CISC637 Spring 2015, Homework 2

Due Tuesday March 10th *in class* and on Sakai.

This homework asks you to draw E-R diagrams. Turn in the E-R diagrams in class, and the rest of the assignment on Sakai by midnight.

Assignment

1. **[10 pts.]** A real estate firm has lists property for sale. Based on the following requirements, draw an E-R diagram for the firm's data.

   - The firm has a number of sales offices in several states. Sales offices are identified by an office number and have a location.
   - Each sales office is assigned one or more employees. Employees are identified by an ID number, and we also need to keep track of their names. An employee can only be assigned to one sales office.
   - There is exactly one employee within each sales office assigned to manage that office.
   - The firm lists property for sale; each property is identified by an ID and has a location consisting of an address, city, state, and zip code.
   - Each unit of property may be listed with only one sales office. A sales office may have any number of properties listed.
   - Each unit of property has one or more owners. Owners are identified by an ID number and have a name. Owners can own more than one unit of property, and if they co-own a unit, we need to know the percentage of that unit they own.

2. **[15 pts]** Draw an E-R diagram for the following situation:

   Yoyodyne Propulsion Systems is an engineering firm with approximately 500 employees. A database is required to keep track of all employees, their skills, projects assigned, and departments worked in. Every employee has a unique number assigned by the firm and is required to store his or her name and date of birth. If an employee is currently married to another employee of Yoyodyne, the date of marriage and who is married to whom must be stored; however, no record of marriage is required if an employee's spouse is not also an employee. Each employee is given a job title (e.g., engineer, assistant, and so on). An employee does only one type of job at any given time, and we only need to retain information for an employee's current job.

   There are 11 different departments, each with a unique name. An employee can report to only one department. Each department has a phone number.

   To procure various kinds of equipment, each department deals with many vendors. A vendor typically supplies equipment to many departments. We are required to store the name and address of each vendor and the date of the last meeting between a department and a vendor.

   Many employees can work on a project. An employee can work on many projects, but can only be assigned to at most one project in a given city. For each city, we are interested in its state and population. An employee can have many skills (preparing material requisitions, checking drawings, and so on), but she or he may use only a

given set of skills on a particular project. (For example, an employee named Maas may prepare requisitions for the Mars One project and also prepare requisitions as well as check drawings for SpaceX.) Employees use each skill that they possess in at least one project. Each skill is assigned a number, and we must store a short description of each skill. Projects are distinguished by project numbers, and we must store the estimated cost of each project.

3. **[20 pts]** 11 Furniture has hired you to design their database, and after studying their business processes, you have identified the following requirements:

   - The company sells a number of different furniture products. These products, identified by an ID number, are grouped into several product lines, also identified by an ID number. For products, we need to store a description, finish, and standard price. Product lines have a name. A product line may group any number of products, but must include at least one. Each product must belong to exactly one product line.
   - Customers submit orders for products. Orders are identified by an ID number and include the date the order was placed. Customers can submit any number of orders, but an order is submitted by exactly one customer. Customers are identified by an ID and also have a name, address, and zip code.
   - A given customer order must request at least one product and only one product per order line item. A quantity is specified for each product ordered.
   - 11 Furniture has established sales territories for its customers. Each customer may do business in any number of these sales territories, but a sales territory must have at least one customer. Sales territories are identified by an ID and have a name.
   - 11 Furniture employes salespeople, identified by ID, with names, telephone numbers, and fax numbers. Each salesperson serves exactly one sales territory. Each sales territory is served by one or more salespeople.
   - Each product is assembled from a specified quantity of one or more raw materials, identified by an ID number. We need to keep track of unit of measure, material name, and standard cost. Each raw material is assembled into one or more products, using a specified quantity of the raw material for each product.
   - Raw materials are supplied by vendors identified by ID and having names and addresses. Raw material can be supplied by one or more vendors. A vendor may supply any number of raw materials to 11 Furniture. The supply unity price is the unit price a particular vendor supplies a particular raw material.
   - 11 Furniture has established a number of work centers identified by ID. Each work center is at a different location. Each product is produced in one or more work centers, and a work center may be used to produce any number of products.
   - The company has more than 100 employees identified by ID, having names, addresses, and skills. Each employee can have one or more skills. Employees can also work in more than one work center. A work center must have at least one employee. Any given skill may be possessed by zero, one, or more employees.
   - Each employee has exactly one supervisor, but managers have no supervisor. A supervisor may supervise any number of employees, but not all employees are supervisors.

4. **[20 pts.]** Convert the E-R diagram you drew for problem #1 into relational schema. Explain how you have captured any cardinality and participation constraints. If you cannot (or have decided not to) capture some constraint that you included in the E-R diagram, explain why.

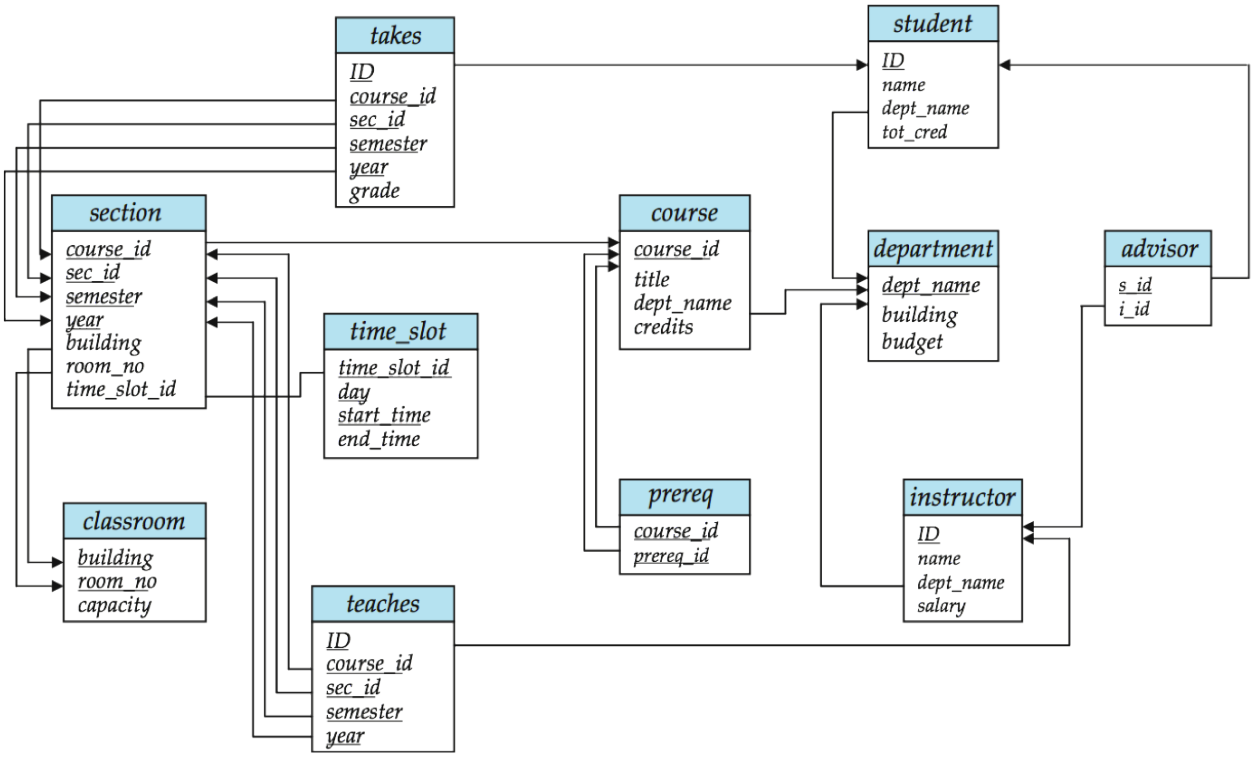
   Write out the SQL `CREATE TABLE` statements needed to implement the relational schema, including all foreign key constraints, any `UNIQUE` fields, and any `NOT NULL` fields.

5. **[20 pts.]** Functional dependencies.

   (a) Identify and write out eight non-trivial functional dependencies captured in the requirements for problem #1.

   (b) Identify and write out eight non-trivial functional dependencies captured in the requirements for problem #2.

   (c) Identify and write out eight non-trivial, non-key functional dependencies captured in the requirements for problem #3.



6. **[15 pts.]**

   Explain in words what each of the following relational algebra expressions is requesting from the university database (relational schema shown above). Write SQL queries that are equivalent to each one.

   - $\pi_{\text{title}}\left(\sigma_{\text{credits} \geq 3 \wedge \text{dept\_name}=\text{MATH}}\left(\text{course}\right)\right)$
   - $\pi_{\text{ID,name}}\left(\sigma_{\text{course\_id}=\text{CISC437}}\left(\text{takes} \bowtie \text{student}\right)\right)$
   - $\pi_{\text{ID}}\left(\sigma_{\text{course\_id}=\text{CISC437}}\left(\text{takes}\right)\right) \bowtie \pi_{\text{ID,name}}\left(\text{student}\right)$
   - ${}_{\text{dept\_name}}\mathcal{G}_{\text{average(capacity)}}\left(\pi_{\text{dept\_name,capacity}}\left(\text{classroom} \bowtie \text{section} \bowtie \text{course}\right)\right)$

Write SQL queries *and* relational algebra expressions for the following questions relating to the university.

- What are the titles of courses taught by Professor Wu?
- Find the names of all students who have taken at least one Math course.
- Find the IDs and names of all instructors who have not taught any course offering before Fall 2009.
- For each department, find the average salary of instructors in that department. (You may assume that each department has at least one instructor.)
- Find the number of open seats in CISC637 in Spring of 2015.

What to turn in:

1. *In class*, turn in your E-R diagrams. They can be hand-drawn or printed from a program (PowerPoint can be a good option).
2. *On Sakai*, turn in your answers to numbers 4, 5, and 6. Please submit a PDF with your answers.