CS4221 - Database Design - Assignments #3
Due on 30 March 2015 (Monday)

The solutions must be hand written, no computer printout, and no photocopy.

1. (From CJ Date's book 4th edition, page 536) Figure 1 represents an IMS database that contains information about published papers in a number of selected subject areas. The segments contain the following fields:

   - Subject: subject classification number (unique), name of subject.
   - Paper: title, abstract, number of pages.
   - Details: publishing house, journal name, volume number, issue number, date of publication (Note that a paper can only be published one time in one place).
   - Author: author name, address (Note that a paper may have several co-authors).

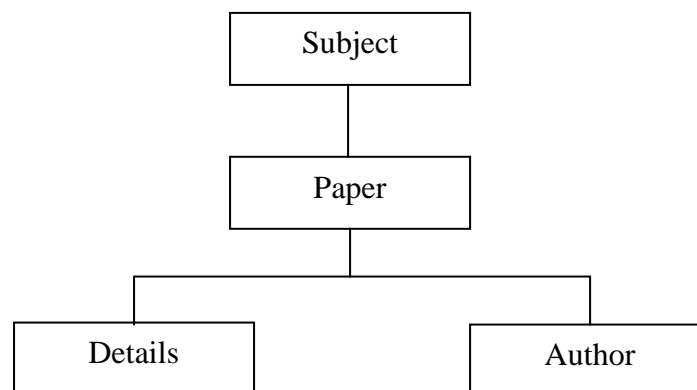   Draw a normal form ER diagram for this database.

Figure 1. Hierarchical structure of a publication database

2. (From CJ Date's book 4th edition, Page 504) Figure 2 contains information about the internal education system of a large industrial company. The company in question maintains an education department whose function is to run a number of training courses for the employees of the company; each course is offered at a number of different locations within the organization, and the database contains details both of offering already given and of offerings scheduled to be given in the future. The database contains the following information:

   - For each course: course number, course title, details of all immediate prerequisite courses, and details of all offerings.
   - For each prerequisite course for a given course: course number for that prerequisite course.

- For each offering of a given course: offering number, date, location, details of all teachers, and details of all students.
- For each teacher of given offering: employee number and name.
- For each student of a given offering: employee number, name and grade.
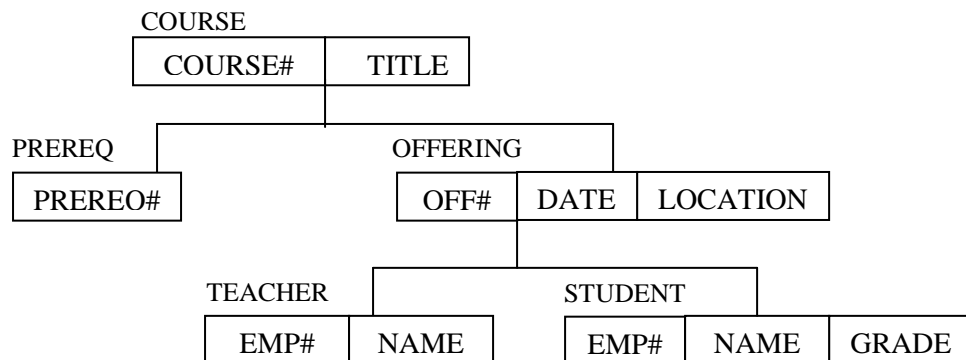
Draw a normal form ER diagram for this database.

COURSE

| COURSE# | TITLE |

PREREQ

| PREREO# |

OFFERING

| OFF# | DATE | LOCATION |

TEACHER

| EMP# | NAME |

STUDENT

| EMP# | NAME | GRADE |

Figure 2. Hierarchical structure of the education database

3. In Figure 3, the relationship type R3 is a recursive type and is similar to a "superior and subordinate" relationship type.

(A) Assume that the 2 functional dependencies:

$$B\# \rightarrow A\# \quad \text{in R1}$$
$$E3 \rightarrow E2$$

hold in the ER diagram in Figure 3. Translate the ER diagram to a set of relations. Are all relations generated in 3NF, BCNF, and/or 4NF?

(B) Assume that the following functional dependencies hold in the ER diagram in Figure 3:

$$E2 \rightarrow E3$$
$$E\# \rightarrow A\# \quad \text{in R1}$$
$$A2, A3 \rightarrow A\#$$

(i) Construct the set of basic dependencies of the entity type E. Is entity type E in entity normal form? Justify your answer.

(ii) Construct the set of basic dependencies of the relationship type R1. Is R1 in relationship normal form? Justify your answer.

(iii) Is the ER diagram in normal form? If not, transform it to a normal form ER diagram.
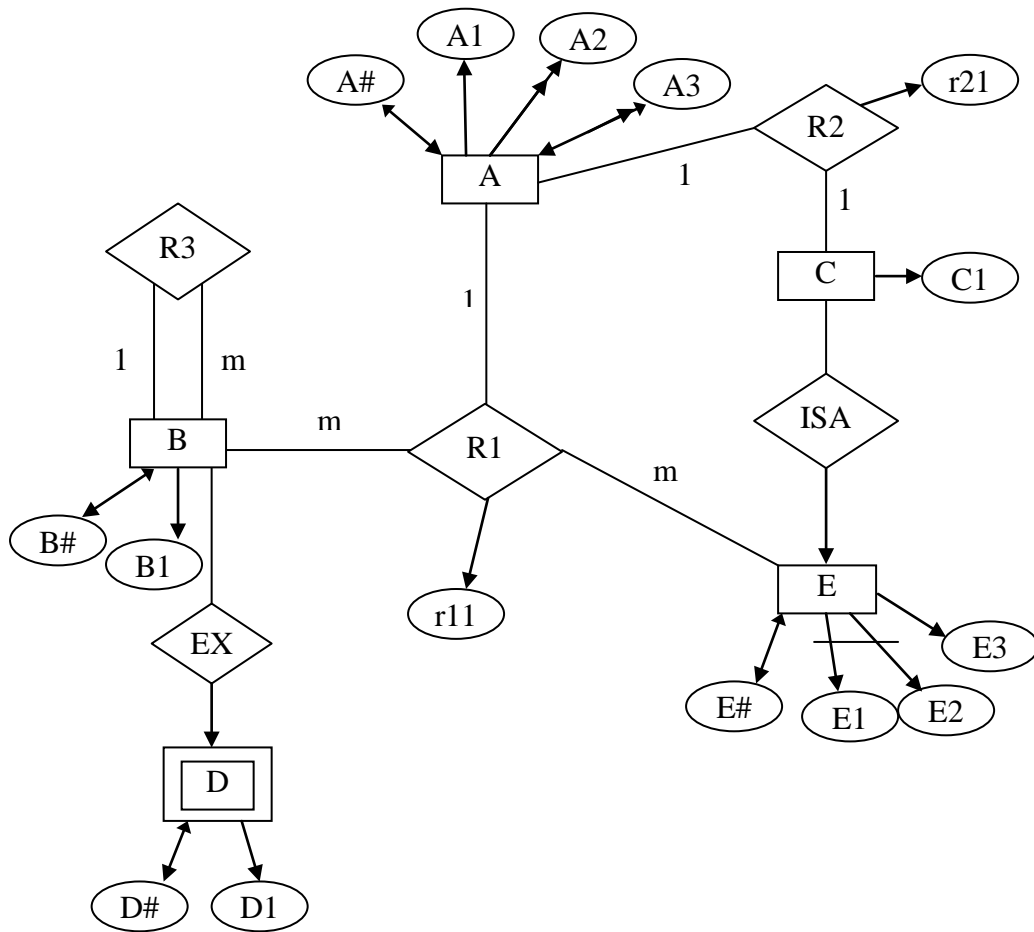
Figure 3. An ER diagram.

4. (From Ramakrishnan & Gehrke's book, 3rd edition, pages 54-55) The Prescriptions-R-X chain of pharmacies has offered to give you a free lifetime supply of medicine if you design its database. Given the rising cost of health care, you agree. Here's the information that you gather:

   - Patients are identified by an SSN, and their names, addresses, and ages must be recorded.
   - Doctors are identified by an SSN. For each doctor, the name, specialty, and years of experience must be record.
   - Each pharmaceutical company is identified by name and has a phone number.
   - For each drug, the trade name and formula must be recorded. Each drug is sold by a given pharmaceutical company, and the trade name identifies a drug uniquely from among the products of that company. If a pharmaceutical company is deleted, you need not keep track of its products any longer.
   - Each pharmacy has a name, address, and phone number.
   - Every patient has a primary physician. Every doctor has at least one patient.
   - Each pharmacy sells several drugs and has a price for each. A drug could be sold at several pharmacies, and the price could vary from one pharmacy to another.
   - Doctors prescribe drugs for patients. A doctor could prescribe one or more drugs for several patients, and a patient could obtain prescriptions from several doctors. Each prescription has a date and a quantity associated with it. You can assume that, if a doctor prescribes the same drug for the same patient more than once, only the last such prescription needs to be stored.
   - Pharmaceutical companies have long-term contracts with pharmacies. A pharmaceutical company can contract with several pharmacies, and a pharmacy can contract with several pharmaceutical companies. For each contract, you have to store a start date, an end date, and the text of the contract.
   - Pharmacies appoint a supervisor for each contract. There must always be a supervisor for each contract, but the contract supervisor can change over the lifetime of the contract.

   (a) Draw an ER diagram that captures the preceding information. Identify any constraints not captured by the ER diagram.

   (b) Translate your designed ER diagram into a relational database schema.

   (c) How would your design change if each drug must be sold at a fixed price by all pharmacies?

5. Consider an incomplete E/R diagram such as the one below, a ternary relationship R with unknown cardinality among entity sets A, B and C.
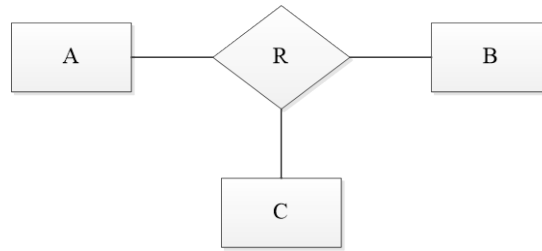
There is a correct interpretation, which is that, given A and C entities, there is at most one related B entity, and, given B and C entities, there is at most one related A entity. There is also an incorrect interpretation "given a C entity, there is at most one related A entity and at most one related B entity."

(a) Give an example of a relationship set that meets the correct interpretation of the diagram but does not meet the incorrect interpretation.

(b) Complete the ER diagram with correct cardinality of the relationship.

(c) Does every relationship set that satisfies the incorrect interpretation also satisfy the correct interpretation? Justify your answer.

(d) On the other hand, if the incorrect interpretation is what we want to say, there is another E/R diagram that says it. Draw this diagram.