CS4604 Midterm Exam

March 3rd, 1999

Please enter the following information:

- **Name:**

- **ID:**

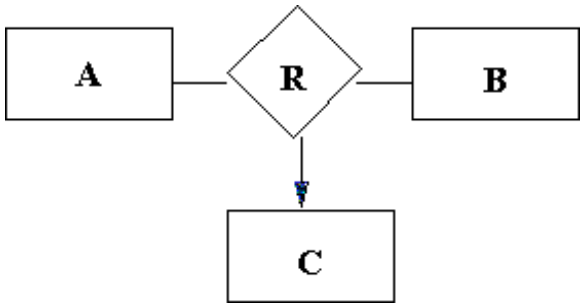
GOOD LUCK!
Do not write below this line

Problem	Max Score	Score
1	10	
2	20	
3	20	
4	20	
5	10	
6	10	
7	3	
8	7	

1. (10 points) Draw an E/R diagram for the following situation describing a database application for a manufacturing parts industry: The company manufactures automobile *parts*, which are of two kinds — *monolithic parts* and *composite parts*. Monolithic parts are parts that are not made up of other parts (they are indivisible). Examples of monolithic parts are spokes, nuts, bolts, washers, couplings etc. Composite parts are those that are made up of other *parts*. An example of a composite part would be, for example, an engine that contains several *parts*, such as pistons, cylinders, rods, links, cranks etc, assembled into one big unit (Notice that piston itself could be composed of more *parts*, and so on.).

   Each *part* has a name, and a unique number (assigned by the company for identification purposes). In addition, *monolithic parts* have a weight attached to them (in pounds), while *composite parts* have a count attached to them (which is the number of parts that are contained in that composite part entity). For example, a full fledged gas turbine engine has nearly $10,000$ *parts*, so this number would be $10,000$ for that entity. Underline key attributes, double border weak sets (if applicable), do not forget to put arrows etc.

2. (20 points) Consider the following E/R diagram:



and the four relationship sets (tables):

Table 1

A	B	C
a1	b1	c1
a1	b1	c2
a1	b2	c1

Table 2

A	B	C
a1	b1	c1
a2	b2	c2

Table 3

A	B	C
a1	b1	c1
a1	b2	c1

Table 4

A	B	C
a1	b1	c1
a2	b1	c1

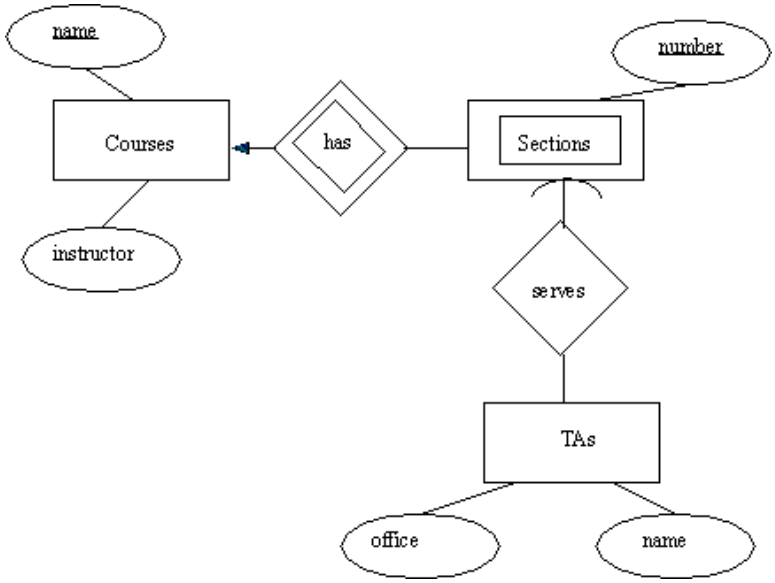
You may assume that different symbols denote different attribute values (i.e., a1 is different from a2 and b1). Which of the below are possible instances of relation R?

- Table 1 only
- Tables 2 and 4 only
- Tables 2,3 and 4 only
- Tables 3 and 4 only

3. (15+5=20 points) Suppose we decompose relation R(A,B,C,D,E) into relation S(A,B,C) and some other relation(s). Give the functional dependencies that hold in S if all of the following dependencies hold in R: $\{ AB \rightarrow D,\ AC \rightarrow E,\ BC \rightarrow D,\ D \rightarrow A,\ E \rightarrow B \}$. Also determine the key(s) of S.

4. (20 points) Design an E/R diagram for the following situation: We wish to model *workers* and *jobs* in a particular organization. A *worker* has a social security number that is unique and is either a *blue-collar* worker or a *white-collar* worker. *Jobs* have a name (like "Scientist A") and a salary (like $200,000) associated with them. Together, they form a key for *Jobs*. Jobs are are either *shop-floor* or *managerial*. A shop-floor job has an associated time (spent on the shop floor per day) and a managerial job has an office. The job for a blue-collar worker is always a shop-floor job. The job for a white-collar worker can be either a shop-floor job (where he/she can supervise an assembly line), a managerial job, or both. Underline key attributes, double border weak sets (if applicable), do not forget to put arrows etc.

5. (3+7=10 points) Consider the following E/R diagram from your homework #1:



Now, assume that we would like to enforce the following additional constraint:

- There can be some TAs for a course that do not serve any specific section of that course. i.e., they could be the TAs that help in lab management, setting up accounts, administering newsgroups etc. that doesn't bring them in contact with students directly (They are the people behind the scenes). These TAs are called *Admin TAs* whereas the kind that the E/R diagram depicts are called *Instruction TAs*.

Modify the E/R diagram to take into account this additional constraint. After modification, convert the E/R diagram to relations, taking care to eliminate any redundant relations. Use the procedure taught in class (and described in your book and which you used for your homework and project). Be sure to underline key attributes!

6. (10 points) Consider the Student relation

   `Student(Name, ID, SSN, AdvisorID, AdvisorName)`

   The idea is that a given student has a name, a unique Social Security Number (supplied by the Social Security administration), an unique ID (assigned by the university for internal purposes; this may or may not be the same as the SSN), has a unique advisor whose name is given by `AdvisorName` and whose ID is `AdvisorID`. Assume that we decompose this relation into:

   ```
   Student1(ID, Name, AdvisorID)
   Student2(ID, SSN)
   Student3(AdvisorID, AdvisorName)
   ```

   Does this decomposition lose any information? If yes, give example instances of `Student1`, `Student2` and `Student3` that when 'joined' together give rise to incorrect instances of `Student`. If no, why not? Just saying 'yes' or 'no' without justification is worth only 2 points.

7. (3 points) Prove that if a relation R has only one key, and is in BCNF, then it is also in 3NF.

8. (7 points) An E/R diagram when converted to relations (using the method that we now know so well), gives rise to the following schema (without normalization):

   `R(a,b,c)`

   `S(a,d)`

   `T(a,d,f,g)`

   You may assume that the same symbols refer to the same attribute and that different symbols refer to different attributes (e.g. the `a` in `R`, `S`, and `T` are the same). Your task is to give at least *two* different E/R diagrams that could have produced these relations.