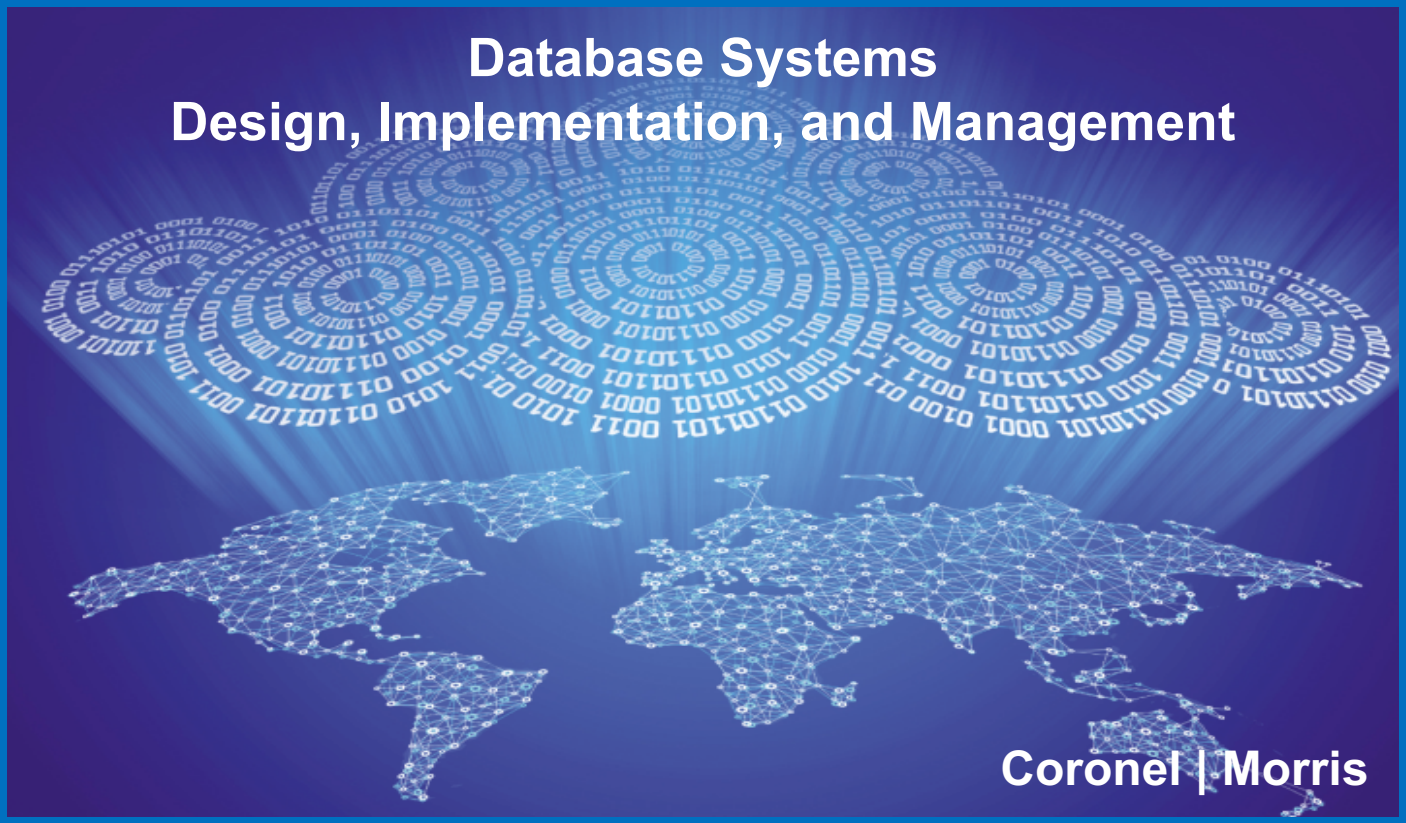
11e



Chapter 4
Entity Relationship (ER) Modeling

Learning Objectives

- In this chapter, students will learn:
  - The main characteristics of entity relationship components
  - How relationships between entities are defined, refined, and incorporated into the database design process
  - How ERD components affect database design and implementation
  - That real-world database design often requires the reconciliation of conflicting goals

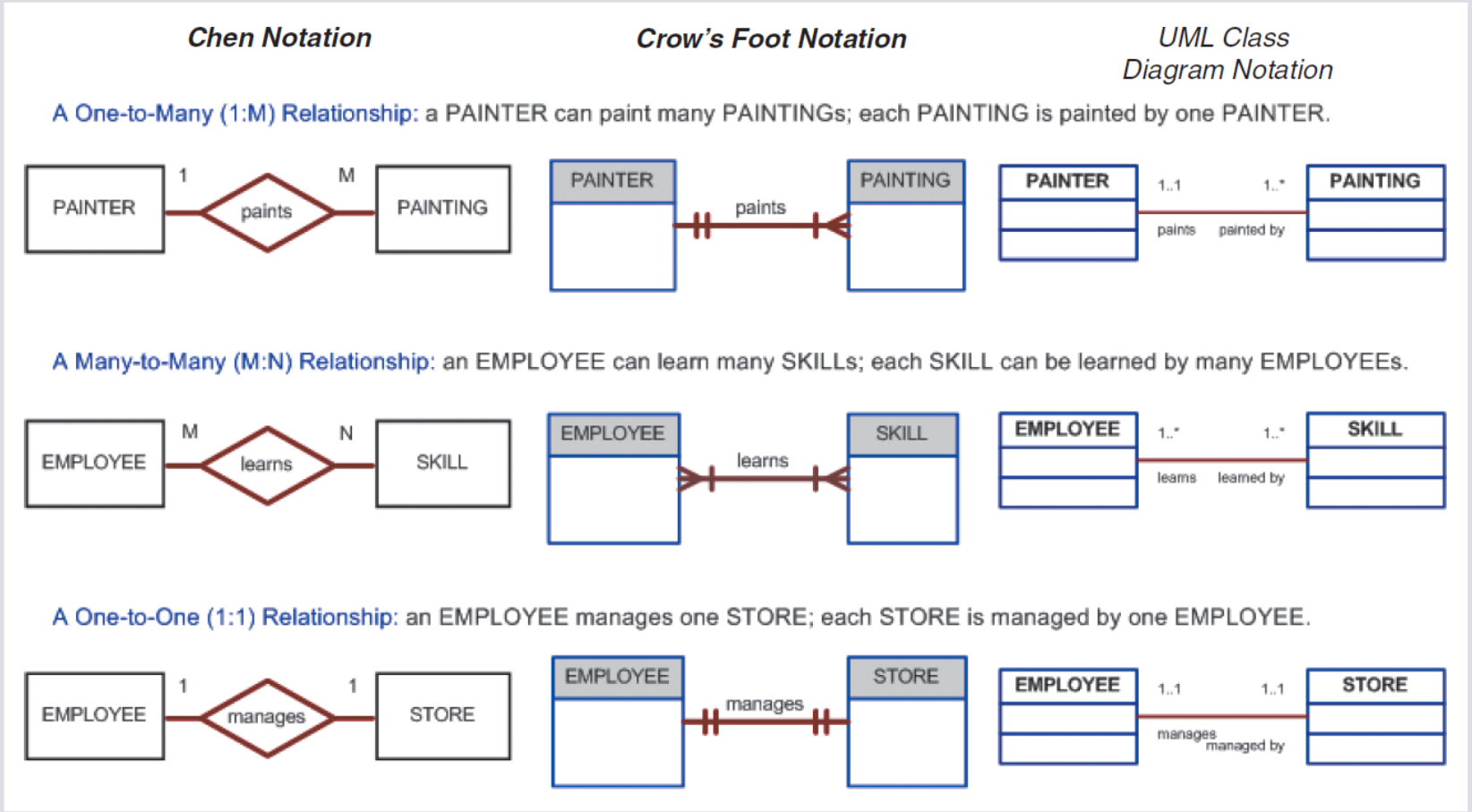
Entity Relationship Model (ERM)

- ER model forms the basis of an entity relationship diagram (ERD)
- ERD represents conceptual database as viewed by end user
- ERD depicts the database's main components
  - Entities
  - Attributes
  - Relationships

Entities

- Refers to entity set and not to single entity occurrence
- Corresponds to table and not to row in relational environment
- In both Chen and Crow's Foot models, entity is represented by rectangle containing entity's name
- Entity name, a noun, is usually written in capital letters

Figure 2.3 - The ER Model Notations

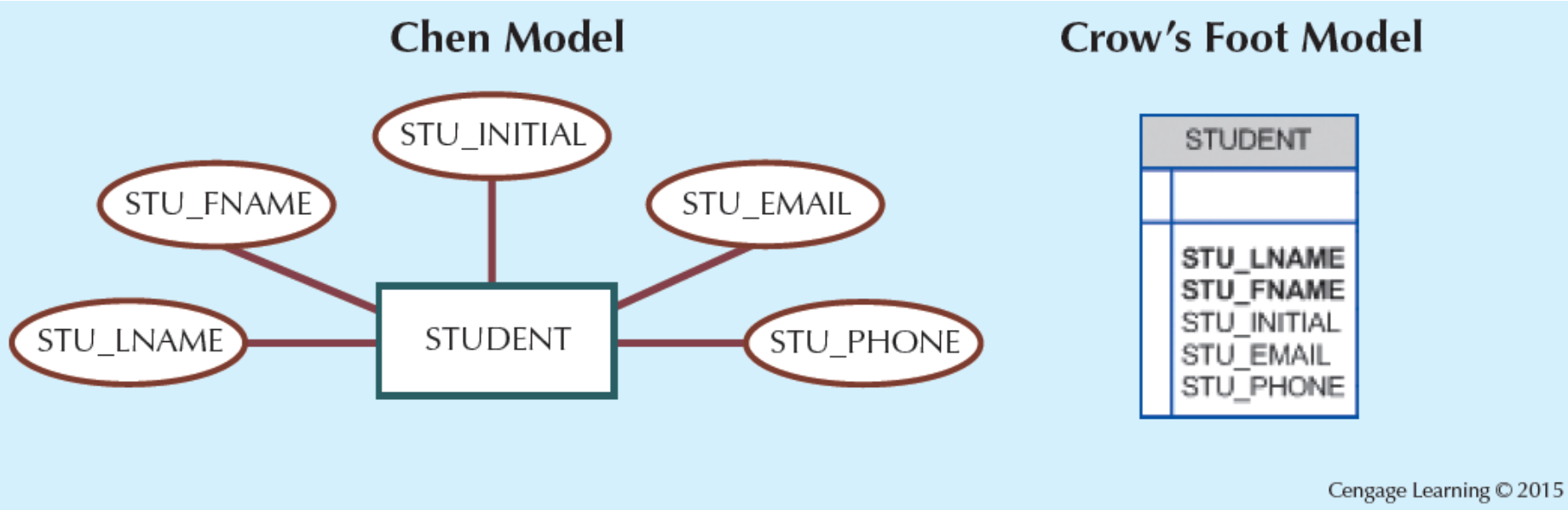


Cengage Learning © 2015

Attributes

- Characteristics of entities
- In Chen model, attributes are represented by ovals and are connected to entity rectangle with a line
- Each oval contains the name of attribute it represents
- In Crow's Foot model, attributes are written in attribute box below entity rectangle

Figure 4.1 - The Attributes of the Student Entity: Chen and Crow's Foot



Attributes (continued)

- **Required attribute**: Must have a value, cannot be left empty
- **Optional attribute**: Does not require a value, can be left empty
- Attributes have a **domain**
  - Domain is attribute's set of possible values
- Attributes may share a domain

Identifiers (Primary Keys)

- Underlined in the ERD
- Key attributes are also underlined in frequently used table structure shorthand

Composite Primary Keys

- Primary key is either composed of only single attribute
- Or may use a composite key
  - Primary key composed of more than one attribute

Composite Primary Keys (continued)

FIGURE 4.2 The CLASS table (entity) components and contents

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	PROF_NUM
0012	ACCT-211	1	MWF 8:00-8:50 a.m.	BUS311	105
10013	ACCT-211	2	MWF 9:00-9:50 a.m.	BUS200	105
10014	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10015	ACCT-212	1	MWF 10:00-10:50 a.m.	BUS311	301
10016	ACCT-212	2	Th 6:00-8:40 p.m.	BUS252	301
10017	CIS-220	1	MWF 9:00-9:50 a.m.	KLR209	228
10018	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10019	CIS-220	3	MWF 10:00-10:50 a.m.	KLR209	228
10020	CIS-420	1	W 6:00-8:40 p.m.	KLR209	162
10021	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114
10022	QM-261	2	TTh 1:00-2:15 p.m.	KLR200	114
10023	QM-362	1	MWF 11:00-11:50 a.m.	KLR200	162
10024	QM-362	2	TTh 2:30-3:45 p.m.	KLR200	162

Composite Attribute

- Do not be confused with a composite key.
- An attribute that can be further subdivided to yield additional attributes.
  - Ex: the attribute ADDRESS can be subdivided into street, city, state, and zip code.
- To facilitate detailed queries, it is wise to change composite attributes into a series of simple attributes.

Simple Attribute

- An attribute that cannot be subdivided.
  - Ex: age, sex, marital status.

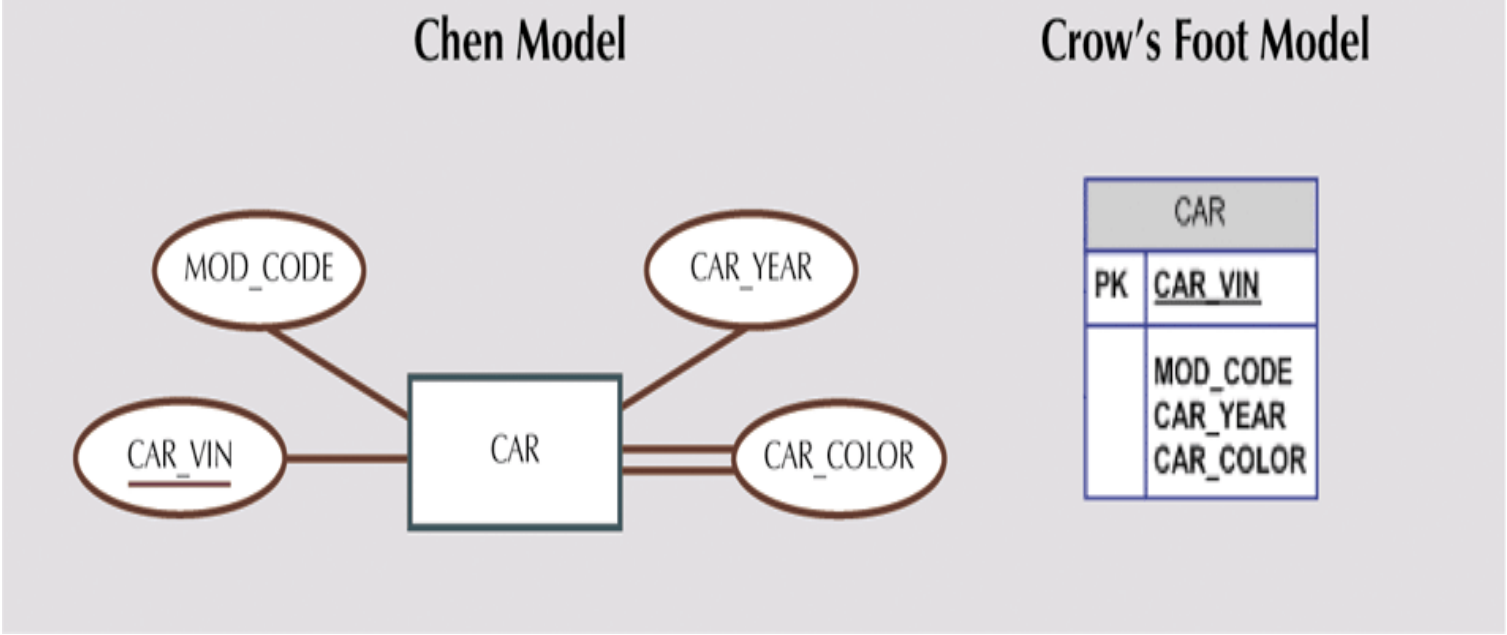
Single-Valued Attributes

- Single-value attribute can have only a single value
  - Ex: a person can have only one Social Security number,
  - Ex: A manufactured part can have only one serial number.
- A single-valued attribute is not necessarily a simple attribute.
  - Ex: a part's serial number (SE-08-02-12345) is single-valued, but it is a composite attribute because it can be subdivided into the region in which the part was produced(SE), the plant within that region (08), the shift within the plant(02), and the part number(12345)

Multivalued Attributes

- Multivalued attributes can have many values

FIGURE 4.3 A multivalued attribute in an entity

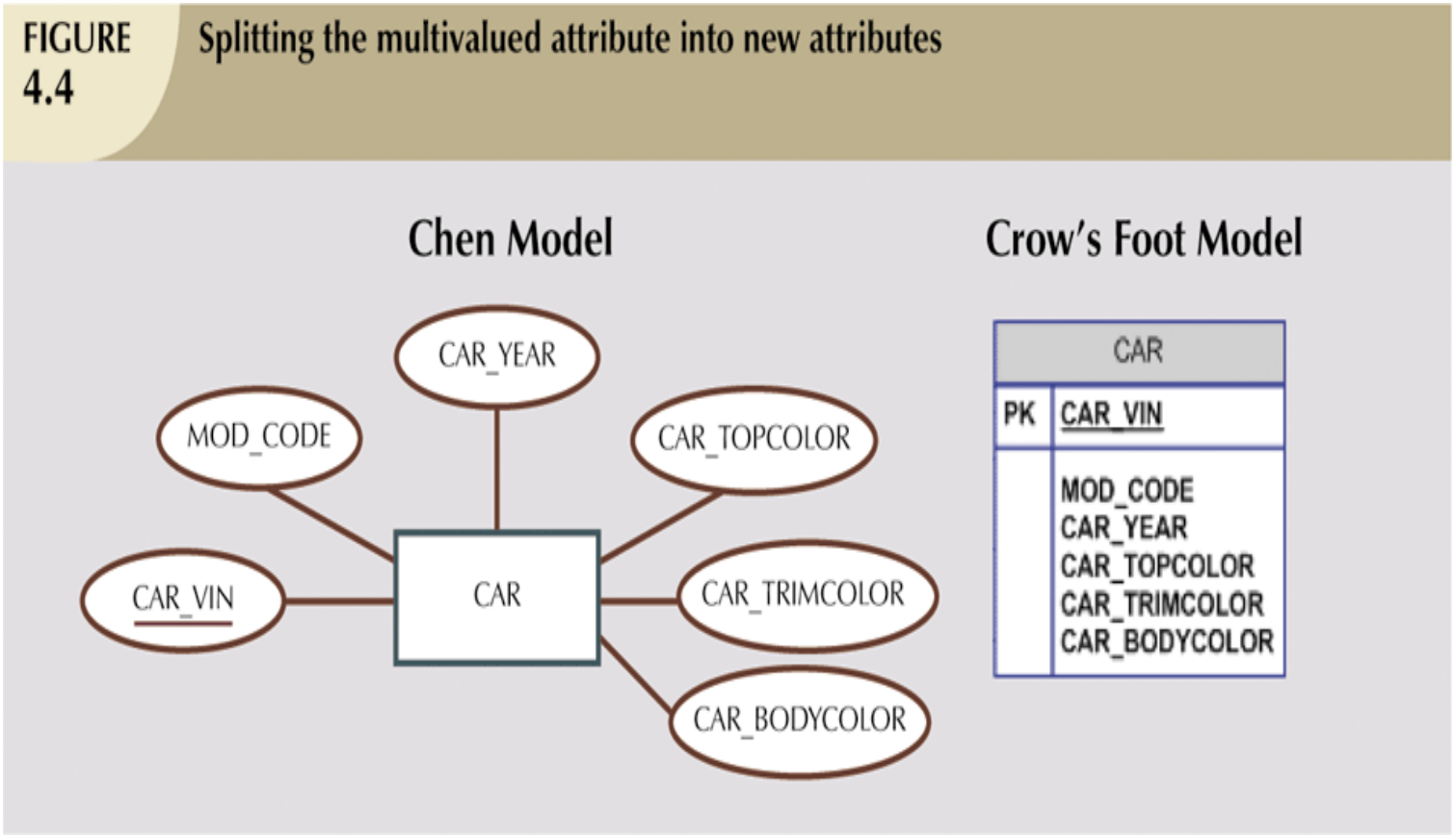


Resolving Multivalued Attribute Problems

- Although conceptual model can handle M:N relationships and multivalued attributes, you should not implement them in relational DBMS
  - Within original entity, create several new attributes, one for each of the original multivalued attribute's components
    - Can lead to major structural problems in table
    - Only acceptable if every instance will have the same number of values for the multivalued attribute, and no instance will ever have more values.
  - Create new entity composed of original multivalued attribute's components

Resolving Multivalued Attribute Problems (continued)

FIGURE 4.4 Splitting the multivalued attribute into new attributes



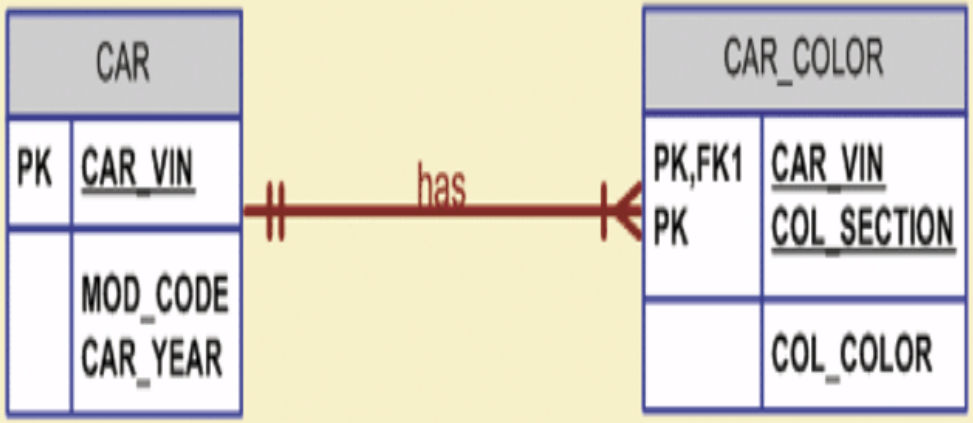
Resolving Multivalued Attribute Problems (continued)

TABLE 4.1 Components of the Multivalued Attribute

SECTION	COLOR
Top	White
Body	Blue
Trim	Gold
Interior	Blue

Resolving Multivalued Attribute Problems (continued)

FIGURE 4.5 A new entity set composed of a multivalued attribute's components

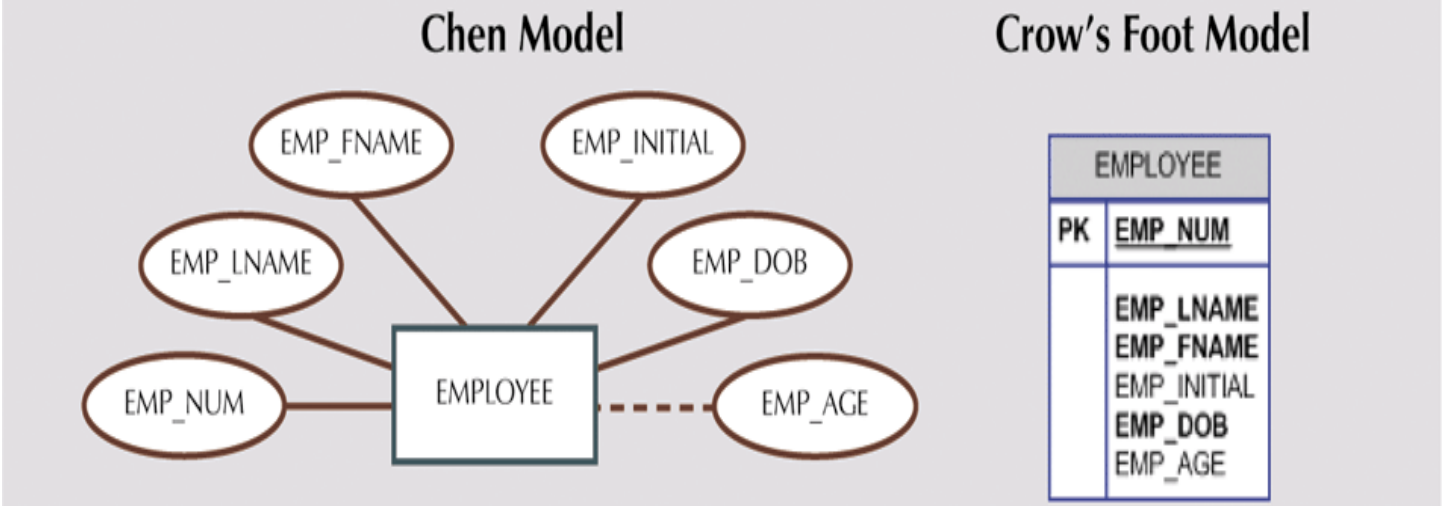


Derived Attributes

- Attribute whose value may be calculated (derived) from other attributes
- Need not be physically stored within database
- Can be derived by using an algorithm

Derived Attributes (continued)

FIGURE 4.6 Depiction of a derived attribute



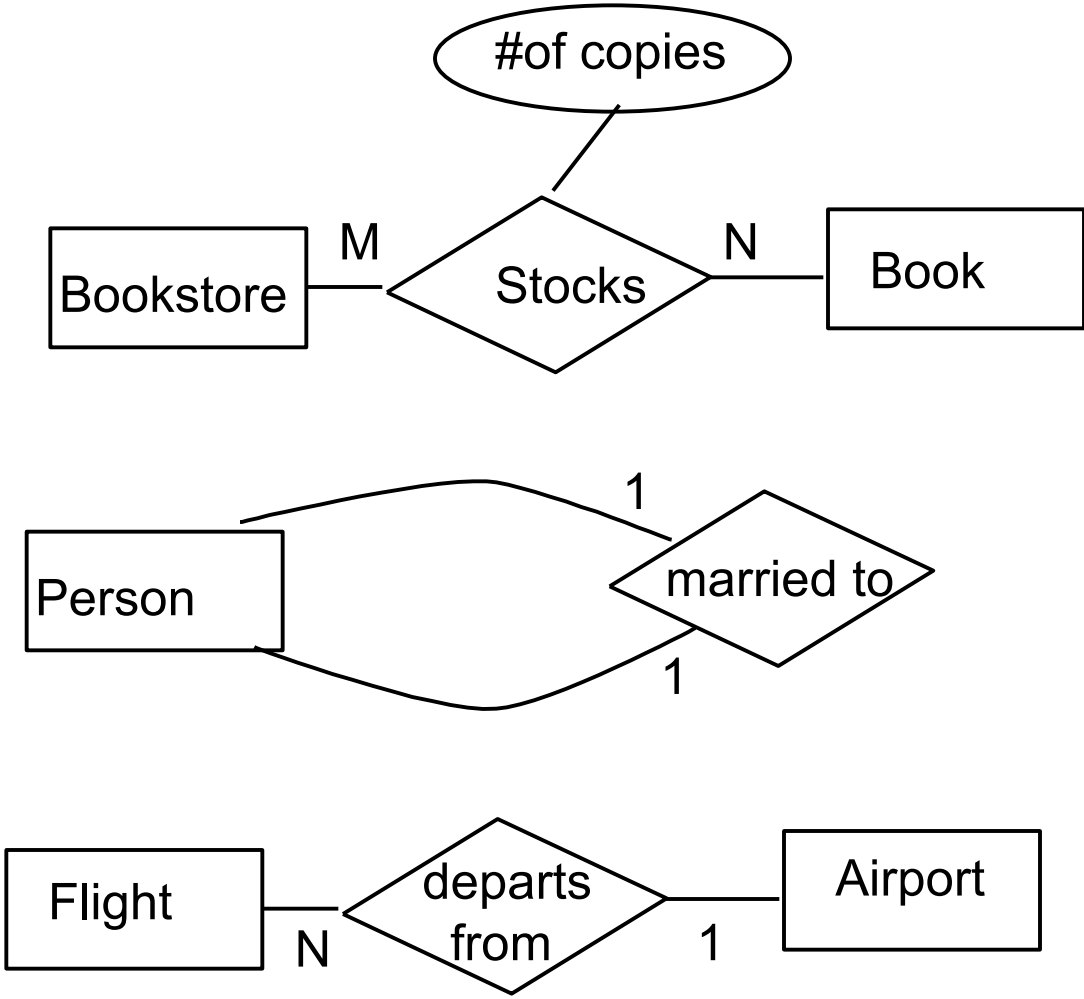
Derived Attributes (continued)

TABLE 4.2 Advantages and Disadvantages of Storing Derived Attributes

	DERIVED ATTRIBUTE	
	STORED	NOT STORED
Advantage	Saves CPU processing cycles Data value is readily available Can be used to keep track of historical data	Saves storage space Computation always yields current value
Disadvantage	Requires constant maintenance to ensure derived value is current, especially if any values used in the calculation change	Uses CPU processing cycles Adds coding complexity to queries

Relationships

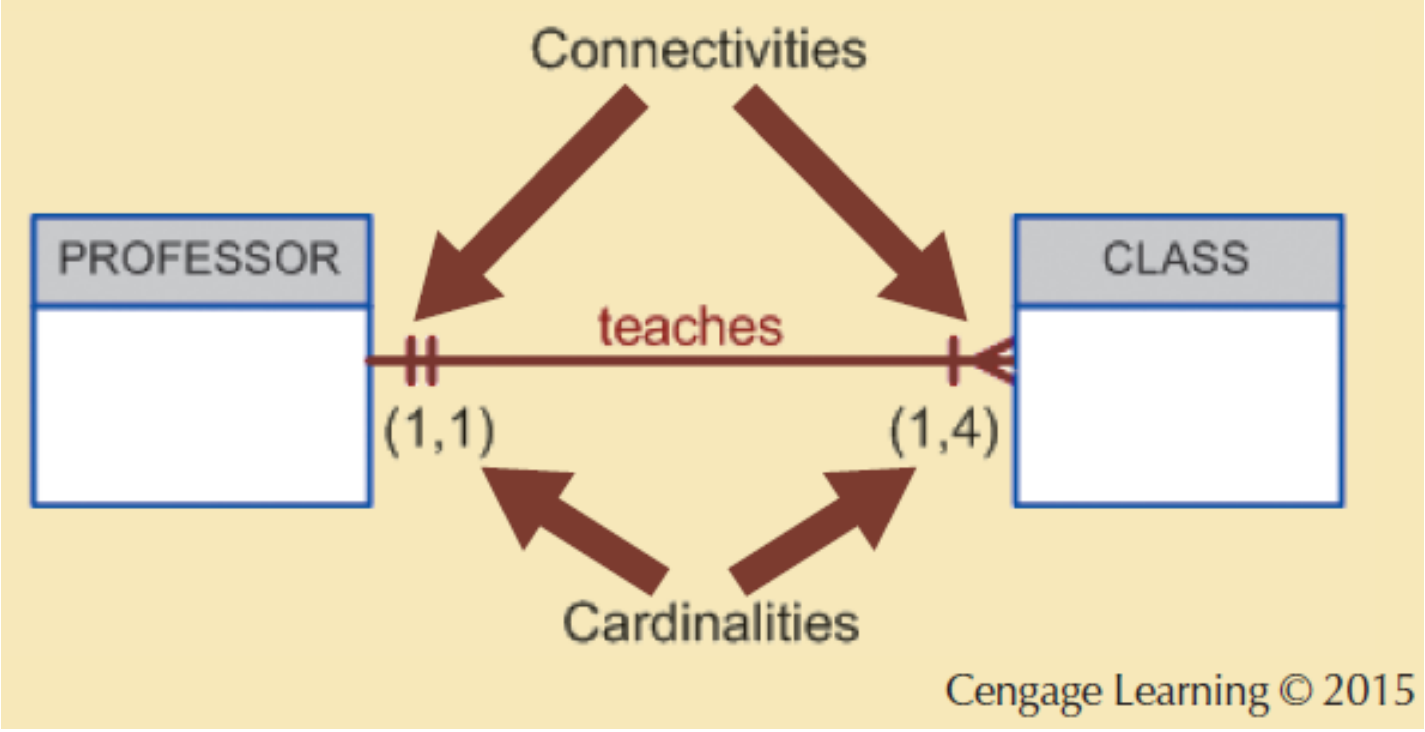
- Association between entities



Relationships

- Association between entities that always operate in both directions
  - A CUSTINER may generate many INVOICEs
  - Each INVOICE is generated by one CUSTOMER
- **Participants**: Entities that participate in a relationship
- **Connectivity**: Describes the relationship classification (1:1,1:M)
- **Cardinality**: Expresses the minimum and maximum number of entity occurrences associated with one occurrence of related entity

Figure 4.7 - Connectivity and Cardinality in an ERD



Existence Dependence

Existence dependence	Existence independence
• Entity exists in the database only when it is associated with another related entity occurrence	• Entity exists apart from all of its related entities • Referred to as a **strong entity** or **regular entity**

Relationship Strength

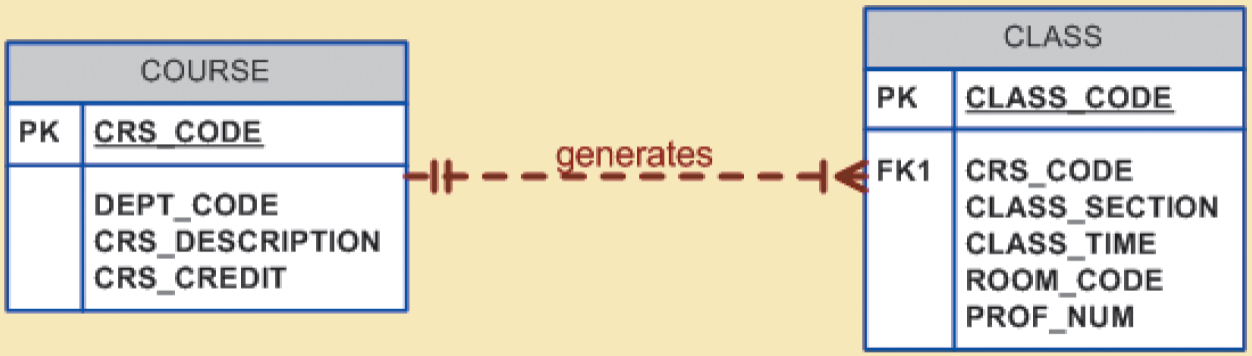
Weak (non-identifying) relationship

- Primary key of the related entity does not contain a primary key component of the parent entity

Strong (identifying) relationships

- Primary key of the related entity contains a primary key component of the parent entity

Figure 4.8 - A Weak (Non-Identifying) Relationship between COURSE and CLASS



Cengage Learning © 2015

Weak (Non-Identifying) Relationships (continued)

FIGURE 4.9 Weak (non-identifying) relationship between COURSE and CLASS

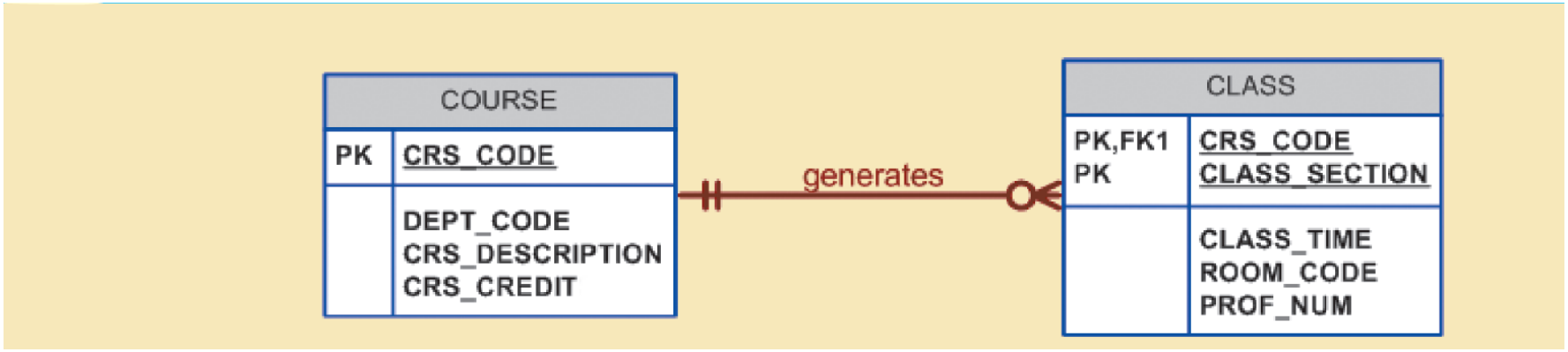
Table name: STUDENT — Database name: CH04_Tiny College

CRS_CODE	DEPT_CODE	CRS_DESCRIPTION	CRS_CREDIT
ACCT-211	ACCT	Accounting I	3
ACCT-212	ACCT	Accounting II	3
CIS-220	CIS	Intro. to Microcomputing	3
CIS-420	CIS	Database Design and Implementation	4
MATH-243	MATH	Mathematics for Managers	3
QM-261	CIS	Intro. to Statistics	3
QM-362	CIS	Statistical Applications	4

Table name: CLASS

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	PROF_NUM
10012	ACCT-211	1	MWF 8:00-8:50 a.m.	BUS311	105
10013	ACCT-211	2	MWF 9:00-9:50 a.m.	BUS200	105
10014	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10015	ACCT-212	1	MWF 10:00-10:50 a.m.	BUS311	301
10016	ACCT-212	2	Th 6:00-8:40 p.m.	BUS252	301
10017	CIS-220	1	MWF 9:00-9:50 a.m.	KLR209	228
10018	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10019	CIS-220	3	MWF 10:00-10:50 a.m.	KLR209	228
10020	CIS-420	1	W 6:00-8:40 p.m.	KLR209	162
10021	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114
10022	QM-261	2	TTh 1:00-2:15 p.m.	KLR200	114
10023	QM-362	1	MWF 11:00-11:50 a.m.	KLR200	162
10024	QM-362	2	TTh 2:30-3:45 p.m.	KLR200	162
10025	MATH-243	1	Th 6:00-8:40 p.m.	DRE155	325

Figure 4.9 - A Strong (Identifying) Relationship between COURSE and CLASS



Cengage Learning © 2015

Weak Entity

- Weak entity meets two conditions
  - Existence-dependent
    - Cannot exist without entity with which it has a relationship
  - Has primary key that is partially or totally derived from parent entity in relationship
- Database designer usually determines whether an entity can be described as weak based on business rules

Figure 4.10 - A Weak Entity in an ERD

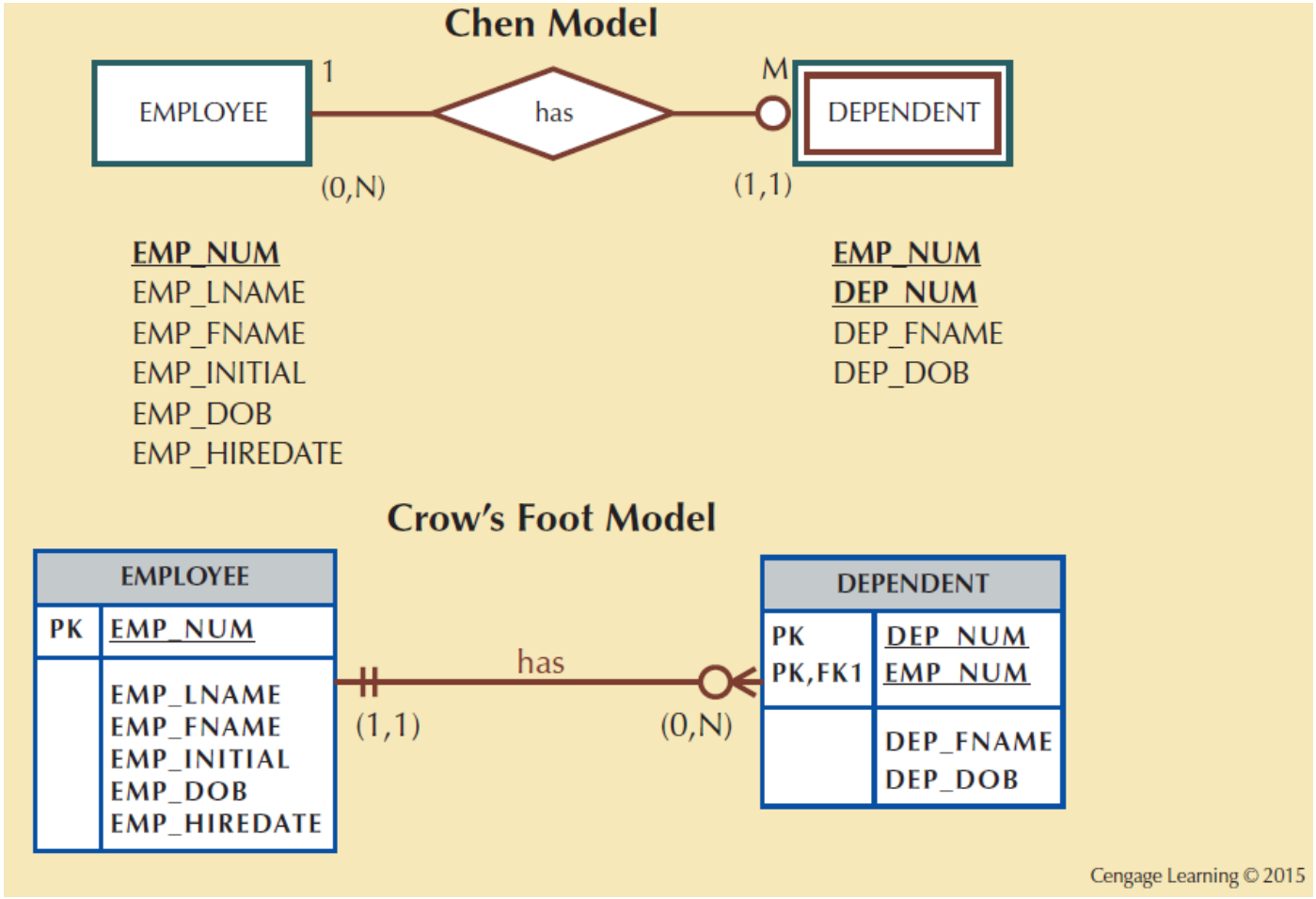


Figure 4.11 - A Weak Entity in a Strong Relationship

Table name: EMPLOYEE **Database name: Ch04_ShortCo**

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_DOB	EMP_HIREDATE
1001	Callifante	Jeanine	J	12-Mar-64	25-May-97
1002	Smithson	William	K	23-Nov-70	28-May-97
1003	Washington	Herman	H	15-Aug-68	28-May-97
1004	Chen	Lydia	B	23-Mar-74	15-Oct-98
1005	Johnson	Melanie		28-Sep-66	20-Dec-98
1006	Ortega	Jorge	G	12-Jul-79	05-Jan-02
1007	O'Donnell	Peter	D	10-Jun-71	23-Jun-02
1008	Brzenski	Barbara	A	12-Feb-70	01-Nov-03

Table name: DEPENDENT

EMP_NUM	DEP_NUM	DEP_FNAME	DEP_DOB
1001	1	Annelise	05-Dec-97
1001	2	Jorge	30-Sep-02
1003	1	Suzanne	25-Jan-04
1006	1	Carlos	25-May-01
1008	1	Michael	19-Feb-95
1008	2	George	27-Jun-98
1008	3	Katherine	18-Aug-03

Cengage Learning © 2015

Relationship Participation

Optional participation

- One entity occurrence does not require a corresponding entity occurrence in a particular relationship

Mandatory participation

- One entity occurrence requires a corresponding entity occurrence in a particular relationship

Figure 4.13 - CLASS is Optional to COURSE

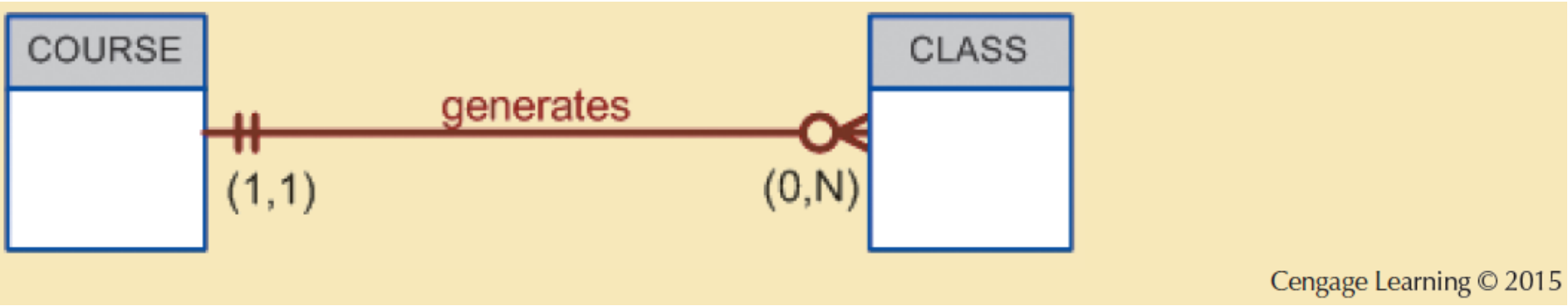


Figure 4.14 - COURSE and CLASS in a Mandatory Relationship

Cengage Learning © 2015

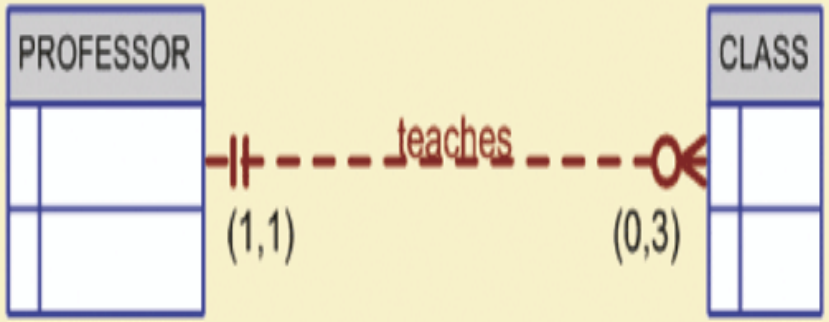
Table 4.3 - Crow's Foot Symbols

CROW'S FOOT SYMBOLS	CARDINALITY	COMMENT
	(0,N)	Zero or many; the "many" side is optional.
	(1,N)	One or many; the "many" side is mandatory.
	(1,1)	One and only one; the "1" side is mandatory.
	(0,1)	Zero or one; the "1" side is optional.

Cengage Learning © 2015

Relationship Participation (continued)

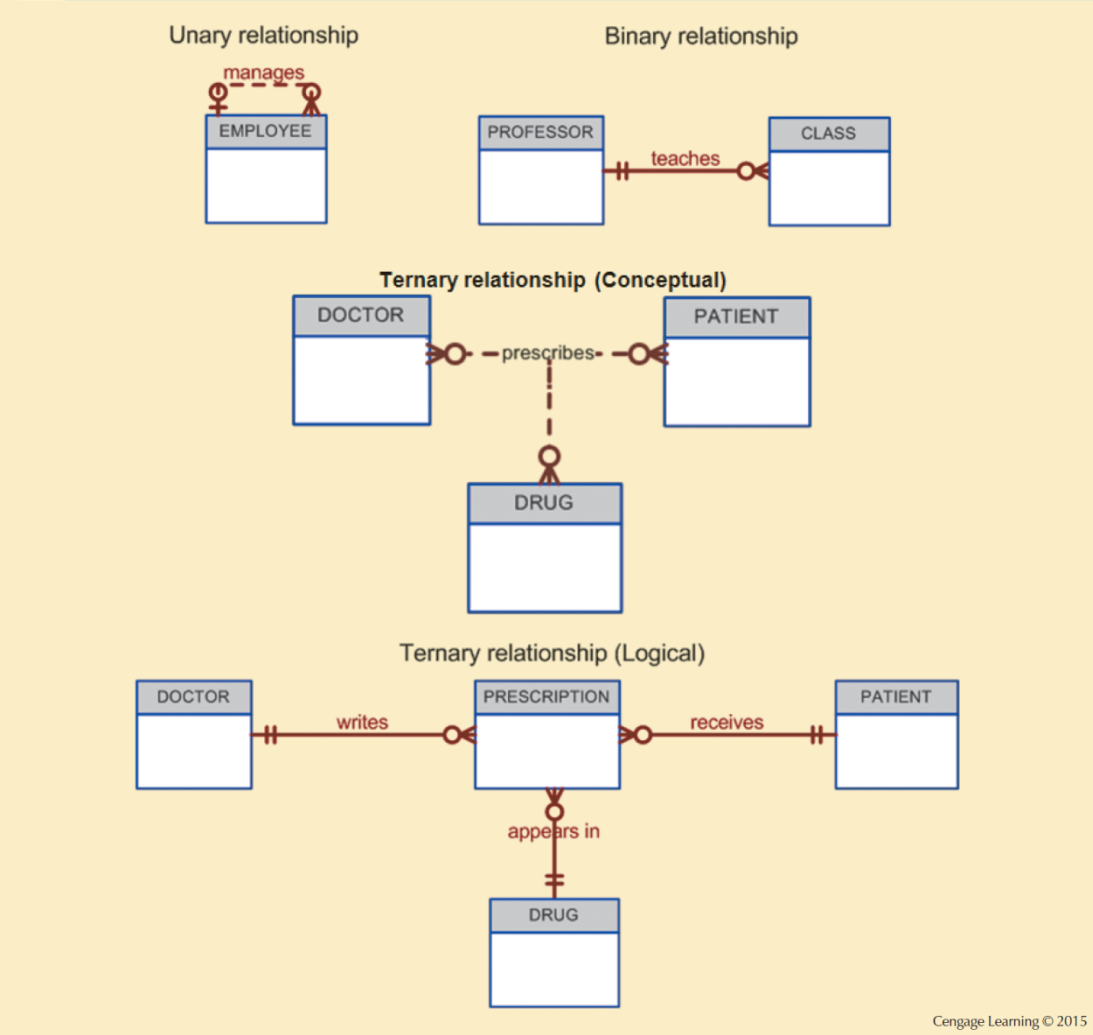
FIGURE 4.13 An optional CLASS entity in the relationship PROFESSOR teaches CLASS



Relationship Degree

- Indicates the number of entities or participants associated with a relationship
- **Unary relationship**: Association is maintained within a single entity
- **Binary relationship**: Two entities are associated
- **Ternary relationship**: Three entities are associated

Figure 4.15 - Three Types of Relationship Degree



Relationship Degree (continued)

FIGURE 4.17 The implementation of a ternary relationship

Database name: Ch04_Clinic

Table name: DRUG

DRUG_CODE	DRUG_NAME	DRUG_PRICE
AF15	Afgapan-15	$25.00
AF25	Afgapan-25	$35.00
DRO	Droalene Chloride	$111.89
DRZ	Druzocholar Cryptolene	$18.99
KO15	Koliabar Oxyhexalene	$65.75
OLE	Oleander-Drizapan	$123.95
TRYP	Tryptolac Heptadimetric	$79.45

Table name: PATIENT

PAT_NUM	PAT_TITLE	PAT_LNAME	PAT_FNAME	PAT_INITIAL	PAT_DOB	PAT_AREACODE	PAT_PHONE
100	Mr.	Kolmycz	George	D	15-Jun-1942	615	324-5456
101	Ms.	Lewis	Rhonda	G	19-Mar-2005	615	324-4472
102	Mr.	Vandam	Rhett		14-Nov-1958	901	675-8993
103	Ms.	Jones	Anne	M	16-Oct-1974	615	898-3456
104	Mr.	Lange	John	P	08-Nov-1971	901	504-4430
105	Mr.	Williams	Robert	D	14-Mar-1975	615	890-3220
106	Mrs.	Smith	Jeanine	K	12-Feb-2003	615	324-7883
107	Mr.	Diante	Jorge	D	21-Aug-1974	615	890-4567
108	Mr.	Wiesenbach	Paul	R	14-Feb-1966	615	897-4358
109	Mr.	Smith	George	K	18-Jun-1961	901	504-3339
110	Mrs.	Genkazi	Leighla	W	19-May-1970	901	569-0093
111	Mr.	Washington	Rupert	E	03-Jan-1966	615	890-4925
112	Mr.	Johnson	Edward	E	14-May-1961	615	898-4387
113	Ms.	Smythe	Melanie	P	15-Sep-1970	615	324-9006
114	Ms.	Brandon	Marie	G	02-Nov-1932	901	882-0845
115	Mrs.	Saranda	Hermine	R	25-Jul-1972	615	324-5505
116	Mr.	Smith	George	A	08-Nov-1965	615	890-2984

Table name: DOCTOR

DOC_ID	DOC_LNAME	DOC_FNAME	DOC_INITIAL	DOC_SPECIALTY
29827	Sanchez	Julio	J	Dermatology
32445	Jorgensen	Annelise	G	Neurology
33456	Korenski	Anatoly	A	Urology
33989	LeGrande	George		Pediatrics
34409	Washington	Dennis	F	Orthopaedics
36221	McPherson	Katye	H	Dermatology
36712	Dreifag	Herman	G	Psychiatry
38995	Minh	Tran		Neurology
40004	Chin	Ming	D	Orthopaedics
40028	Feinstein	Denise	L	Gynecology

Table name: PRESCRIPTION

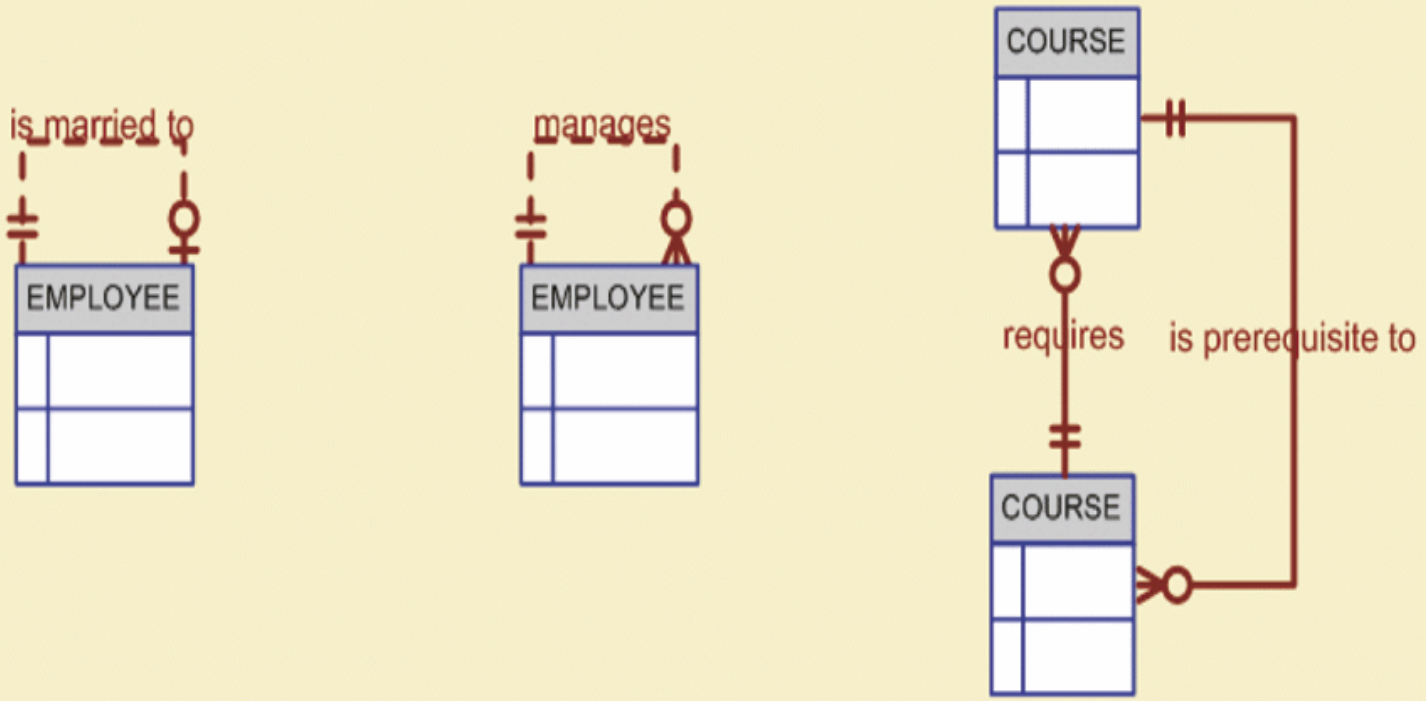
DOC_ID	PAT_NUM	DRUG_CODE	PRES_DOSAGE	PRES_DATE
32445	102	DRZ	2 tablets every four hours -- 50 tablets total	12-Nov-05
32445	113	OLE	1 teaspoon with each meal -- 250 ml total	14-Nov-05
34409	101	KO15	1 tablet every six hours -- 30 tablets total	14-Nov-05
36221	109	DRO	2 tablets with every meal -- 60 tablets total	14-Nov-05
38995	107	KO15	1 tablet every six hours -- 30 tablets total	14-Nov-05

Recursive Relationships

- Relationship can exist between occurrences of the same entity set
- Naturally found within unary relationship

Recursive Relationships (continued)

FIGURE 4.18 An ER representation of recursive relationships



Recursive Relationships (continued)

FIGURE 4.19 The 1:1 recursive relationship "EMPLOYEE is married to EMPLOYEE"

Database name: CH04_PartCo
Table name: EMPLOYEE_V1

	EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_SPOUSE
▶	345	Ramirez	James	347
	346	Jones	Anne	349
	347	Ramirez	Louise	345
	348	Delaney	Robert	
	349	Shapiro	Anton	346

Recursive Relationships (continued)

FIGURE 4.20 Another unary relationship: "PART contains PART"

Table name: PART_V1 Database name; CH04_PartCo

PART_CODE	PART_DESCRIPTION	PART_IN_STOCK	PART_UNITS_NEEDED	PART_OF_PART
AA21-6	2.5 cm. washer, 1.0 mm. rim	432	4	C-130
AB-121	Cotter pin, copper	1034	2	C-130
C-130	Rotor assembly	36		
E129	2.5 cm. steel shank	128	1	C-130
X10	10.25 cm. rotor blade	345	4	C-130
X34AW	2.5 cm. hex nut	879	2	C-130

Recursive Relationships (continued)

FIGURE 4.21 Implementation of the M:N recursive "PART contains PART" relationship

Table name: COMPONENT **Database name: Ch04_PartCo**

COMP_CODE	PART_CODE	COMP_PARTS_NEEDED
C-130	AA21-6	4
C-130	AB-121	2
C-130	E129	1
C-131A2	E129	1
C-130	X10	4
C-131A2	X10	1
C-130	X34AW	2
C-131A2	X34AW	2

Table name: PART

PART_CODE	PART_DESCRIPTION	PART_IN_STOCK
AA21-6	2.5 cm. washer, 1.0 mm. rim	432
AB-121	Cotter pin, copper	1,034
C-130	Rotor assembly	36
E129	2.5 cm. steel shank	128
X10	10.25 cm. rotor blade	345
X34AW	2.5 cm. hex nut	879

Recursive Relationships (continued)

FIGURE 4.22 Implementation of the M:N "COURSE requires COURSE" recursive relationship

Table name: COURSE **Database name: Ch04_TinyCollege**

CRS_CODE	DEPT_CODE	CRS_DESCRIPTION	CRS_CREDIT
ACCT-211	ACCT	Accounting I	3
ACCT-212	ACCT	Accounting II	3
CIS-220	CIS	Intro. to Microcomputing	3
CIS-420	CIS	Database Design and Implementation	4
MATH-243	MATH	Mathematics for Managers	3
QM-261	CIS	Intro. to Statistics	3
QM-362	CIS	Statistical Applications	4

Table name: PREREQ

CRS_CODE	PRE_TAKE
CIS-420	CIS-220
QM-261	MATH-243
QM-362	MATH-243
QM-362	QM-261

Recursive Relationships (continued)

FIGURE 4.23 **Implementation of the 1:M "EMPLOYEE manages EMPLOYEE" recursive relationship**

Database name: Ch04_PartCo
Table name: EMPLOYEE_V2

EMP_CODE	EMP_LNAME	EMP_MANAGER
101	Waddell	102
102	Orincona	
103	Jones	102
104	Reballoh	102
105	Robertson	102
106	Deltona	102

Associative Entities

- Also known as composite or bridge entities
- Used to represent an M:N relationship between two or more entities
- Is in a 1:M relationship with the parent entities
  - Composed of the primary key attributes of each parent entity
- May also contain additional attributes that play no role in connective process

Figure 4.23 - Converting the M:N Relationship into Two 1:M Relationships

Table name: STUDENT

Database name: Ch04_CollegeTry

STU_NUM	STU_LNAME
321452	Bowser
324257	Smithson

Table name: ENROLL

CLASS_CODE	STU_NUM	ENROLL_GRADE
10014	321452	C
10014	324257	B
10018	321452	A
10018	324257	B
10021	321452	C
10021	324257	C

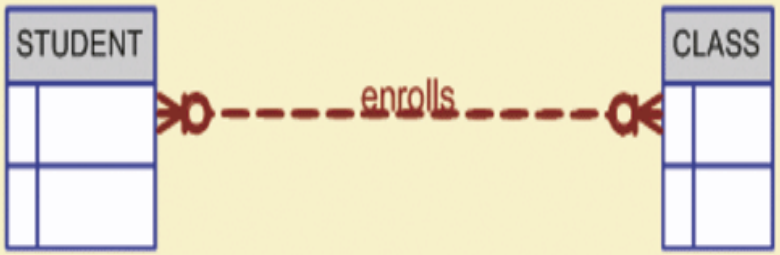
Table name: CLASS

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	PROF_NUM
10014	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10018	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10021	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114

Cengage Learning © 2015

Composite Entities (continued)

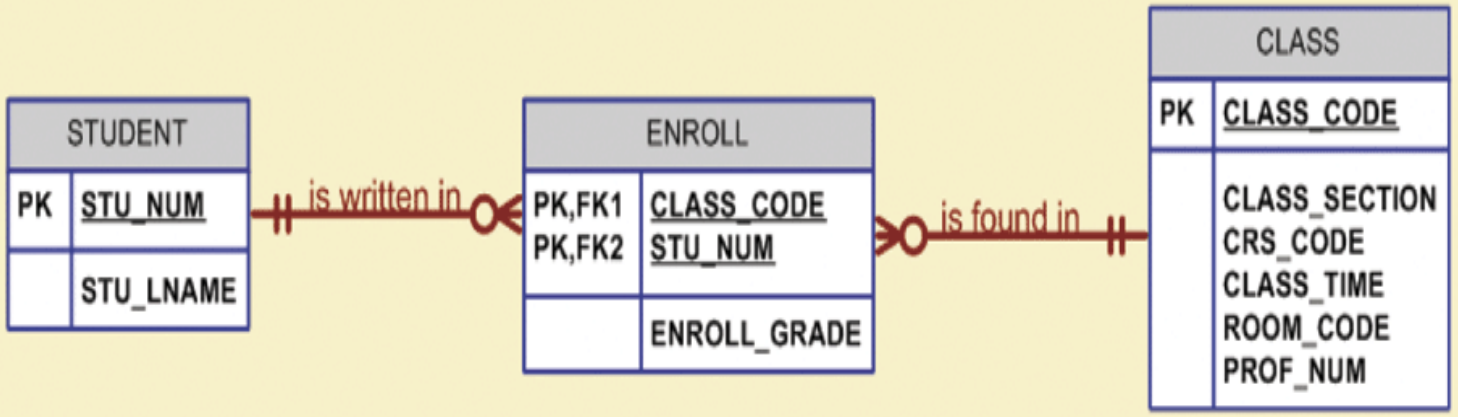
FIGURE 4.25 The M:N relationship between STUDENT and CLASS



Visio does not permit the definition of a M:N relationship. To make this illustration, two 1:M relationships have been superimposed.

Composite Entities (continued)

FIGURE 4.26 A composite entity in an ERD



Developing an ER Diagram

- Database design is iterative rather than linear or sequential process
- Iterative process
  - Based on repetition of processes and procedures

Developing an ER Diagram

- Building an ERD usually involves the following activities:
  - Create detailed narrative of organization's description of operations
  - Identify business rules based on description of operations
  - Identify main entities and relationships from business rules
  - Develop initial ERD
  - Identify attributes and primary keys that adequately describe entities
  - Revise and review ERD

Developing an ER Diagram: Example

- A company database needs to store information about employees (identified by *ssn*, with name, *salary* and *phone* as attributes),
- departments (identified by *dno*, with *dname,* and *budget* as attributes),
- Projects (identified by pno, with project name, and project location, where each project is managed by a department and may have many locations)
- children of employees (with *name* and *age* as attributes).
- Employees *work* in departments;
- each department is *managed by* an employee;
- Employees work on projects, an employee may work on multiple projects and number of hours on each project are noted.
- An employee may have a supervisor
- a child must be identified uniquely by *name* when the parent (who is an employee and assume that only one parent works for the company) is known
- We are not interested in information about a child once the parent leaves the company.

Steps to convert from E-R to Relational

- Create a relation for each regular entity with its attributes
- For each weak entity, create a relation and add the primary key attribute of its owner entity
- For each 1:1 relationship, add the primary key of one relation as a foreign key of the other relation
- For each 1:N relationship, add PK of 1 side as a FK of N side
- For each M:N relationship, form a new relation
- Create a new relation for each multivalued attribute

Another Example

- Tiny College
  - Tiny College is divided into several schools
    - Each school is composed of several departments
  - Each department may offer courses
  - Each department may have many professors assigned to it
  - Each professor may teach up to four classes; each class is section of course
  - Student may enroll in several classes, but (s)he takes each class only once during any given enrollment period
  - Each department has several students
    - Each student has only a single major and is associated with a single department
  - Each student has an advisor in his or her department
    - Each advisor counsels several students
  - The relationship between class is taught in a room and the room in the building

Figure 4.26 - The First Tiny College ERD Segment

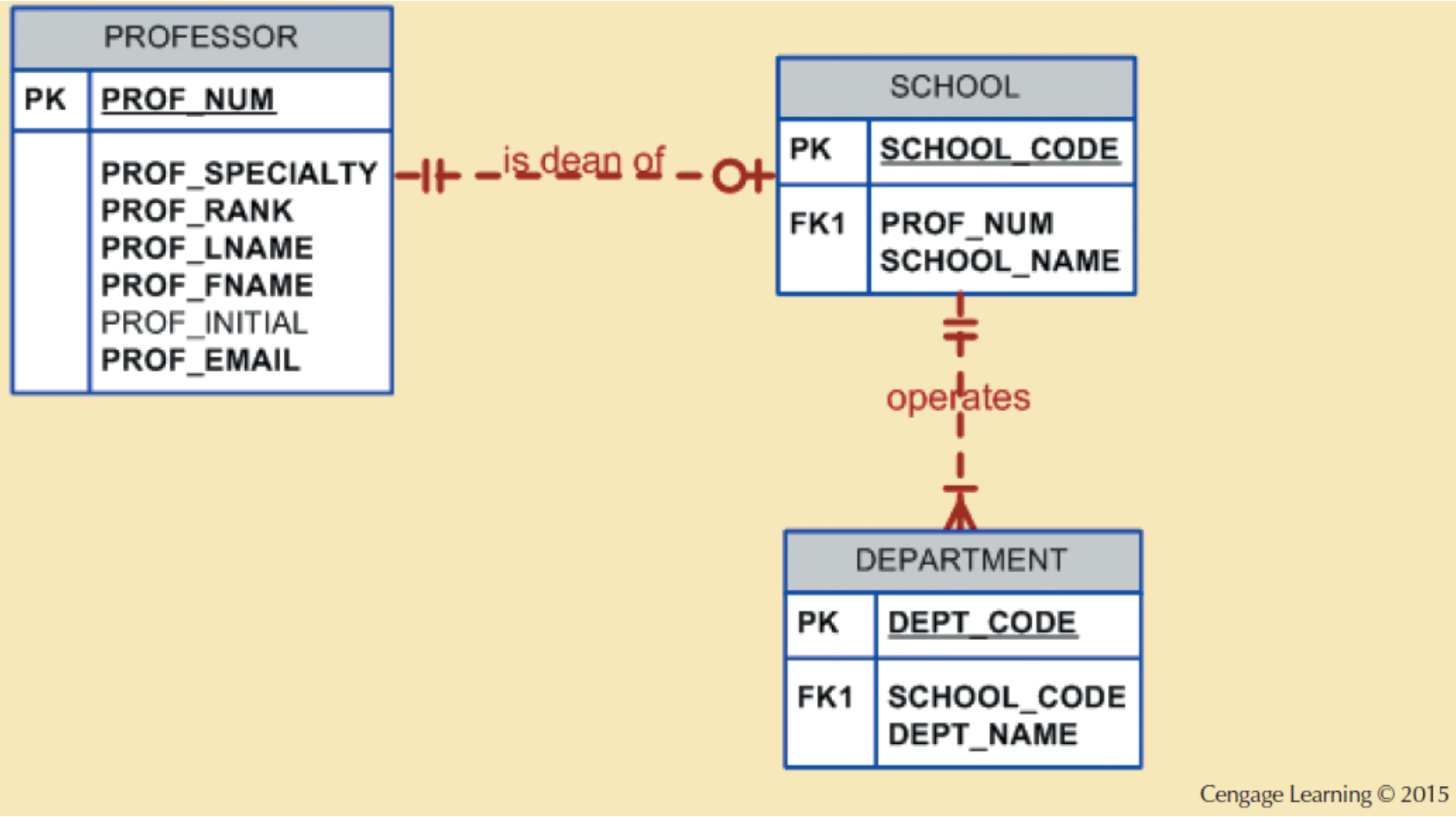
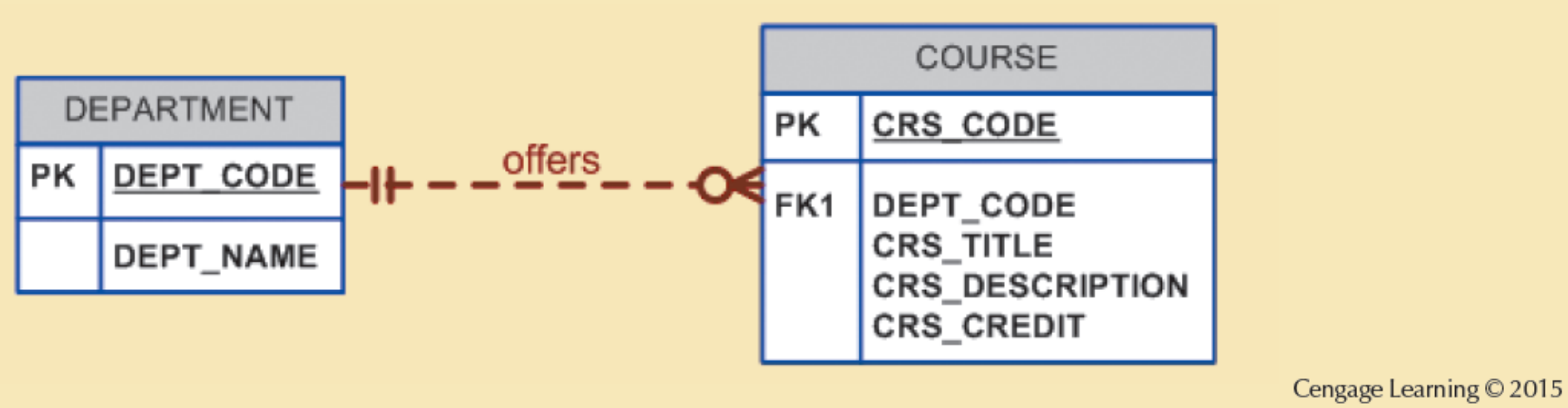


Figure 4.26 - The First Tiny College ERD Segment

- Relationship between PROFESSOR and SCHOOL
  - Each school is administered by a dean who is a professor.
  - Each professor can be the dean of only one school.
  - A professor is not required to be the dean of any school.

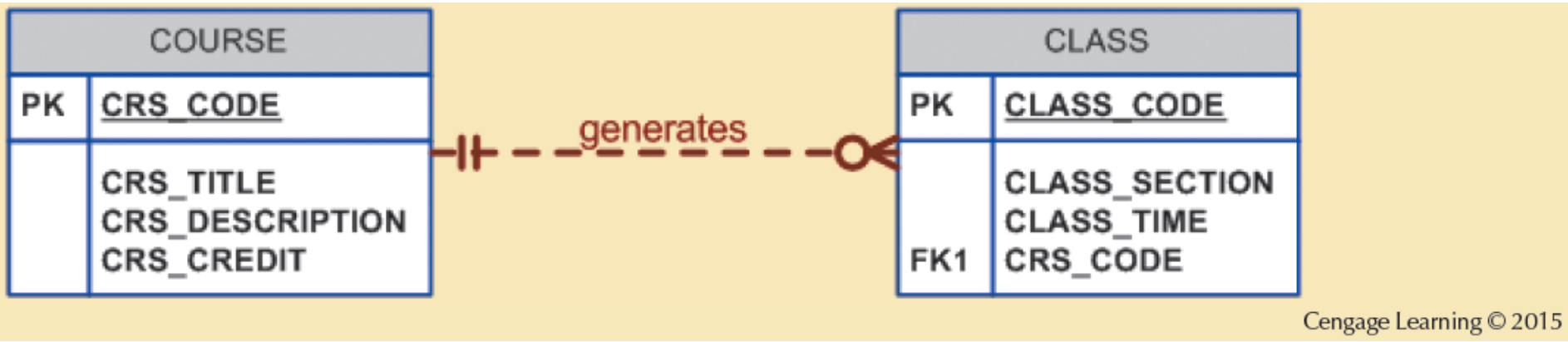
- Relationship between SCHOOL and DEPARTMENT
  - Each school comprises several departments.
  - Each department belongs to only a shingle school

Figure 4.27 - The Second Tiny College ERD Segment



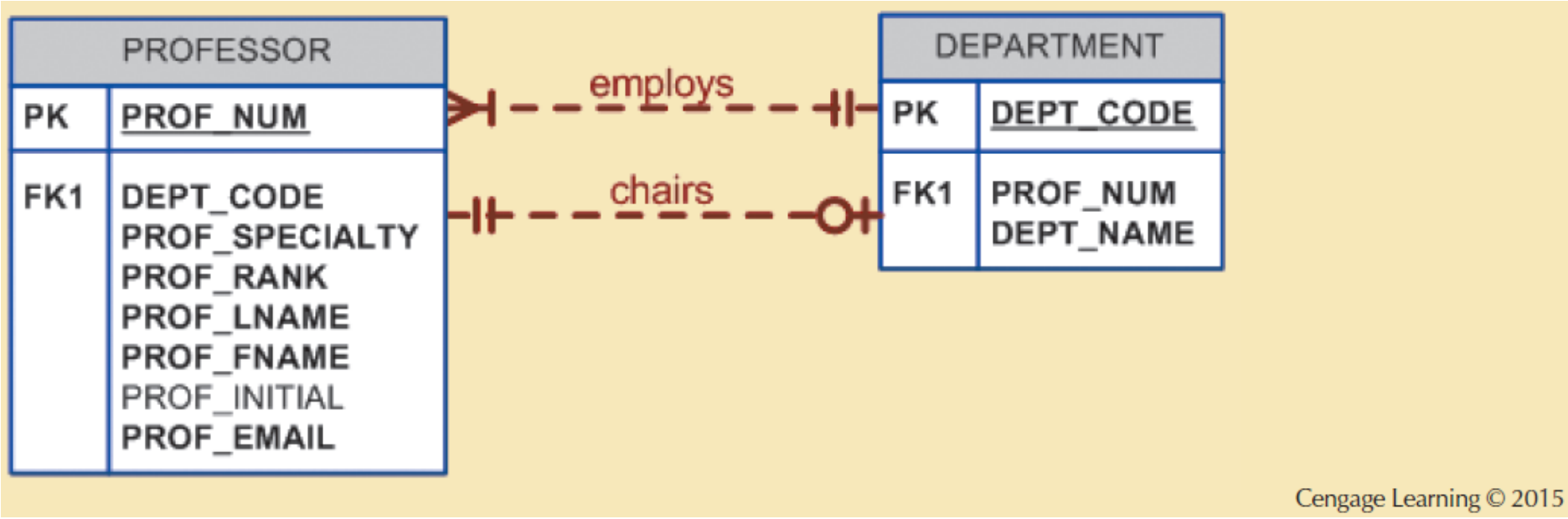
- Each courses are offered by one and only one department.
- Each department may offer courses.
- Some departments that are classified as “research only” and may not offer courses.

Figure 4.28 - The Third Tiny College ERD Segment



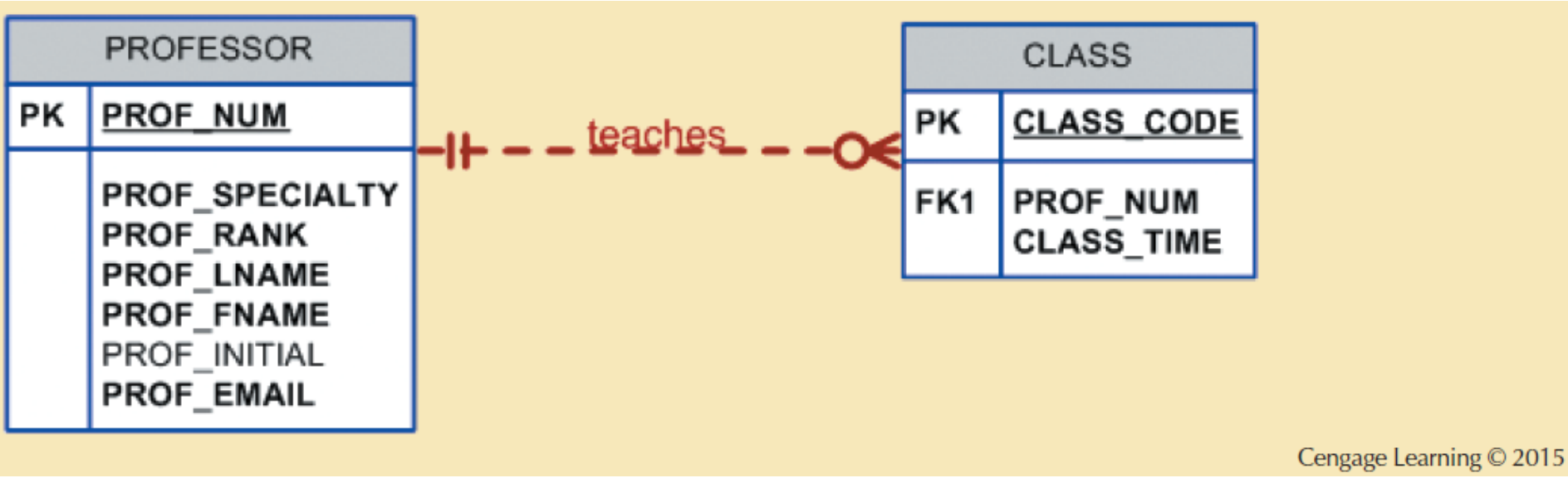
- A course may generates several classes.
- A course may still exist in course catalog even when it is not offered as a class in a current class schedule

Figure 4.29 - The Fourth Tiny College ERD Segment



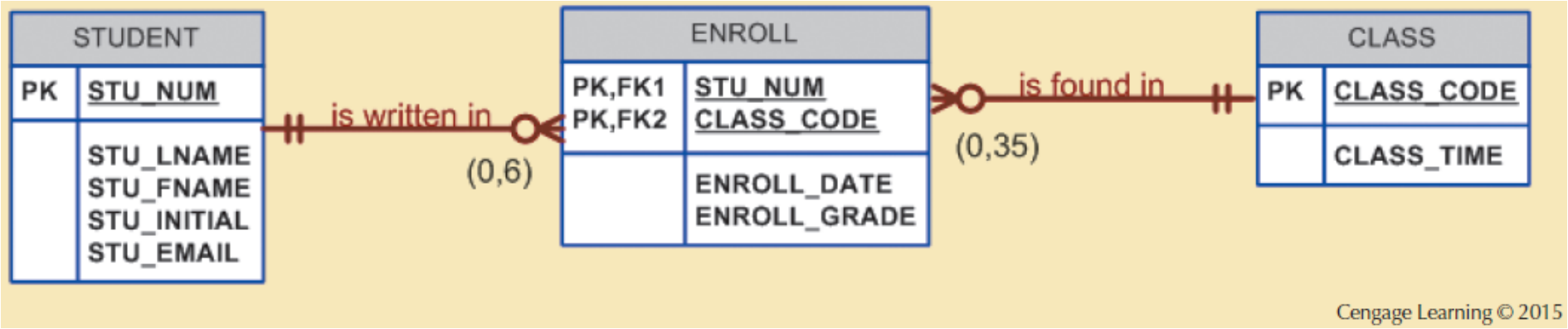
- Each department should have one or more professors assigned to it.
- One and only one of those professors chairs the department.
- No professor is required to accept the chair position.

Figure 4.30 - The Fifth Tiny College ERD Segment



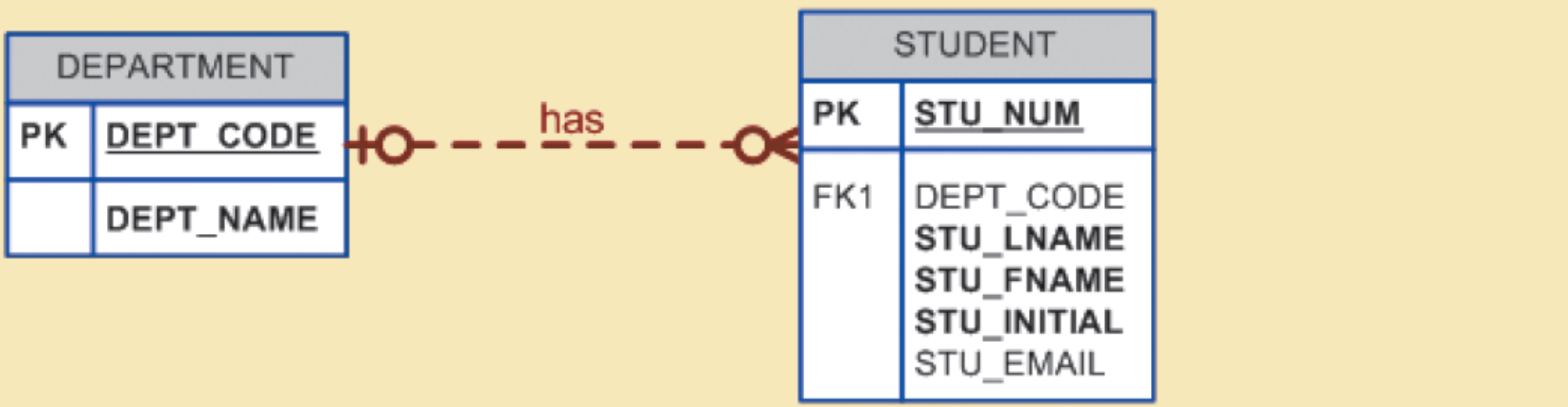
- Each professor may teach up to four classes.
- A professor may also be on a research contract and teach ono classes at all.

Figure 4.31 - The Sixth Tiny College ERD Segment



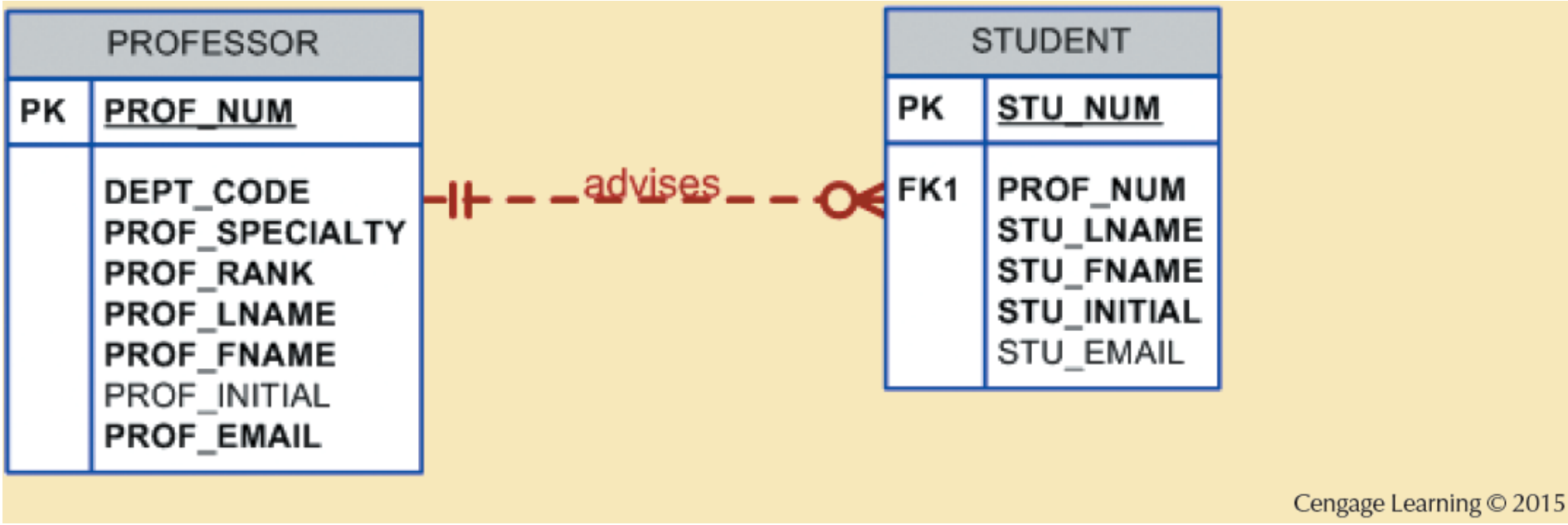
- A student may enroll in several classes.
- Each student may enroll in up to six classes.
- Each class may have up to 35 students.
- If a class exists but has no students enrolled in it, that class does not occur in the ENROLL table.
- ENROLL entity is weak and existence-dependent.

Figure 4.32 - The Seventh Tiny College ERD Segment



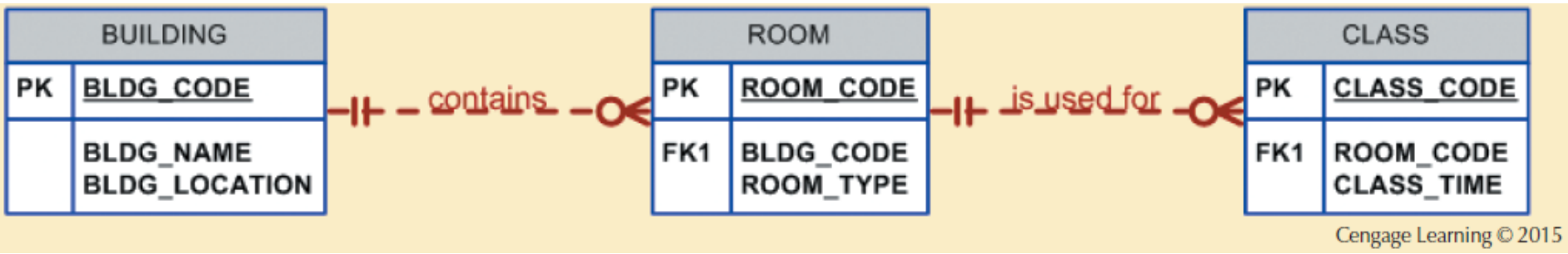
- Each department has several (or many) students whose major is offered by that department.
- Each student has only a single major and is therefore associated with a single department
- A student may not declare a major field of study yet.

Figure 4.33 - The Eighth Tiny College ERD Segment



- Each student has an advisor in his or her department.
- Each advisor counsels several students.
- An advisor is also a professor, but not all professor advise students.

Figure 4.34 - The Ninth Tiny College ERD Segment



- A class is taught in a room.
- ROOM_CODE in CLASS is the FK to an entity named ROOM.
- A BUILDING can contain many ROOMs
- Each ROOM is found in a single BUILDING.
- Some buildings do not contain (class) rooms.

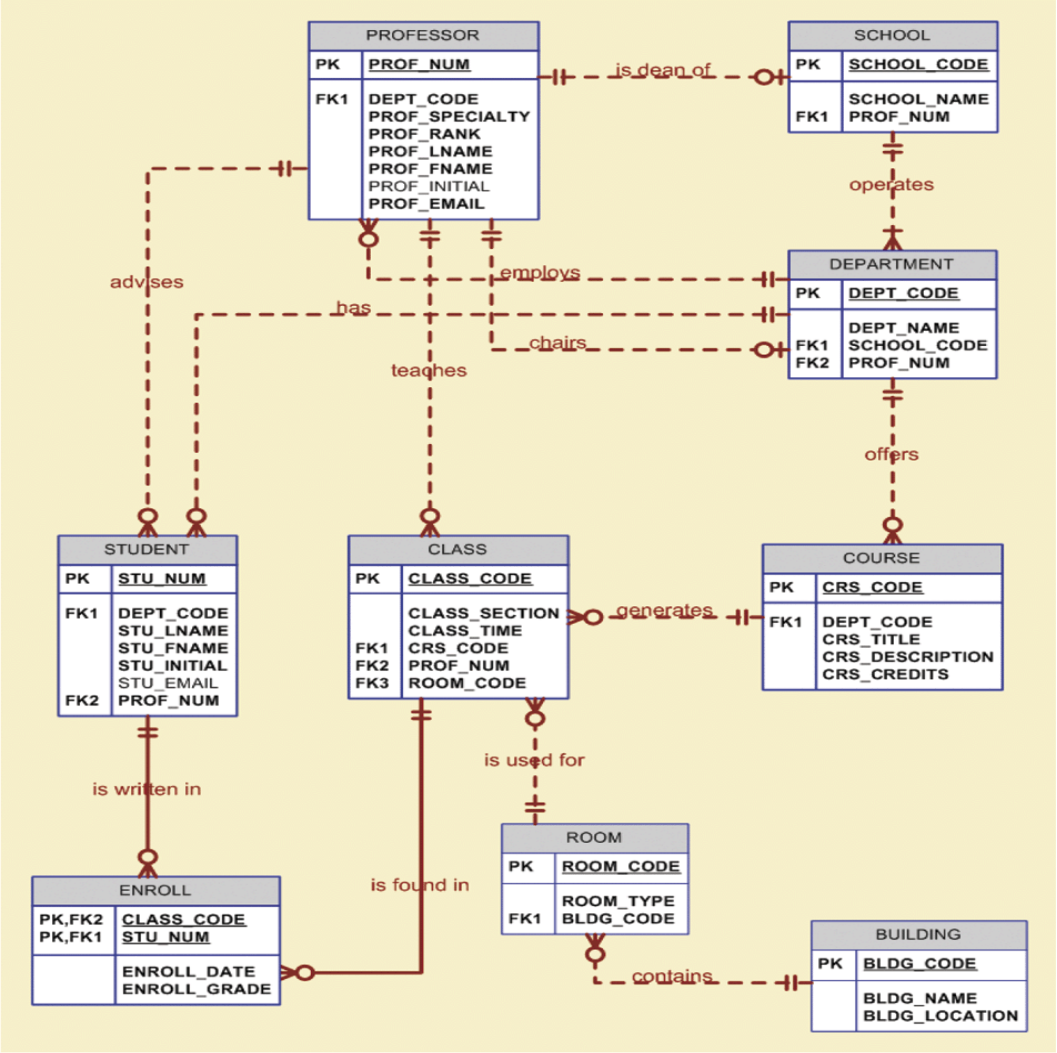
Table 4.4 - Components of the ERM

ENTITY	RELATIONSHIP	CONNECTIVITY	ENTITY
SCHOOL	operates	1:M	DEPARTMENT
DEPARTMENT	has	1:M	STUDENT
DEPARTMENT	employs	1:M	PROFESSOR
DEPARTMENT	offers	1:M	COURSE
COURSE	generates	1:M	CLASS
PROFESSOR	is dean of	1:1	SCHOOL
PROFESSOR	chairs	1:1	DEPARTMENT
PROFESSOR	teaches	1:M	CLASS
PROFESSOR	advises	1:M	STUDENT
STUDENT	enrolls in	M:N	CLASS
BUILDING	contains	1:M	ROOM
ROOM	is used for	1:M	CLASS
Note: ENROLL is the composite entity that implements the M:N relationship "STUDENT enrolls in CLASS."			

Cengage Learning © 2015

Developing an ER Diagram

FIGURE 4.36 The completed Tiny College ERD



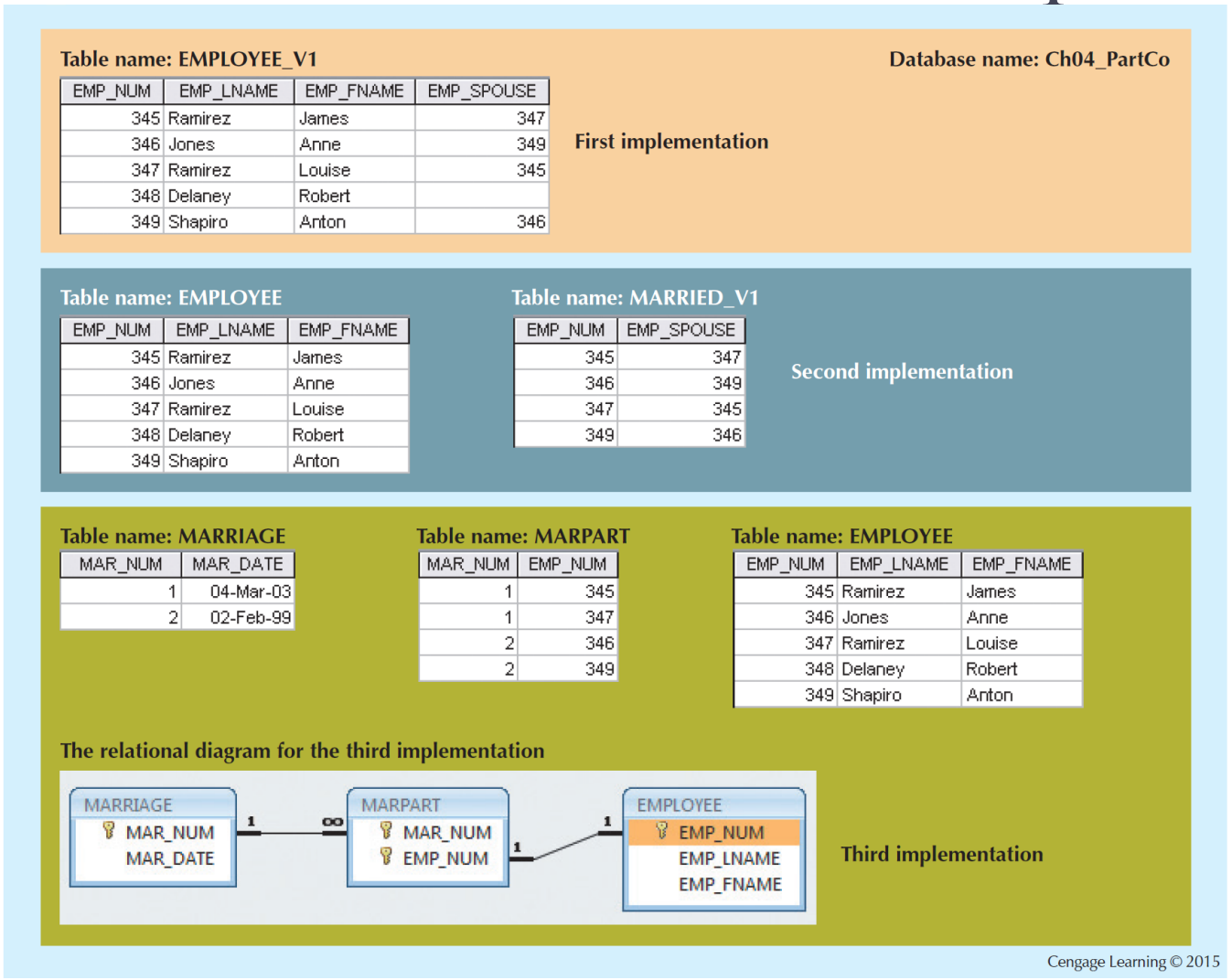
Database Design Challenges: Conflicting Goals

Database design must conform to design standards

Need for high processing speed may limit the number and complexity of logically desirable relationships

Quest for timely information may lead to loss of clean design structures

Figure 4.38 - Various Implementations of the 1:1 Recursive Relationship



Summary

- Entity relationship (ER) model
  - Uses ERD to represent conceptual database as viewed by end user
  - ERM's main components:
    - Entities
    - Relationships
    - Attributes
  - Includes connectivity and cardinality notations

Summary (continued)

- Connectivities and cardinalities are based on business rules
- In ERM, M:N relationship is valid at conceptual level
- ERDs may be based on many different ERMs
- Database designers are often forced to make design compromises