

## Theory

Coronel, C., Morris, S. Database Systems: Design, Implementation & Management, Chapter 12. New Questions and Problems.

## Review Questions



## Conceptual Design

*The answers supplied for these review questions are based on the support material supplied by the textbook where a less stringent view of a conceptual ERD and FK's is held. In looking at these sample solutions you should keep this in mind, and remember for this unit **you must not include FK's on a CONCEPTUAL ERD.***

1. What two conditions must be met before an entity can be classified as a weak entity? Give an example of a weak entity.

To be classified as a weak entity, two conditions must be met:

1. The entity must be existence-dependent on its parent entity.
2. The entity must inherit at least part of its primary key from its parent entity.

For example, the (identifying) relationship depicted in the text's Figure 4. 9 shows a weak CLASS entity:

1. CLASS is clearly existence-dependent on COURSE. (You can't have a database class unless a database course exists.)
2. The CLASS entity's PK is defined through the combination of CLASS\_SECTION and CRS\_CODE. The CRS\_CODE attribute is also the PK of COURSE.

The conditions that define a weak entity are the same as those for an identifying relationship between an entity and its parent. In short, the existence of a weak entity produces an identifying relationship. And if the entity is strong, its relationship to the other entity is non-identifying. (Note the solid relationship line in the text's Figure.)

Keep in mind that whether or not an entity is weak usually depends on the database designer's decisions. For instance, if the database designer had decided to use a single-attribute as shown in the text's Figure 4.8, the CLASS entity would be strong. (The CLASS entity's PK is CLASS\_CODE, which is not derived from the COURSE entity.) In this case, the relationship between COURSE and CLASS is non-identifying. (Note the dashed relationship line in the text's Figure 4.8) **However, regardless of how the designer classifies the relationship – non-identifying or identifying– CLASS is always existence-dependent on COURSE.**

2. What is a strong (or identifying) relationship, and how is it depicted in a Crow's Foot ERD?

An identifying relationship exists when an entity is existence-dependent on another entity and inherits its primary key from that entity. An identifying relationship is depicted with a double line from the entity to the relationship. In other words, an identifying relationship exists when a weak entity is associated with a strong parent entity. (Note the discussion in question 1.)

3. Given the business rule "An employee may have many degrees," discuss its effect on attribute relationships. (Hint: Remember what a multivalued attribute might be implemented.)

Suppose that an employee has the following degrees: BA, BS, and MBA. These degrees could be stored in a single string as a multivalued attribute named EMP\_DEGREE in an EMPLOYEE table such as the one shown next:

EMP_NUM	EMP_LNAME	EMP_DEGREE
123	Carter	AA, BBA
124	O'Shanski	BBA, MBA, Ph.D.
125	Jones	AS
126	Ortez	BS, MS

Although the preceding solution has no obvious design flaws, it is likely to yield reporting problems. For example, suppose you want to get a count for all employees who have BBA degrees. You could, of course, do an "in-string" search to find all of the BBA values within the EMP\_DEGREE strings. But such a solution is cumbersome from a reporting point of view. Query simplicity is a valuable thing to application developers – and to end users who like maximum query execution speeds. Database designers ought to pay some attention to the competing database interests that exist in the data environment.

One – very poor – solution is to create a field for each expected value. This "solution is shown next:

EMP_NUM	EMP_LNAME	EMP_DEGREE1	EMP_DEGREE2	EMP_DEGREE3
123	Carter	AA	BBA	
124	O'Shanski	BBA	MBA	Ph.D.
125	Jones	AS		
126	Ortez	BS	MS	

This solution yields nulls for all employees who have fewer than three degrees. And if even one employee earns a fourth degree, the table structure must be altered to accommodate the new data value. (One piece of evidence of poor design is the need to alter table structures in response to the need to add data of an existing type.) In addition, the query simplicity is not enhanced by the fact that any degree can be listed in any column. For example, a BA degree might be listed in the second column, after an "associate of arts (AA) degree has been entered in EMP\_DEGREE1.

One might simplify the query environment by creating a set of attributes that define the data entry, thus producing the following results:

EMP_NUM	EMP_LNAME	EMP_AA	EMP_AS	EMP_BA	EMP_BS	EMP_BBA	EMP_MS	EMP_MBA	EMP_PhD
123	Carter					X			
124	O'Shanski					X		X	X
125	Jones		X						
126	Ortez				X		X		

This "solution" creates no nulls at an ever-increasing pace.



The only reason to create a new DEGREE entity that stores each degree in a separate row is to create the following tables. (There is a 1:M relationship between EMPLOYEE and DEGREE). Note that the EMP\_NUM can occur more than once in the DEGREE table. The DEGREE table's PK is EMP\_NUM + DEGREE\_CODE. This solution also makes it possible to record the date on which the degree was earned, the institution from which it was earned and so on.

**Table name: EMPLOYEE**

EMP_NUM	EMP_LNAME
123	Carter
124	O'Shanski
125	Jones
126	Ortez

**Table name: DEGREE**

EMP_NUM	DEGREE_CODE	DEGREE_DATE	DEGREE_PLACE
123	AA	May-1999	Lake Sumter CC
123	BBA	Aug-2004	U. of Georgia
124	BBA	Dec-1990	U. of Toledo
124	MBA	May-2001	U. of Michigan
124	Ph.D.	Dec-2005	U. of Tennessee
125	AS	Aug-2002	Valdosta State
126	BS	Dec-1989	U. of Missouri
126	MS	May-2002	U. of Florida

Note that this solution leaves no nulls, produces a simple query environment, and makes it unnecessary to alter the table structure when employees earn additional degrees. (You can make the environment even more flexible by naming the new entity QUALIFICATION, thus making it possible to store degrees, certifications, and other useful data that define an employee's qualifications.)

#### 4. What is a composite entity, and when is it used?

A composite entity is generally used to transform M:N relationships into 1:M relationships. A composite entity, also known as a bridge entity, is one that has a primary key composed of multiple attributes. The PK attributes are inherited from the entities that it relates to one another.

5. Suppose you are working within the framework of the conceptual model in Figure Q4.5.

Figure Q4.5 The conceptual model for Question 5



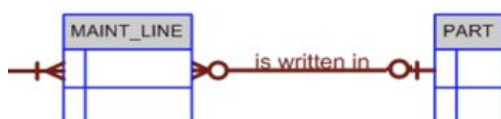
- a. Write the business rules that are reflected in it.

Even a simple ERD such as the one shown in Figure Q4.5 is based on many business rules. Make sure that each business rule is written on a separate line and that all of its details are spelled out. In this case the business rules are derived from the ERD in a “reverse engineering” procedure designed to document the database design. In a real world database design situation, the ERD is generated on the basis of business rules that are written before the first entity box is drawn. (Remember that the business rules are derived from a carefully and precisely written description of operations.)

Given the ERD shown in Figure Q4.5, you can identify the following business rules:

1. A customer can own many cars.
2. Some customers do not own cars.
3. A car is owned by one and only one customer.
4. A car may generate one or more maintenance records.
5. Each maintenance record is generated by one and only one car.
6. Some cars have not (yet) generated a maintenance procedure.
7. Each maintenance procedure can use many parts.

(Comment: A maintenance procedure may include multiple maintenance actions, in the model shown above every maintenance action *requires* a part. If this was not the case, which is a more realistic business rule, then the minimum cardinality at PART for the “is written in” relationship would need to be zero:



Such a change would also mean that a unique key would be required for MAINT\_LINE which did not depend on PART, for example: maintenance\_no and maintenance\_line\_no)

8. A part may be used in many maintenance records.

(Comment: Each time an oil change is made, an oil filter is used. Therefore, many oil filters may be used in a short period of time. Naturally, you are not using the *same* oil filter each time. The entity classified as “oil filter” shows up in many maintenance records.)

Note that the relationship between MAINTENANCE and PART has been resolved by the composite entity named MAINT\_LINE. The MAINT\_LINE entity is the M:N relationship between MAINTENANCE and PART has been broken up to produce the two 1:M relationships shown in business rules 9 and 10.

9. Each maintenance procedure generates one or more maintenance lines.

10. Each part may appear in many maintenance lines.

As you review the business rules 9 and 10, use the following two tables to show some sample data entries. For example, take a look at the (simplified) contents of the following MAINTENANCE and LINE tables and note that the MAINT\_NUM 10001 occurs three times in the LINE table.

Sample MAINTENANCE Table Data

MAINT_NUM	DATE
10001	15-Mar-2006
10002	15-Mar-2006
10003	16-Mar-2006

Sample LINE Table Data

MAINT_NUM	LINE_NUM	LINE_DESCRIPTION	LINE_PART	LINE_UNITS
10001	1	Replace fuel filter	FF-015	1
10001	2	Replace air filter	AF-1187	1
10001	3	Tighten alternator belt	NA	0
10002	1	Replace taillight bulbs	BU-2145	2
10003	1	Replace oil filter	OF-2113	1
10003	2	Replace air filter	AF-1187	1

b. Identify all of the cardinalities.

The Crow's Foot ERD, shown in Figure Q4.5, does not show cardinalities directly. Instead, the cardinalities are implied through the Crow's Foot symbols. You might write the cardinality (0,N) next to the MAINT\_LINE entity in its relationship with the PART entity to indicate that a part might occur “N” times in the maintenance line entity or that it might never show up in the maintenance line entity. The latter case would occur if a given part has never been used in maintenance.

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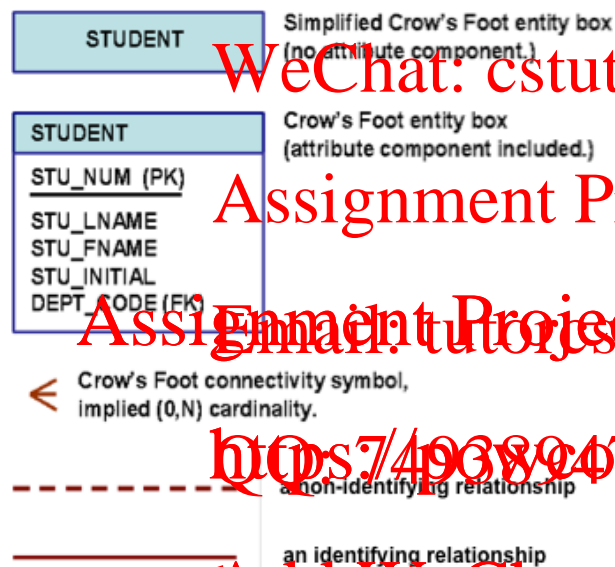
6. What is a recursive relationship? Given an example

A recursive relationship exists when an entity is related to itself. For example, a COURSE may be a prerequisite to a COURSE. (See Section 4.1.10, "Recursive Relationships,"

7. How would you identify each of the following ER components in a Crow's Foot model?

The answers to (a) through (d) are illustrated with the help of Figure Q4.7.

FIGURE Q4.7 Crow's Foot ER Components



a. an entity

An entity is represented by a rectangle containing the entity name. (Remember that, in ER modeling, the word "entity" actually refers to the entity set.)

b. the cardinality (0,N)

Cardinalities are implied through the use of Crow's Foot symbols. For example, note the implied (0,N) cardinality in Figure Q4.7.

c. a non-identifying relationship

A non-identifying relationship exists when the PK of the related entity does not contain at least one of the PK attributes of the parent entity. For example, if the PK of a COURSE entity is CRS\_CODE and the PK of the related CLASS entity is CLASS\_CODE, the relationship between COURSE and CLASS is non-identifying. (Note that the CLASS PK does not include the CRS\_CODE attribute.)



d. an identifying relationship

An identifying relationship exists when the PK of the related entity contains at least one of the PK attributes of the entity. For example, if the PK of a COURSE entity is CRS\_CODE and the PK of a CLASS entity is CRS\_CODE + CLASS\_SECTION, the relationship between COURSE and CLASS is identifying. (Note that the CLASS entity has the CRS\_CODE attribute.)

8. Discuss the difference between a composite key and a composite attribute. How would each be indicated in an ER diagram?

A composite key is one that consists of more than one attribute. If the ER diagram contains the attribute names for each of its entities, a composite key is indicated in the ER diagram by the fact that more than one attribute name is underlined to indicate its participation in the primary key.

A composite attribute is one that can be subdivided to yield meaningful attributes for each of its components. For example, the composite attribute CUS\_NAME can be subdivided to yield the CUS\_FNAME, CUS\_INITIAL, and CUS\_LNAME attributes. There is no ER convention that enables us to indicate that an attribute is a composite attribute.

9. What two courses of action are available to a designer when he or she encounters a multivalued attribute?

The discussion that accompanies the answer to Question 3 is valid as an answer to this question.

10. What is a derived attribute? Give an example.

A derived attribute is an attribute whose value is calculated (derived) from other attributes. The derived attribute need not be physically stored within the database; instead, it can be derived by using an algorithm. For example, an employee's age, EMP\_AGE, may be found by computing the integer value of the difference between the current date and the EMP\_DOB. If you use MS Access, you would use  $\text{INT}((\text{DATE}() - \text{EMP\_DOB})/365)$ .

Similarly, a sales clerk's total gross pay may be computed by adding a computed sales commission to base pay. For instance, if the sales clerk's commission is 1%, the gross pay may be computed by:

$\text{EMP\_GROSSPAY} = \text{INV\_SALES} * 1.01 + \text{EMP\_BASEPAY}$

Or the invoice line item amount may be calculated by

$\text{LINE\_TOTAL} = \text{LINE\_UNITS} * \text{PROD\_PRICE}$

11. How is a relationship between entities indicated in an ERD? Give an example, using the Crow's Foot notation.

Use Figure 4.7 as the basis for your answer. Note that many products show a distinction between dashed and solid relationship lines, to indicate identifying and non-identifying relationships.



12. Discuss two ways in which the 1:M relationship between COURSE and CLASS can be implemented. (Hint: Think about relationship strength.)

The relationship is implemented as identifying when the CLASS entity's PK contains the COURSE entity.

COURSE(CRS\_CODE, CRS\_TITLE, CRS\_DESCRIPTION, CRS\_CREDITS)  
 CLASS(CRS\_CODE, CLASS\_SECTION, CLASS\_TIME, CLASS\_PLACE)

Note that the CLASS entity's PK contains CRS\_CODE + CLASS\_SECTION – and that the CRS\_CODE component of the CLASS entity's PK has been “borrowed” from the COURSE entity. (Because CLASS is existence dependent on COURSE and uses a PK component from its parent (COURSE) entity, the CLASS entity is weak in this identifying relationship between COURSE and CLASS. The Crow's Foot ERD shows an identifying relationship as a solid line. (See Figure Q4.12a.)

Figure Q4.12a Identifying COURSE and CLASS Relationship



Sample data are shown next:

Table name: COURSE

CRS_CODE	CRS_TITLE	CRS-DESCRIPTION	CRS_CREDITS
ACCT-211	Basic Accounting	An introduction to accounting. Required of all business majors.	3
CIS-380	Database Techniques I	Database design and implementation issues. Uses CASE tools to generate designs that are then implemented in a major database management system.	3
CIS-490	Database Techniques II	The second half of CIS-380. Basic Web database application development and management issues.	4

Table name: CLASS

CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_PLACE
ACCT-211	1	8:00 a.m. – 9:30 a.m. T-Th.	Business 325
ACCT-211	2	8:00 a.m. – 8:50 a.m. MWF	Business 325
ACCT-211	3	8:00 a.m. – 8:50 a.m. MWF	Business 402
CIS-380	1	11:00 a.m. – 11:50 a.m. MWF	Business 415
CIS-380	2	3:00 p.m. – 3:50 a.m. MWF	Business 398
CIS-490	1	1:00 p.m. – 3:00 p.m. MW	Business 398
CIS-490	2	6:00 p.m. – 10:00 p.m. Th.	Business 398

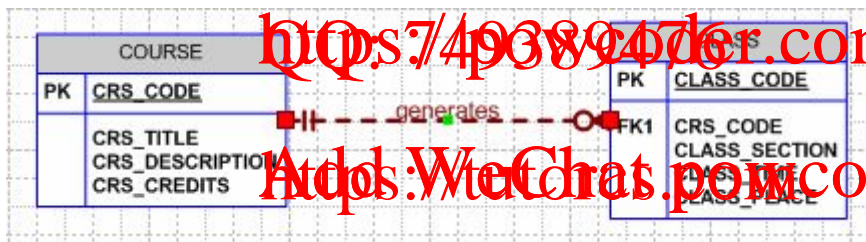
The relationship between COURSE and CLASS is non-identifying when the CLASS entity's PK does not contain the COURSE entity's PK. For example,

COURSE(CRS\_CODE, CRS\_TITLE, CRS\_DESCRIPTION, CRS\_CREDITS)  
 CLASS(CLASS\_CODE, CRS\_CODE, CLASS\_SECTION, CLASS\_TIME, CLASS\_PLACE)

(Note that CRS\_CODE is no longer part of the CLASS PK, but that it continues to serve as the FK to COURSE.)

The Crow's Foot ERD shows a non-identifying relationship as a dashed line. (See Figure Q4.12b.)

Figure Q4.12b Non-identifying COURSE and CLASS Relationship



Given the non-identifying relationship depicted in Figure Q4.13b, the CLASS table contents would look like this:

Table name: CLASS

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_PLACE
21151	ACCT-211	1	8:00 a.m. – 9:30 a.m. T-Th.	Business 325
21152	ACCT-211	2	8:00 a.m. – 8:50 a.m. MWF	Business 325
21153	ACCT-211	3	8:00 a.m. – 8:50 a.m. MWF	Business 402
38041	CIS-380	1	11:00 a.m. – 11:50 a.m. MWF	Business 415
38042	CIS-380	2	3:00 p.m. – 3:50 a.m. MWF	Business 398
49041	CIS-490	1	1:00 p.m. – 3:00 p.m. MW	Business 398
49042	CIS-490	2	6:00 p.m. – 10:00 p.m. Th.	Business 398

The advantage of the second CLASS entity version is that its PK can be referenced easily as a FK in another related entity such as ENROLL. Using a single-attribute PK makes implementation easier. This is especially true when the entity represents the “1” side in one or more relationships. In general, it is advisable to avoid composite PKs whenever it is practical to do so.

13. How is a composite entity represented in an ERD, and what is its function?  
Illustrate the Crow's Foot model.

The label "composite" is based on the fact that the composite entity contains at least the primary key attributes of the entities that are connected by it. The composite entity is an improvement over the ER model because relational database models should not contain many-to-many relationships – and the composite entity can be used to break up such relationships into two one-to-many relationships.

**Avoid composite entities if it is practical to do so.** Note that the CLASS entity structure shown in Figure 4.12a is far better than that of the CLASS entity structure shown in Figure 4.12a. Suppose, for example, that you want to design a class enrollment entity to serve as the "bridge" between STUDENT and CLASS in the M:N relationship defined by these two business rules:

- A student can take many classes.
- Each class can be taken by many students.

In this case, you could create a (composite) entity named ENROLL to link CLASS and STUDENT, using these structures:

```
STUDENT(STU_NUM, STU_LNAME .....)  
ENROLL(STU_NUM, CLASS_NUM, ENROLL_GRADE .....)  
CLASS(CLASS_CODE, CRS_CODE, CLASS_SECTION, CLASS_TIME, CLASS_PLACE)
```

You might argue that a composite PK in ENROLL does no harm, since it is not likely to be related to another entity in the typical academic database setting. Although that is a good observation, you would run into a problem in the event that might trigger a required relationship between ENROLL and another entity. In any case, you may simplify the creation of future relationships if you create an "artificial" single-attribute PK such as ENROLL\_NUM, while maintaining the STU\_NUM and CLASS\_NUM as FK attributes. In other words:

```
ENROLL(ENROLL_NUM, STU_NUM, CLASS_NUM, ENROLL_GRADE .....)
```

The ENROLL\_NUM attribute values can easily be generated through the proper use of SQL code or application software, thus eliminating the need for data entry by humans.

Let's examine another example of the use of composite entities. Suppose that a trucking company keeps a log of its trucking operations to keep track of its driver/truck assignments. The company may assign any given truck to any given driver many times and, as time passes, each driver may be assigned to drive many of the company's trucks. Since this M:N relationship should not be implemented, we create the composite entity named LOG whose attributes are defined by the end-user information requirements. In this case, it may be useful to include LOG\_DATE, TRUCK\_NUM, DRIVER\_NUM, LOG\_TIME\_OUT, and LOG\_TIME\_IN.

Note that the LOG's TRUCK\_NUM and DRIVER\_NUM attributes are the driver LOG's foreign keys. The TRUCK\_NUM and DRIVER\_NUM attribute values provide the bridge between the TRUCK and DRIVER, respectively. In other words, to form a proper bridge between TRUCK and DRIVER, the composite LOG entity must contain at least the primary keys of the entities connected by it.

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You might think that the combination of the composite entity's foreign keys may be designated to be the composite entity's primary key. However, this combination will not produce unique values over time. For example, the same driver may drive a given truck on different dates. To the PK attributes will solve that problem. But we still have a non-unique combination when the same driver drives a given truck twice on the same date. Adding LOG\_DATE will finally create a unique set of PK attribute values – but the PK is not LOG\_DATE, and LOG\_DATE, and TRUCK\_NUM, DRIVER\_NUM, LOG\_DATE, and LOG\_TIME\_OUT. (The combination of these attributes yields a unique outcome, because a driver cannot check out two trucks at the same time on a given date.)



**Because multi-attribute PKs may be difficult to manage, it is often advisable to create an “artificial” single-attribute PK, such as LOG\_NUM, to uniquely identify each record in the LOG table.** (Oracle users can fill such an attribute via a sequence to ensure that the system will generate unique LOG\_NUM values for each record.) Note that this solution produces a LOG table that contains two candidate keys: the designated primary key and the combination of foreign keys that *could* have served as the primary key.

While the preceding solution simplifies the PK definition, it does not prevent the creation of duplicate records that may have different LOG\_NUM values. Note, for example, the first two records in the following table:

LOG_NUM	LOG_DATE	TRUCK_NUM	DRIVER_NUM	LOG_TIME_OUT	LOG_TIME_IN
10015	12-Mar-2006	545567	1215	07:18 a.m.	04:23 p.m.
10016	12-Mar-2006	545567	1215	07:18 a.m.	04:23 p.m.
10017	12-Mar-2006	545567	1298	08:12 a.m.	09:15 p.m.

To avoid such duplicate records, a unique primary key is made of TRUCK\_NUM + DRIVER\_NUM + LOG\_DATE + LOG\_TIME\_OUT.

Composite entities may be named to reflect their component entities. For example, an employee may have several insurance policies (life, dental, accident, health, etc.) and each insurance policy may be held by many employees. This M:N relationship is converted to a set of two 1:M relationships, by creating a composite entity named EMP\_INS. The EMP\_INS entity must contain *at least* the primary key components of each of the two entities connected by it. How many additional attributes are kept in the composite entity depends on the end-user information requirements.

14. **Briefly, but precisely, explain the difference between single-valued attributes and simple attributes. Give an example of each.**

A single-valued attribute is one that can have only one value. For example, a person has only one first name and only one social security number.

A simple attribute is one that cannot be decomposed into its component pieces. For example, a person's sex is classified as either M or F and there is no reasonable way to decompose M or F. Similarly, a person's first name cannot be decomposed into meaningful components. (In contrast, if a phone number includes the area code, it can be decomposed into the area code and the phone number. And a person's name may be decomposed into a first name, an initial, and a last name.)

Single-valued attributes are not necessarily simple. For example, an inventory code HWPRIJ23145 may refer to a classification scheme in which HW indicates Hardware, PR indicates Printer, IJ indicates Inkjet, and 23145 indicates an inventory control number. Therefore, HWPRIJ23145 may be decomposed into its component parts... even though it is a single-valued attribute. To facilitate product tracking, manufacturing serial codes must be single-valued, but they do not have to be simple.

For instance, the number TNP5S2M231109154321 might be decomposed this way:

TN = standard time  
P5 = plant number 5  
S2 = shift 2  
M23 = machine 23  
11 = month, i.e., November  
09 = day  
154321 = time on a 24-hour clock, i.e., 15:43:21, or 3:43 p.m. plus 21 seconds.

15. What are multivalued attributes, and how can they be handled within the database design?

The answer to question 15 is just as tricky as an answer to this question. You can augment that discussion with the following discussion.

As the name implies, multi-valued attributes may have many values. For example, a person's educational history may include a high school diploma, a 2-year college associate degree, a four-year college degree, a Master's degree, a Doctoral degree, and various professional certifications such as a Certified Public Accounting certificate or a Certified Data Processing Certificate.

There are basically three ways to handle multi-valued attributes -- and two of those three ways are bad:

1. Each of the possible outcomes is kept as a separate attribute within the table. This solution is undesirable for several reasons. First, the table would generate many nulls for those who had minimal educational attainments. Using the preceding example, a person with only a high school diploma would generate nulls for the 2-year college associate degree, the four-year college degree, the Master's degree, the Doctoral degree, and for each of the professional certifications. In addition, how many professional certification attributes should be maintained? If you store two professional certification attributes, you will generate a null for someone with only one professional certification and you'd generate two nulls for all persons without professional certifications. And suppose you have a person with five professional certifications? Would you create additional attributes, thus creating many more nulls in the table, or would you simply ignore the additional professional certifications, thereby losing information?



2. The educational attainments may be kept as a single variable-length string or character field. This solution is undesirable because it becomes difficult to query the table. For example, even a simple question such as "how many employees have four-year college degrees" requires string partitioning that is time-consuming at best. Of course, if we need to ever group employees by education, the variable-length solution is acceptable from a design point of view. However, as database design evolves, sooner or later, information requirements are likely to grow that make this design a bad idea from that perspective, too.
3. Finally, the deal with multi-valued attributes is to create a composite entity that links employees to education. By using the composite entity, there will never be a situation in which additional attributes must be created within the EMPLOYEE table to accommodate people with multiple certifications. In short, we eliminate the generation of nulls. In addition, we gain information flexibility because we can also store the details (date earned, place earned, etc.) for each of the educational attainments. The (simplified) structures might look like those in Figure Q4.16 A and B.

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Figure Q4.16a The Ch04\_Questions Database Tables

EMP_NUM	EMP_LNAME
215	Smith
216	Romero
217	Randall
218	Aarden

EDU_CODE	EDU_DESCRIPTION
B4	Bachelor's degree
CDP	Certified data Processing
CNP	Certified Network Professional
CPA	Certified Public Accountant
DR	Earned Doctorate degree
HS	Highschool diploma
JC	Junior College degree
M2	Master's degree

EMP_NUM	EDU_CODE	EE_YEAR
215	B4	2002
215	HS	1991
215	JC	1994
216	B4	1989
216	CDP	2004
216	CNP	2002
216	HS	1985
217	HS	1992
217	JC	2000
218	B4	1990
218	CDP	2000
218	CNP	2005
218	HS	1984
218	M2	1995

Figure Q4.16b The Ch04\_Questions Relational Diagram



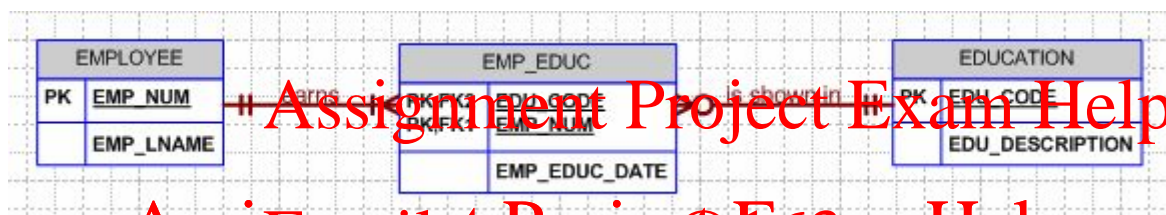
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By looking at the structures shown in Figures Q4.16a and Q4.16b, we can tell that the employee named Romero earned a Bachelor's degree in 1989, a Certified Network Professional certification in 2002, and a Certified Data Processing certification in 2004. If Randall were to earn a degree and a Certified Public Accountant certification later, we merely add another record to the EMP\_EDUC table. If additional educational attainments beyond those shown in the EMP\_EDUC table are earned by any employee, all we need to do is add another record(s) to the EDUCATION table, then enter the employee's attainment in the EMP\_EDUC table. There are no nulls, we have superb query capability, all in all. Not a bad set of design goals!



The database design on which Figures Q4.16a and Q4.16b are based is shown in Figure Q4.16c.

Figure Q4.16c The Crow's Foot ERD for the CH04 Questions Database



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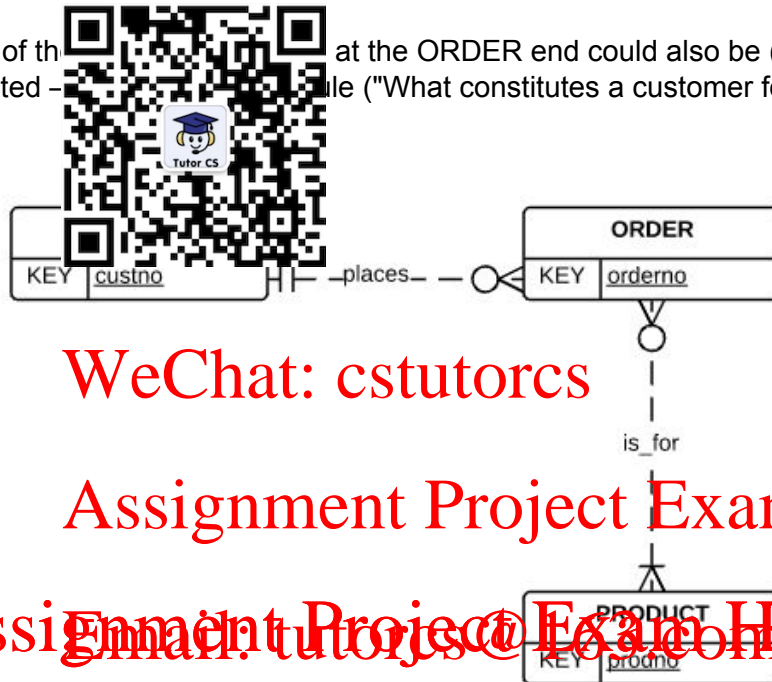
<https://49389476.com>

<https://t.me/wechat.pomcoder>



(i) Basic ERD showing only primary keys

The cardinality of the relationship at the ORDER end could also be (1,N) rather than (0,N) as illustrated - "What constitutes a customer for the company"



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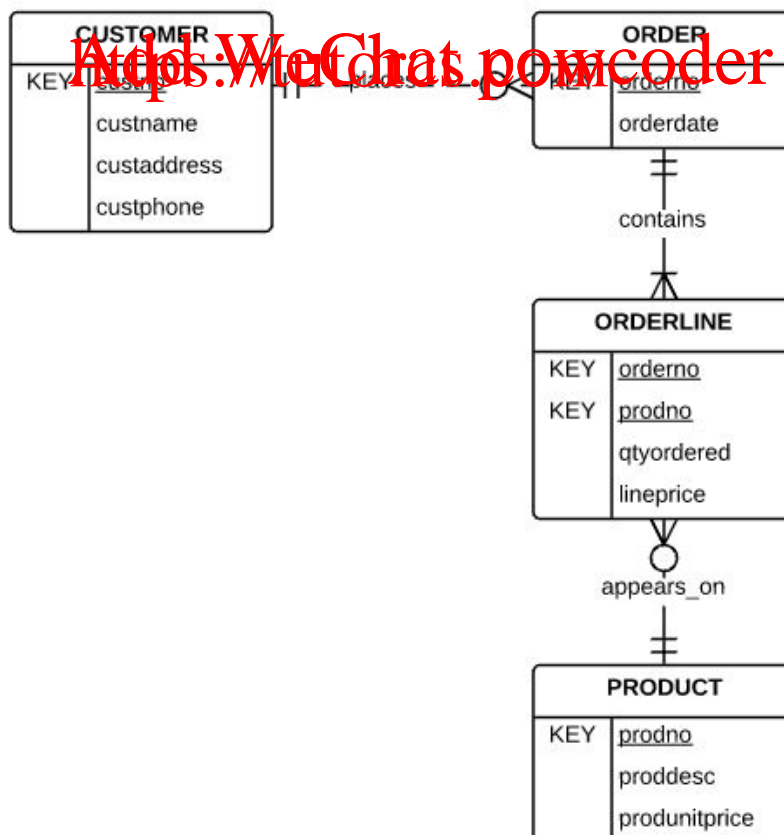
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(ii) Complete ERD showing all attributes

QQ: 749389476

WeChat: powcoder



# Practical Work 程序代写代做 CS编程辅导

NOTE for ER diagram

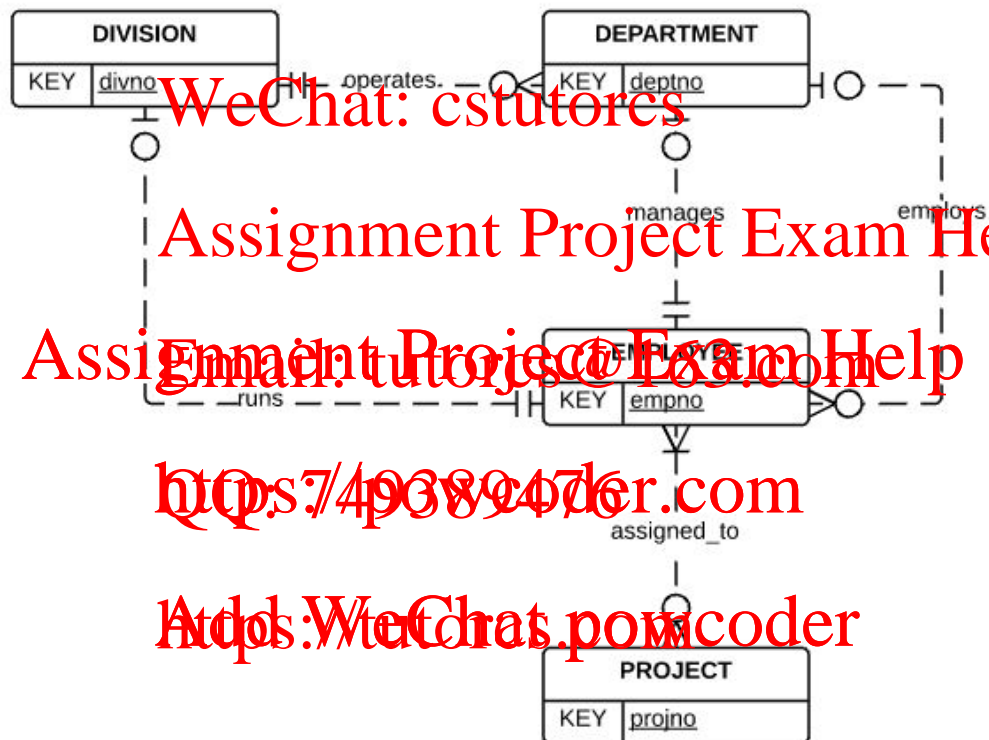
- lines should
- lines must



although they may be stepped), and

Question 1 – no

al model shows keys only



Question 2 – note this Conceptual Model shows all attributes

