Chapter 4 - ER Modeling

CSCI 475

Benefits of Normalization and ER Modeling

- Can be used as a “blueprint” for a database design
- Directly maps to relational database tables
- Simple to understand, short learning curve
- Useful to communicate with customers

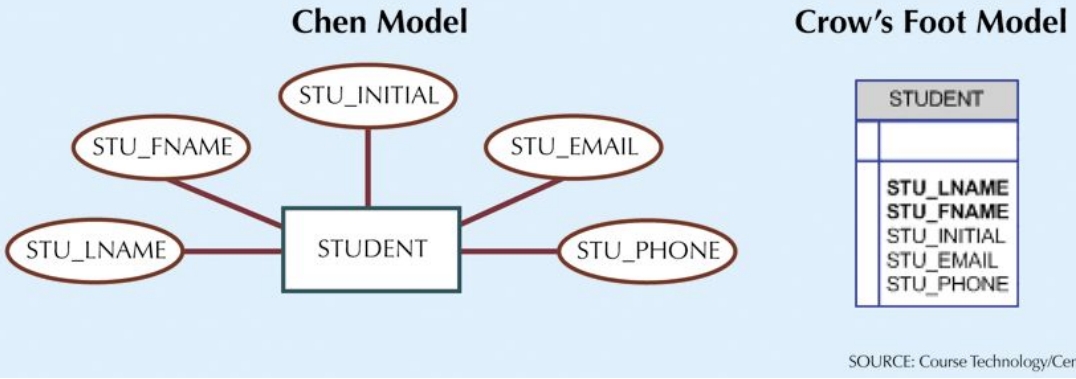
Basic Concepts of ER Modeling

- Introduced in 1976 by Peter Chen (MIT Professor)
- Separates entities (objects, people, classes) from relationships (associations)
- Localizes data as attributes
- Entities play roles in relationships

Basic Concepts of ER Modeling

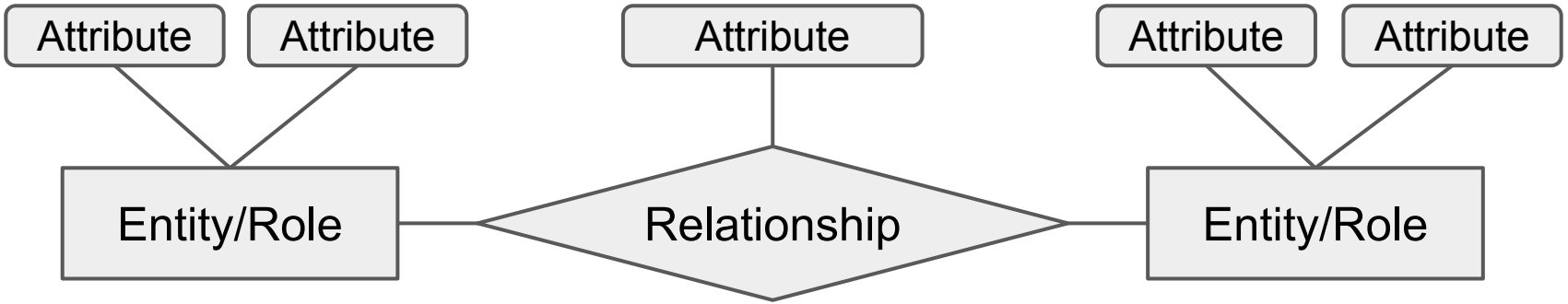
- **Entities** are nouns
  - People, Jobs, Accounts, Objects
- **Relationships** can be expressed as verbs
  - Owns, Rents, Borrows, Checks out, Buys, has-a
- **Attributes** are data associated with entities and relationships (typically adjectives)
  - Color, Height, Weight
  - Name, Title, ID
  - Date, Timespan
- **Roles** are entities' parts or jobs in relationships (typically nouns)
  - Further classify entities

FIGURE 4.1 The attributes of the STUDENT entity: Chen and Crow's Foot

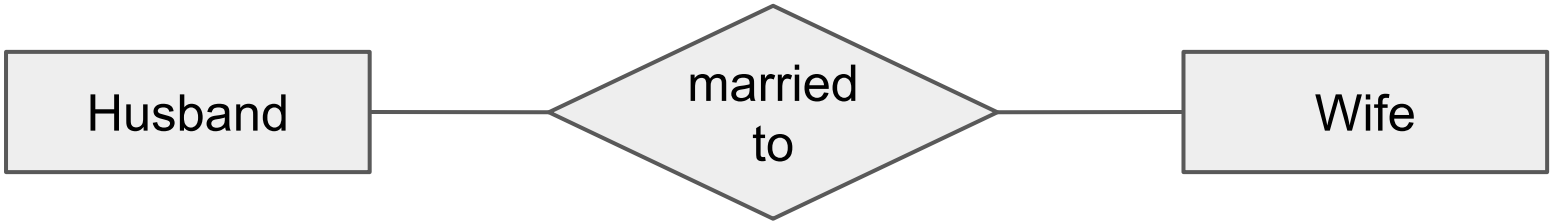


SOURCE: Course Technology/Cengage Learning

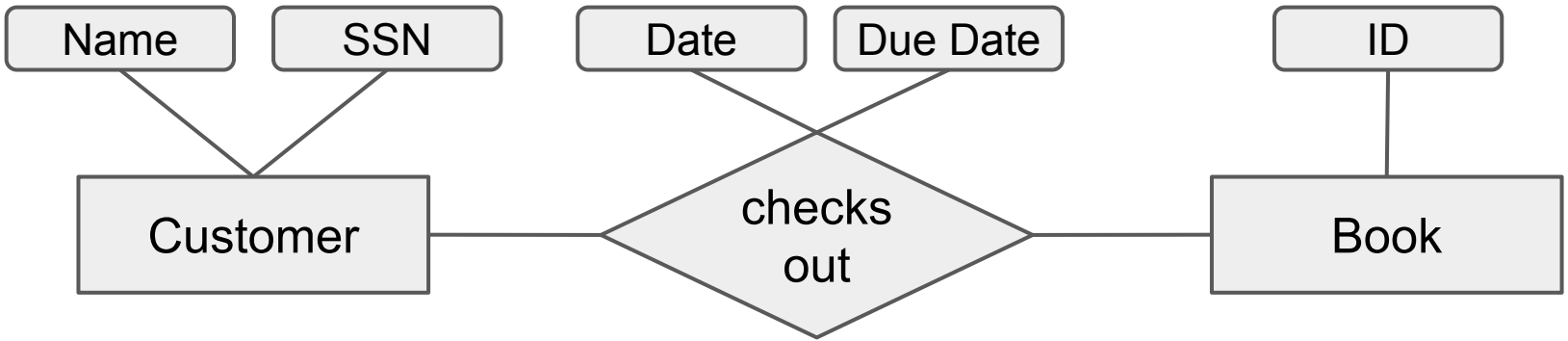
ER Modeling - General Form



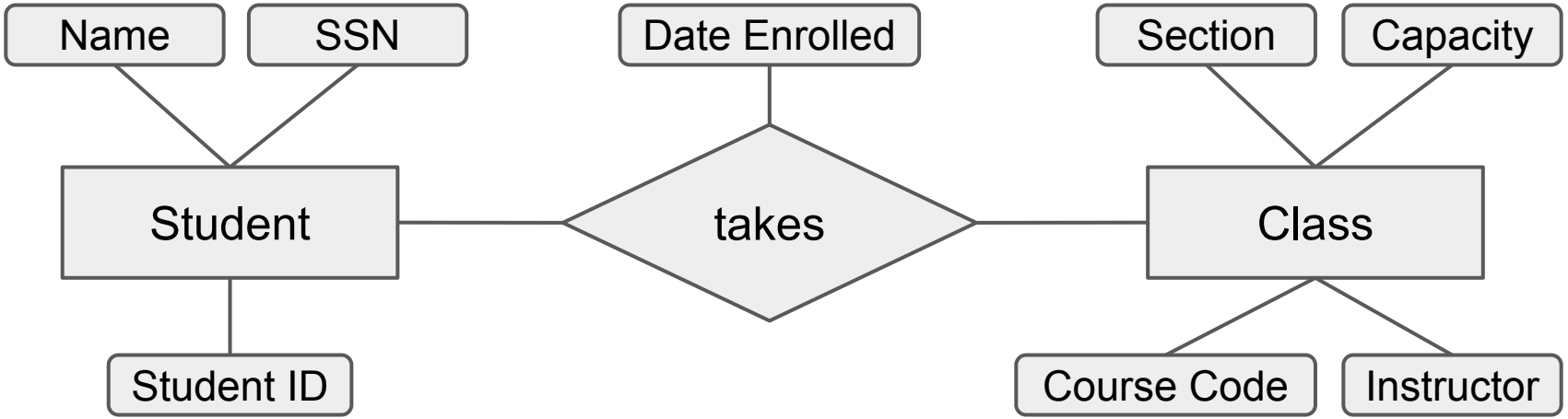
ER Modeling - Example: Husband/Wife



ER Modeling - Example: Library Checkout



ER Modeling - Example: Student/Class

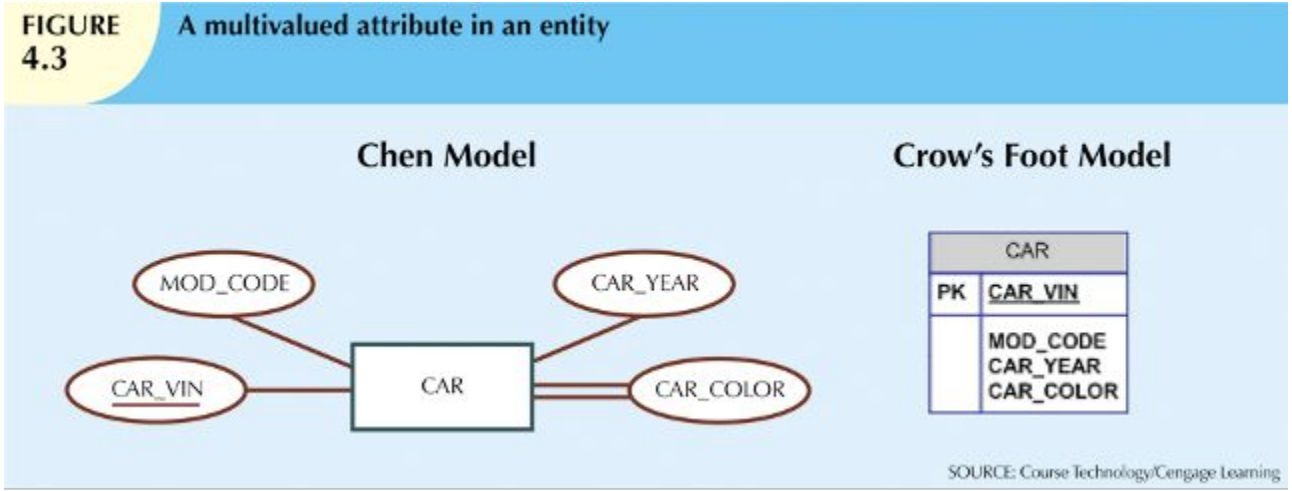


Definitions

- **Domain** – set of possible values for an attribute
  - e.g. GPA domain (0, 4)
- **Composite Attribute** – attributes that can be further subdivided
  - e.g. ADDRESS NUMBER, STREET, CITY, STATE
  - e.g. PHONE # AREA CODE, EXCHANGE #
- **Single Attribute** – cannot be subdivided
  - e.g., age, marital status
- **Single-Valued Attribute** – attribute that can only have a single value
  - e.g., SSN (also a single attribute), VIN, serial # (NOT single attribute since it can typically be subdivided into region & plant)

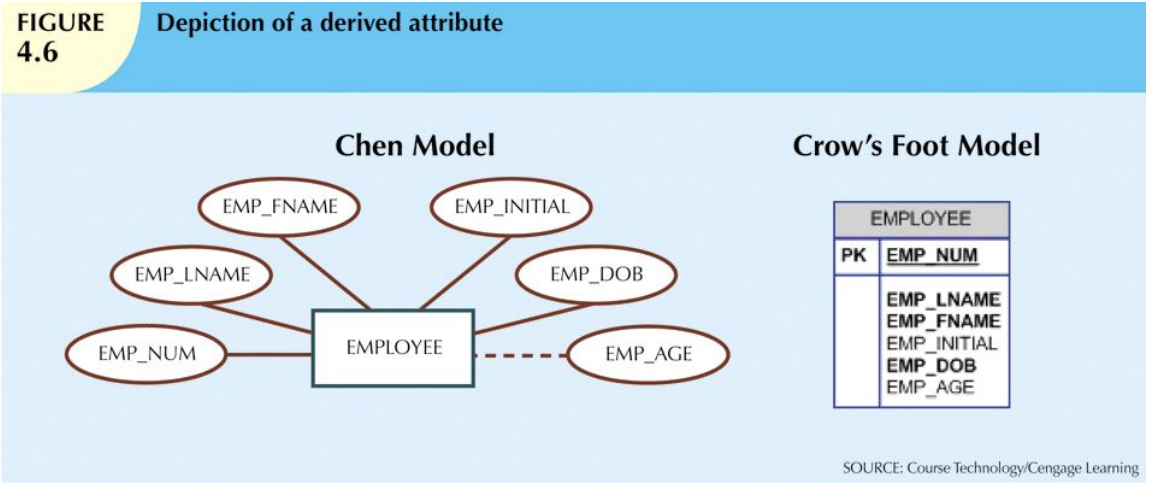
Definitions

- **Multivalued Attribute** – attribute can have more than one value
  - e.g. college degrees, household phones
  - typically link with composite/bridge entity



Definitions

- **Derived/Computed Attribute** – attribute calculated from another attribute
  - e.g. tax



Definitions

- **Weak Relationship**
  - a.k.a. non-identifying relationship
  - Foreign key is NOT also a composite key
  - Use dotted line to denote weak (between Course & Class)
  - Entity relationship is <u>weak</u> because the foreign key CRS_CODE in Class is not also part of the composite key in Class

FIGURE 4.8 A weak (non-identifying) relationship between COURSE and CLASS

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: 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

SOURCE: Course Technology/Cengage Learning

Definitions

- **Strong Relationship**
  - Foreign key is also a composite key
  - Entity relationship is strong because the foreign key CRS_CODE in Class is also part of the composite key in Class

FIGURE 4.9 A strong (identifying) relationship between COURSE and CLASS

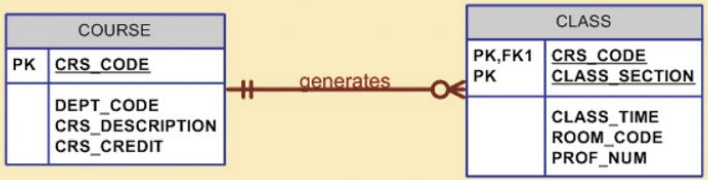


Table name: COURSE — **Database name: Ch04_TinyCollege_Alt**

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

CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	PROF_NUM
ACCT-211	1	MWF 8:00-8:50 a.m.	BUS311	105
ACCT-211	2	MWF 9:00-9:50 a.m.	BUS200	105
ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
ACCT-212	1	MWF 10:00-10:50 a.m.	BUS311	301
ACCT-212	2	Th 6:00-8:40 p.m.	BUS252	301
CIS-220	1	MWF 9:00-9:50 a.m.	KLR209	228
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QM-362	2	TTh 2:30-3:45 p.m.	KLR200	162

SOURCE: Course Technology/Cengage Learning

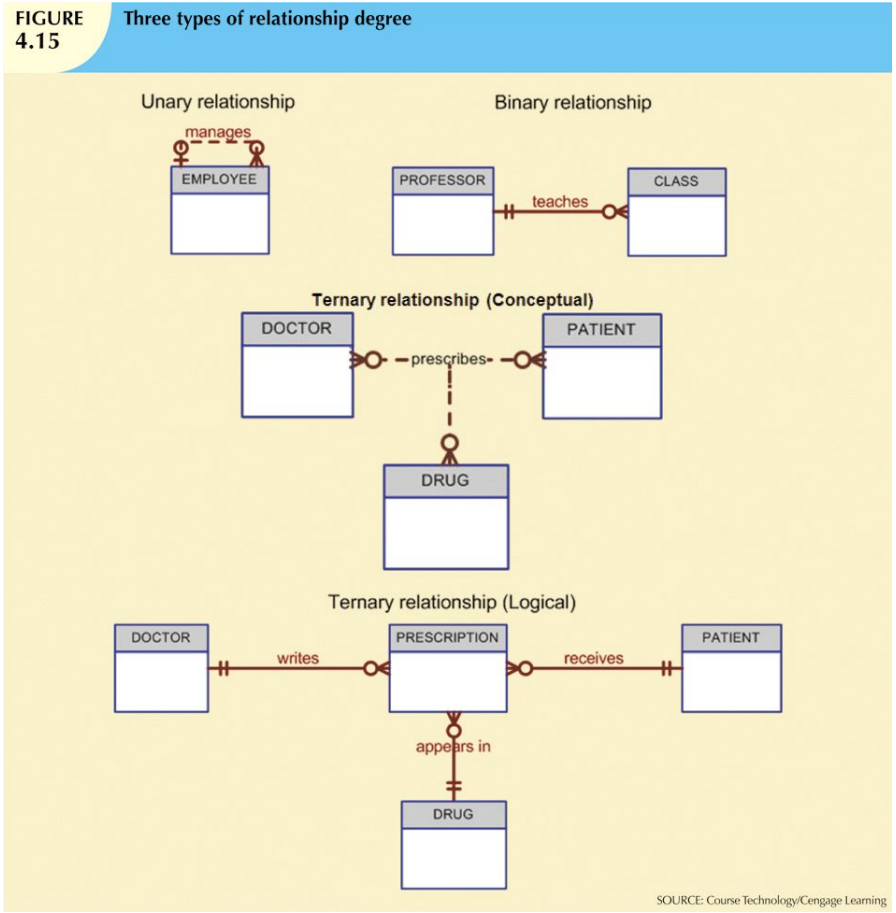
Crow’s Foot Notation

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.

Degrees of Relationships

- **Unary** – just one table
  - typically recursive (relationship exists between records within the same table)
  - Ex: if A & B are employees: A manages many B (1:M), B managed by one A (1:1)
- **Binary** – two tables (MOST COMMON) are associated with each other
- **Ternary** – three tables are associated with each other



Degrees of Relationships - Example: Unary

1:1 relationship - If one employee is married to another employee

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

Degrees of Relationships - Example: Unary

1:M relationship - 1 employee manages several employees

Table name: EMPLOYEE_V2

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

Degrees of Relationships - Example: Unary

M:N relationship - a part that contains another part

MUST BE DIVIDED

Table name: PART_V1

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

Degrees of Relationships - Implementing M:N

Implementation of this M:N recursive relationship as follows:

Table name: COMPONENT

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	1034
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

Algorithm for Developing an ER Model/Diagram

1. Create detailed narrative of organization’s order of operation
2. Identify business rules based on those operations
3. Identify entities and relationships
4. Develop ERD
5. Identify fields, primary and foreign keys
6. Revise as necessary

Tiny College Business Rules Exercise

Tiny College Business Rules Exercise

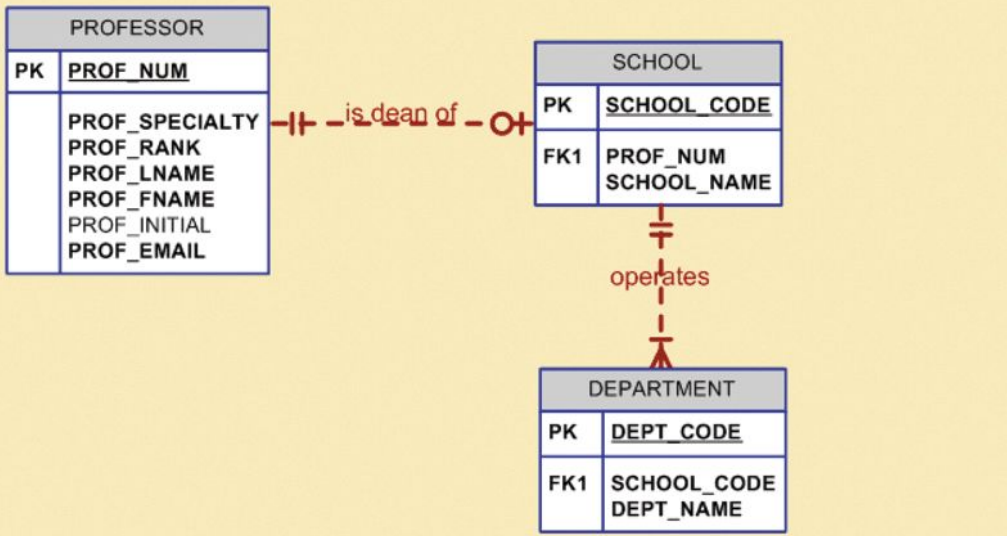
TABLE 4.4 Components of the ERM

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."

Tiny College Business Rules Exercise

FIGURE 4.26 The first Tiny College ERD segment



SOURCE: Course Technology/Cengage Learning

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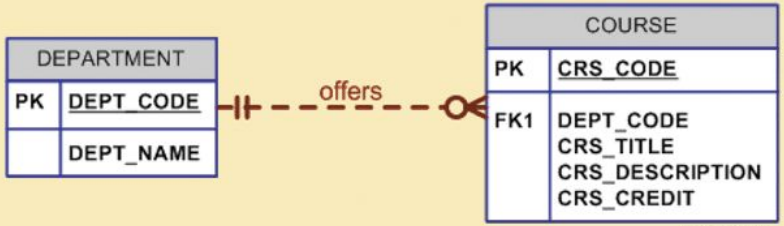
FIGURE 4.27 The second Tiny College ERD segment



SOURCE: Course Technology/Cengage Learning

FIGURE 4.28 The third Tiny College ERD segment

SOURCE: Course Technology/Cengage Learning

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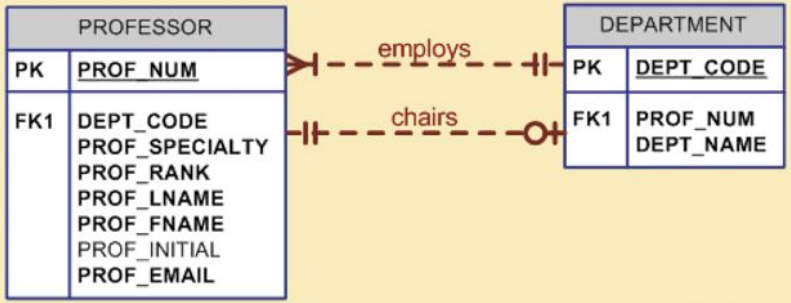
FIGURE 4.29 The fourth Tiny College ERD segment



SOURCE: Course Technology/Cengage Learning

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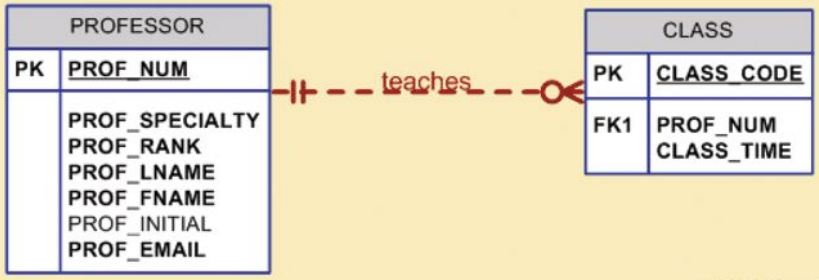
FIGURE 4.30 The fifth Tiny College ERD segment



SOURCE: Course Technology/Cengage Learning

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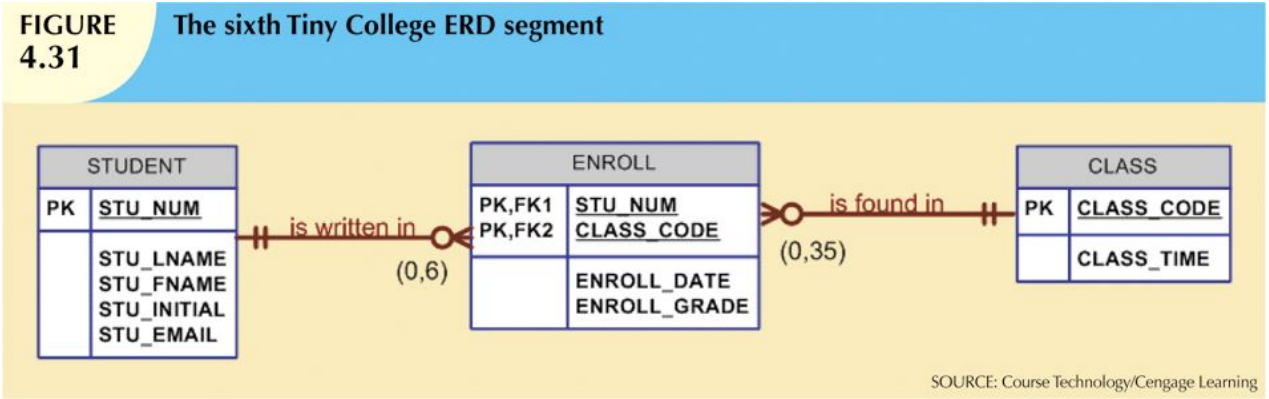

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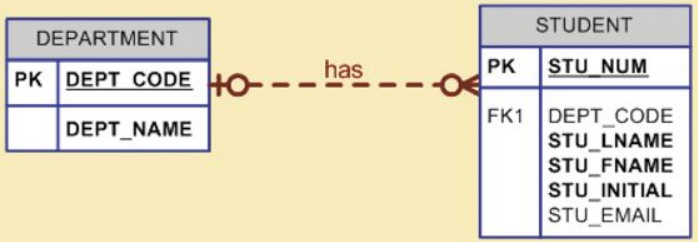
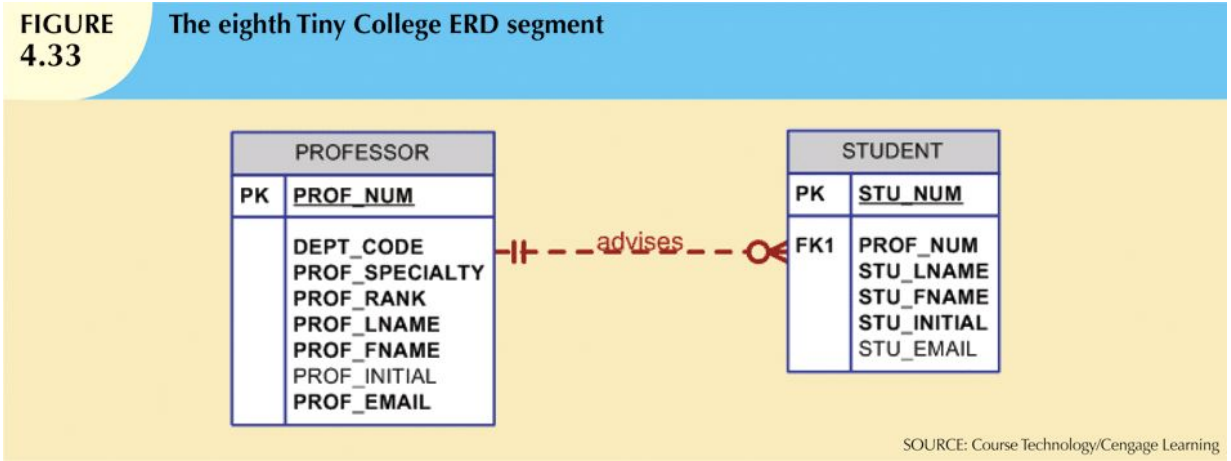
FIGURE 4.32 The seventh Tiny College ERD segment



SOURCE: Course Technology/Cengage Learning

Tiny College Business Rules Exercise



Tiny College Business Rules Exercise

FIGURE 4.34 The ninth Tiny College ERD segment

SOURCE: Course Technology/Cengage Learning

Tiny College Business Rules Exercise

FIGURE 4.36 The conceptual UML class diagram for Tiny College