

Computer Science Department
Stanford University
Comprehensive Examination in Databases
Autumn 1996

October 18, 1996

READ THIS FIRST!

1. You should write your answers for this part of the Comprehensive Examination in a BLUE BOOK. Please use a separate blue book for each problem. Be sure to write your MAGIC NUMBER on the cover of every blue book that you use.
2. This exam is **OPEN** BOOK.
3. Show your work, since PARTIAL CREDIT will be given for incomplete answers. For example, you can get credit for making a reasonable start on a problem even if the idea doesn't work out; you can also get credit for realizing that certain approaches are incorrect. On a true/false question, you might get partial credit for explaining why you think something is true when it is actually false. But no partial credit can be given if you write nothing.

Test: 2 pages

(31)

Database Comprehensive CSD Exam Fall 1996. 30 minutes total (6+5+6+3 = 20).

Question 1. Relational Algebra (6 minutes)

Consider the following two relations:

```
Enroll(studentID, course#) // <studentID,course#> is the key
Course(course#, dept)      // course# is the key
```

Write a relational algebra expression to find the IDs of all students enrolled in courses in at least two different departments. You may use a "relation renaming" operator if you find it helpful.

Question 2. SQL 1 (5 minutes)

Given the same relations used in Question 1, write an SQL query reporting the studentID's of students whose list of classes enrolled does not include a class in the physics department.

Question 3. SQL 2 (6 minutes)

Consider the simple relational schema $R(A,B)$, where both A and B are integers, and A is a key but B is not. Give the simplest SQL query you can think of over this schema such that an equivalent query cannot be expressed in relational algebra. The simpler the query, the more credit given.

Question 4. Database Design (3 minutes)

Given the Entity-relationship models on the attached page determine the minimum number of 3NF relations needed to contain all of key and dependent data described in each of the following relationships:

- 4.a: one-to-one relationship between
Employee (name and address) and ID (ID# and position)
- 4.b: many-to-one relationship between
Employee (name and address) and Department (dept# and manager)

- 4.c: many-to-many relationship between
Employee (name and address) and Project (project# and customer)

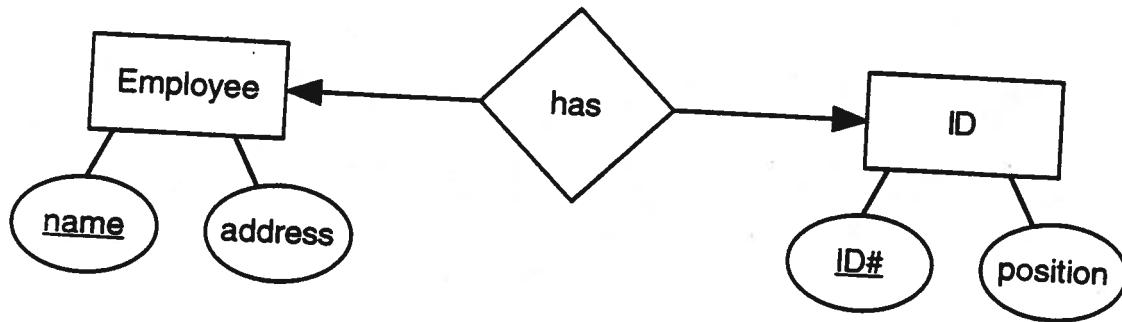
Question 5: Dependencies (10 minutes)

Consider a relation R with attributes A, B, C, and D and the functional dependencies $AB \rightarrow C$, $C \rightarrow D$, and $D \rightarrow A$.

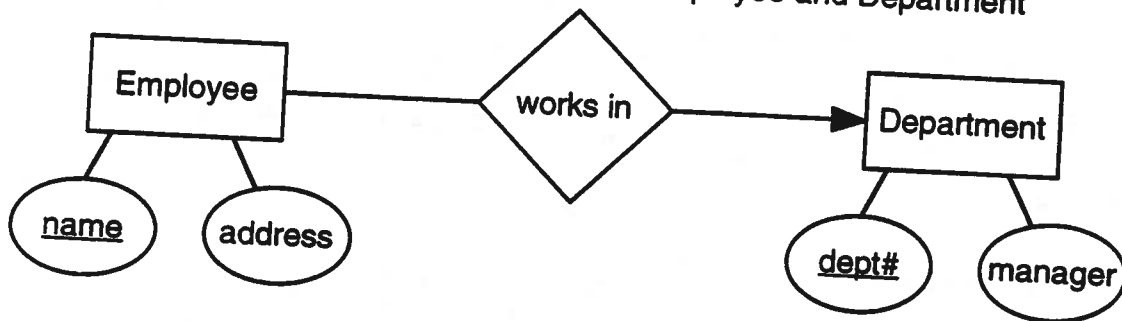
- a) Find all the (minimal) keys for R.
- b) Are there any 3NF violations? Give one example if so.
- c) Are there any BCNF violations? Give one example if so.

What is the minimum number of 3NF relations needed to contain all of the data described in each of the following relationships and corresponding E-R diagram? (Keys are underlined.)

a. one-to-one relationship between Employee and ID



b. many-to-one relationship between Employee and Department



c. many-to-many relationship between Employee and Project

