**Ex\_4: E-R Diagramming**

**Problem 1: Unique Wholesale**

Vendors order products from Unique Wholesale and pay for the products later. The E-R diagram derived from the statements below should capture information about each order and the corresponding payment.

*Entities*:

* Database needs to store information about each vendor. Each Vendor has a unique vendor\_id. Two vendors do not have the same vendor\_id. Database stores the vendor’s current name and address.
* Database needs to store information about each product. Each Product has a unique stock#. Two products do not have the same stock#. Database stores each product’s current price and description.
* Database needs to store information about each order. Each Order has a unique order number. Database records the date the order is placed.
* Database needs to store information about each payment. Each payment is assigned a unique payment number. Database records the issue date and amount for each payment.

*Relationships:*

* Vendors place orders to Unique Wholesale. Database needs to store which vendor placed each order. Each order is placed by exactly one vendor. (Of course, each vendor may place many orders.)
* Database needs to store what products are ordered in each order. Each order may contain many products. (Of course each product may appear in many orders.)
* Eventually, a payment will be made for each order; each order is always paid for with one payment. Database needs to store which order each payment is for.

**Problem 2:ValleyClub Dinner Events**

ValleyClub frequently hosts dinners for its members. The E-R diagram derived from the statements below should capture information about who attended each dinner event, what the entrée choices are for each dinner event, what the dessert is for each dinner event.

* Database needs to record each dinner event’s location, date, and time.
* Each member has a unique member\_id. Database records each member’s current name, address, cell phone number, and some other information.
* For each dinner event, database needs to store which members attended it. Each member may attend as many dinner events as he/she chooses to.
* ValleyClub offers a few entrée choices to choose from for each dinner event. These choices may be different for different dinner events. Database needs to store all dinner choices for each dinner event.
* Only one type of dessert is offered for each dinner event, though desserts may be different for different dinner events. Database needs to store what dessert is served at each dinner event.

**Problem 3: InDisguise Oil Change**

InDisguise Company is in the quick oil and lube business. Although customers bring in their vehicles for what is described as "quick oil changes," InDisguise also replaces windshield wipers, oil filters, and air filters, subject to customer approval. The E-R diagram should contain information about each customer, his/her vehicle, date of service, grade and amount of oil used, parts replaced, and of course, total amount due.

* Information about a vehicle that needs to be stored includes plate#, make, model, and year. Plate#’s are unique.
* Database needs to store who owns each vehicle. Each vehicle is owned by one customer, but each customer may have more than one vehicle.
* Each part (windshield wiper, oil filter, or air filter, sparkplugs, etc.) has a unique part number. Database needs to record the current part cost and labor cost for each part per unit.
* Different grades of oils are available. Database needs to store grade name, (premium, standard, economy, etc) and the current price/qt.
* When a customer takes a vehicle to InDisguise for oil change, some parts may be replaced in the transaction, if approved by the customer. Database needs to store which parts are replaced.
* (For each part replaced on a vehicle, database needs to store unit part cost and unit labor cost because those costs can change. Also since two of the same parts can be replaced, e.g., sparkplugs, the database needs to record the quantity of each part replaced.
* Similarly, different vehicles may require different amounts of oil. Database needs to record the amount of oil used in each oil, as well as price/qt at the time of oil change.)

**Problem 4**: Prepare an E-R diagram for a real estate firm that lists properties for sale. The following describes this organization:

* The firm has a number of sales offices in several states. Each office has a unique Office\_Number. The database needs to store current address and phone number of each office.
* Each Sales office is assigned one or more employees. An employee must be assigned to only one sales office. Each employee has a unique employee\_id. Database needs to store each employee's name, first date of employment, and birth\_date.
* For each sales office, there is always one employee assigned to manage that office. This information needs to be stored in the database as well.
* The firm lists properties for sale. Each property has a unique property\_id. Database needs to store address of each property.
* Each property must be listed with one (and only one) of the sales offices. A sales office may have any number of properties listed. Database needs to keep track of all properties listed.
* Each unit of property has one or more owners. An owner may own one or more units of property. Each owner has a unique owner\_Id. Database needs to store each owner's name, phone, and address and ownership information of each property.
* (In case a property has many owners, the database needs to store the percentage of ownership of each owner.)
* (An employee may have a reporting manager, who is an employee working in the same office. Database needs to store who an employee reports to for each employee.)

**Problem 5:** **Sales Function of a Bookstore**

* Book: database needs to store each book’s ISBN (which is unique) and its cover type. Some books are paperbacks and some are hard covers. (A title may come in both paperback and hard cover, in which case the ISBNs are different). For each book, the database needs to store number of copies in stock, number of copies in order, current price, and number of pages.
* There are many categories of books (fiction, non-fiction, mystery, etc.) sold in the bookstore. Information needs to be stored about each category includes a category name and a location in the store.
* A book is classified into one category only. Database needs to store each book’s classification information.
* A book may be co-authored (A book can be written by many authors). Database needs to store who the authors are in a searchable fashion.
* A customer may purchase a few books in the same purchase. Database needs to store which books are purchased in each purchase.
* The total due needs to be stored with each purchase.
* If a book is not available, he/she places an order for a book. Each order is for only one title. The database needs to contain customer information so that the bookstore can notify the customer when his (her) orders arrive.

**Problem 6**: Design an ERD that captures information needed for the Hillside County Basketball Conference (HCBC) (an amateur basketball association).

* Each city (or town) in the county has one team that represents it.
* Each team has a maximum of twelve players and a minimum of nine players.
* Each team also has up to three coaches (offensive, defensive, and PT coaches.)
* A player or coach only serves in one team.
* Each team plays two games (home and visitor) against each of the other teams during the season.

HCBC needs to design a relational database that captures information about players, coaches, teams, and all games (date, time, which one is home team or guest team, score). Design an ER diagram that would represent this information requirement.

**Problem 7**: Draw an E-R diagram for the library application according to the following statements.

* Database needs to store information about each book. Barcode uniquely identifies each physical copy of the book. The library may carry multiple copies of the same book, in which case, ISBN and title are the same for all copies of the same book, but barcodes are different for different copies of the same book. Database also records ISBN, title, and whether it is paperback or hard cover. For the same book title, the ISBN for the paperback is different from the ISBN for the hard cover.
* SSN uniquely identifies each student. Database needs to store a student’s current name, address, and phone. Different students may have the same name.
* There are two types of books: Regular and Journal. Regular books are due in 4 weeks while journals are due in 1 week.
* A student may borrow multiple books at one time. Database needs to store which date/time when a student borrows books and which books are borrowed.
* When a book is returned, database needs to record date/time.

**Problem 8**: Draw an ER diagram for the problem described below. The database is to be designed to store information on fund raising and the charity organizations involved in the event.

* There are many participating charity organizations. Name, headquarter, and phone should be stored.
* Each charity organization has one type. For example, some charity is for cancer research, some for children's welfare, and some for breast cancer research. The type of organization needs to be stored.
* Each fund raising event is for only one type of charity. That is, charity organizations allowed to participate in any one fund raising event should be of the same type. For each charity event, database needs to store what type it is and which charity organizations participating in that event.
* There are many donors. Name, phone, and address should be stored. Each donor has a unique donor number.
* A donor may participate in many fund raising events. He/she may donate different amounts for different fund raising event. For example, a donor may donate $2000 for cancer research fund raising event on one date, and donate $3000 for children's welfare fund raising event on another date. For each fund raising event, the database needs to store amount of donation by each donor.

**Problem 9**: S**ales function of Online Order Clothing Company**

* The company carries different styles of women's clothing. Each style comes in different sizes (XL, L, M, S, XL) and different colors. For each size and color of each style, the database should store quantity available and current price.
* A customer may order many clothes in one order.
* Each order is paid with a credit card. Card info (card#, type, expiration date) should be stored with each order.
* The database should store a shipping charge rate table based on the total value of the order. (For example, up to $40, shipping charge is $6.99, $40 to $200, shipping charge is $9.99, etc.)
* There is a shipping charge for each order based on total value of the order and the shipping charge rate table. This charge should be stored for each order.

**Design the ERD for the database that stores detailed information about each order, order dollar total, shipping charge, and credit card information.**

**Problem 10: Dental Office Visits**

*DenDisc*, a dental center of 3 dentists, only accepts patients with dental insurance.

* Each dental patient is insured with only one insurance company. Database needs to store which insurance company each patient is insured with.
* A dental patient visits the same dentist always. Database needs to store which dentist each patient visits.
* The database needs to store a list of services that this dental office can provide. For each service, the current price is stored. All patients receiving a service pay the current price of the service.
* One or more types of dental services may be performed during each dental visit. Database needs to store what services were performed during each visit and the price charged since “current price” can change.
* Each insurance company may have different allowable limits for each service. For example, company A may pay up to $70 for dental cleaning while company B may pay up to $90. Database needs to store those allowable limits so they can generate the right bill.

**Problem 11 Shopping Mall Income Management**

A real estate investment company owns many shopping malls. The E-R diagram derived from the statements below for this application should capture rental income and sales revenue during each month from each shop.

Each mall contains many shops. Each shop is rented to one retailer. Each shop generates sales revenue in each month. The monthly rental of each shop is based on a flat rental charge and a percentage of monthly sales revenue. Both the flat charge and the percentage can differ from shop to shop.

Database needs to store the current retailer, monthly sales revenue for each shop, flat charge, and the aforementioned percentage.

Variation: What if the user requires that past rental history of each shop be also recorded? When the same shop is rented to a different retailer, the flat charge and the % can change.

**Problem 12:** Draw an ER diagram for the application described below. Identify all entities, primary key and other attributes of each entity, relationships, and relationship attributes, if any.

**ShowDogs** is a local pet store that sells purebred puppies and pet supplies. The database should store purchases made by each customer.

* Each puppy is AKC (American Kennel Club) registered and has a unique AKC number. The database should store each puppy’s breed, date of birth, gender, color, AKC numbers of its sire (father) and dam (mother) and, and name of the breeder.
* Each type of supplies has a unique stock number. Price and a brief description are also stored.
* When a customer comes to shop, he/she may purchase some supplies (quantities need to be stored), one or more puppies each with its own AKC number, or both.
* All sales of supplies are final. However, puppies can be returned within 10 days of purchase. A plausible reason has to be given by the customer and stored in the database. A returned puppy can be sold again (presumably after the reported problem is fixed or at a reduced price. However, presently you need not worry about storing information about fixing the problem nor about storing the price).
* Information about the customer includes name, phone number, and address.

**Problem 13:** Draw an ER diagram for the application described below. Identify all entities, primary key and other attributes of each entity, relationships, and relationship attributes, if any.

Barbara is a 3rd grade teacher who loves horseback riding. She has instilled the same in her 3rd graders. Barbara owns a horse, Jasper. Twice during each semester, Barbara starts a reading competition among her 3rd graders: whoever reads the most number of books from a list Barbara gives within the competition duration will be able to ride Jasper for an hour as the reward. Each competition has a theme (such as Animals, Countries, Friendship, etc.) Each list contains about 100 books (appropriate for 3rd graders) that her students can choose from to read for the competition. Books in a list corresponding to a competition should reflect the theme of that competition. A book can have more than one theme and may appear in multiple lists. No two lists are exactly the same even though they may contain some common books. The database needs to keep track of books used in competitions, and who won in each competition (only one can win), and # of books read by each student in each competition.

**Problem 14**: The database should track work orders, estimates and completion of work orders. The following detailed information requirements should be represented by the ERD.

* The database records basic information about the customer. Information stored about a customer includes a unique customer identifier, a name, and a billing address, which includes street, city, state, and zip.
* A work order has a unique work order number, a creation date, a date required, a completion date, and a work address, which includes street, city, state and zip.
* Customers submit work orders. Each work order is submitted by one customer only.
* A work order is accomplished with a set of tasks. Each task has a unique identifier, a task name, and an hourly rate. Tasks are standardized across work orders so that the same task may be performed on many work orders.
* When a work order is submitted, the company decides on which set of tasks needs to be performed. For example, tasks T1, T4, T6 may need to be performed in order to accomplish work order W1. Tasks T2, T5, and T6 may need to be performed to accomplish work order W2. A task can require different number of hours to complete for different work orders. For example, T6 of W1 may take 5 hours to complete while T6 of W2 may take 6 hours to complete. For each task required for a particular work order, the database needs to store the estimated number of hours. When the task is actually performed for that work order, the database should store the start date, the completion date, and the actual number of hours spent on that task.

**Problem 15:** The database tracks subscribing accounts, cable services subscribed, channel line-up, and pricing. The following detailed information requirements need to be represented by ERD.

Database should store information about each current or past subscriber, such as first name, last name, subscribing address, billing address, and phone number. Each subscriber is assigned a unique account Id. A current subscriber is one who currently has cable services installed. A past subscriber is one who once had cable but now has disconnected. Installation date and disconnection date, if disconnected, should also be stored in the database. When a subscriber disconnects and later reinstalls, he’ll be given a new account id. When a subscriber moves to a new address, he’ll also be given a new account Id.

The cable market is divided into different submarkets (e.g. East, West, North, South, and Central). The submarket divisions are exclusive, that is, a subscription address can belong to only one submarket. Each submarket has a unique name.

The cable company offers 3 levels of services to all customers in all submarkets: basic, standard, and premium. The Basic service contains a group of about 10 channels; the Standard, about 25 channels; and the Premium, about 60 channels. The Standard consists of all channels offered at the Basic level, plus some more. The Premium consists of all channels offered at the Standard level, plus some more. The channel packaging is the same across all submarkets and all accounts. The database needs to store information about channel packaging. This information may change from time to time. However, only the current packaging is stored.

Information about channels include unique channel name (e.g. A&E), current channel line up number (e.g. 41), and offering company name (e.g. AETN). The channel line-up is the same across all submarkets and all accounts. The channel line-up may change from time to time. However, only the current lineup is stored. (Notice the difference between “channel name” and “channel line up number.” When we say “Channel 41 is A&E,” we mean “A&E programming is sent through the band of frequencies denoted by the number 41.”)

Monthly subscription fee for a particular level of service (say, the Basic) can vary depending on which submarket the subscribing address is in. For example, subscribers in Central submarket may be charged $15.00/month for basic service while subscribers in West submarket may be charged $16.00/month. All subscribers in the same submarket pay the same monthly subscription fee for the same level of service. All levels of services are offered in all submarkets. (Pricing history is not stored at this time. Pricing History entity is needed to store price history.)

A subscriber account can only subscribe to one level of service. The database stores the current and past subscription levels should the subscription level change.

The database should record information about subscribers, channels, channel line up, service packaging, service pricing, and subscription levels, as described above.

**Problem 16** Draw an ERD for a database that should track baluster designs, balusters sold, and customer orders for a company that sells various wood balusters. Details follow:

There are various baluster designs to choose from. Each wood baluster design can be offered in various wood species, such as oak, maple, and hickory. However, not all wood species are available to all designs. (Some only come in oak, others come in both oak and maple, still others may have wider wood species selection.) A unique **design id** is used to denote each design. Not all designs are available to ship to all states. The database needs to store all baluster designs and what wood species are available for each design. In addition, for each design, the database needs to store which states it can't be shipped to.

Designs can come in up to 5 lengths: 31", 34", 39", 41", and 44". Database needs to store which lengths are offered for each design. For a design in each length, an image of the baluster should be stored to give customers more visual information.

Price can vary depending on the design, the wood species, and the length. The database needs to store pricing information for each type of balusters.

Each baluster of a particular design, wood species, and length is assigned a unique **baluster id.**

When a customer orders balusters, she chooses the design, the wood species, and the length. The database should store all balusters ordered, as well as the quantity and the unit price for each baluster. The database also stores customer's first name, last name, address, phone, and email.

**Problem 17**: Revise the ER diagram of ValleyClub Dinner Event based on this new information requirement: An invitation is sent to each member for each dinner event. The date when the invitation was mailed and the date the reply was received should be stored as well as what the reply was (sorry, I can’t attend, or Yes, I’d be glad to attend). If the member replied “Yes, I’d be Glad to Attend”, then the entrée chosen by the attending member should be recorded with the reply to the invitation. The entrée actually eaten, for one reason or another, can be different from the entrée chosen when a member replies to the invitation. The actual entrée eaten is not stored in the database.

**The original ER diagram is shown here:**



**Problem 18**: Revise the ER diagram of “InDisguise Oild Change” based on this new information requirement: Since automobiles are different and certain vehicle may require more time than others when replacing the same part, instead of charging a standardized labor cost for each type of parts replaced, the database should record the time duration of labor for each type of parts replaced in 15-minute intervals for each such replacement. The unit charge of $50/hour will be applied. This unit charge is not stored in the database. In addition, the database should also record the mileage of the vehicle being serviced.

**The original ER diagram is shown here.**

