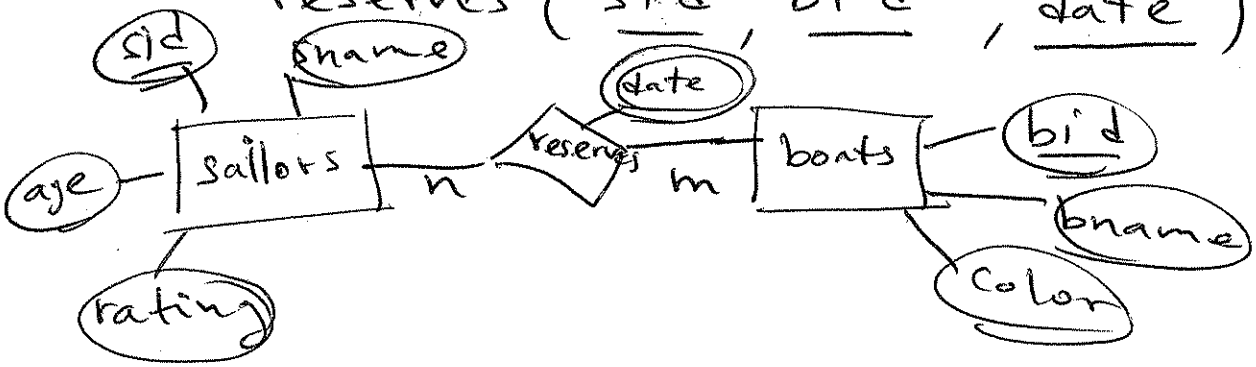
A/B3

sno
S1

A/B4

sno
S1

sailors(sid, sname, age, rating)
boats (bid, bname, color)
reserves (sid, bid, date)



query 9: List the name of students taking ALL courses offered by the csci department.

$$t1 \leftarrow \prod_{cid}\left(\sigma_{did='csci'}(courses)\right)$$

answer $\leftarrow \Pi_{name}\left(\left((takes / t1) \bowtie students\right)\right)$

query 10: List the name of sailors who have reserved all red boats.

$t1 \leftarrow \Pi_{bid}\left(\sigma_{color='red'}(boats)\right)$

answer $\leftarrow \Pi_{sname}\left(\left((\Pi_{sid,bid}(reserves) / t1) \bowtie sailors\right)\right)$

query 11:

List the name of sailors with rating >20 younger than 18 who have not reserved a green boat but have reserved red and blue boats.

$t1 \leftarrow \Pi_{sid}\left(\sigma_{color='green'}(boats) \bowtie reserves\right)$

$t2 \leftarrow \Pi_{sid}\left(\sigma_{color='red'}(boats) \bowtie reserves\right)$

$t3 \leftarrow \Pi_{sid}\left(\sigma_{color='blue'}(boats) \bowtie reserves\right)$

$t4 \leftarrow \Pi_{sid}(sailors)$

$$t_5 \leftarrow (t_2 \cap t_3) \cap (t_4 - t_1)$$

$$\pi_{sname}\left(\sigma_{\substack{rating > 20 \\ and \\ age < 18}}(t_5 \bowtie Sailors)\right)$$

Name Quevedo

In Class Assignment

Use these relations to solve in relational algebra de queries that follow.

employees(<u>eid</u>, *name, salary,did,m_did)*
projects(<u>pid</u>,*description)*
works_on(<u>eid, pid</u>, *hours)*
departments(<u>did</u>, *location)*

1. List the name of the project that have employees from the systems department working less than 5 hours. Pid is also the name of the project.

$$\Pi_{pid}\left(\sigma_{hours<5}(works\_on) \bowtie \left(\sigma_{did='systems'}(employees)\right)\right)$$

2. List the name of employees with a salary greater than their manager's salary.

$$e \leftarrow employees$$
$$m \leftarrow employees$$
$$\Pi_{e.name}\left(\sigma_{e.salary>m.salary}\left(e \bowtie_{e.m\_did=m.eid} m\right)\right)$$

3. List the name of employees working on all projects.

$$\Pi_{name}\left(\left(\Pi_{eid,pid}(works\_on) \div \Pi_{pid}(projects)\right) \bowtie employees\right)$$

4. List the name of employees making more than $100,000 and working on zero projects

$$t1 \leftarrow \Pi_{eid}\left(\sigma_{salary>100000}(employees)\right) - \Pi_{eid}(works\_on)$$
$$\Pi_{name}(t1 \bowtie employees)$$

5. List the name of employees working on both projectX and projectY

$$t1 \leftarrow \Pi_{eid}\left(\sigma_{pid='ProjectX'}(works\_on)\right) \cap \Pi_{eid}\left(\sigma_{pid='ProjectY'}(works\_on)\right)$$
$$\Pi_{name}(t1 \bowtie employees)$$

Files and Databases
Quiz 3

Using the following schema, solve the queries that follow in ~~SQL~~ Relational Algebra

Suppliers(sid, sname, city)
Supply(sid, pid, cost)
Part(pid, pname, description, color)

1. Find the sname of suppliers that supply both blue and green parts

$$t1 \leftarrow \Pi_{sid}\left(\sigma_{color='blue'}(Supply \bowtie Part)\right) \cap \Pi_{sid}\left(\sigma_{color='green'}(Supply \bowtie Part)\right)$$

$$\Pi_{sname}(t1 \bowtie suppliers)$$

2. List the sname of suppliers that do not supply a yellow part

$$t1 \leftarrow \Pi_{sid}(suppliers) - \Pi_{sid}\left(\sigma_{color='yellow'}(Supply \bowtie Part)\right)$$

$$\Pi_{sname}(t1 \bowtie suppliers)$$