

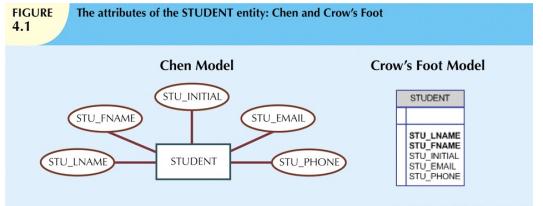
## 1 Entities

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

1

## 2 Attributes

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



SOURCE: Course Technology/Cengage Learning

2

## 3 Attributes (cont'd.)

- Required attribute: must have a value
- Optional attribute: may be left empty
- Domain: set of possible values for an attribute
  - Attributes may share a domain
- Identifiers: one or more attributes that uniquely identify each entity instance
- Composite identifier: primary key composed of more than one attribute

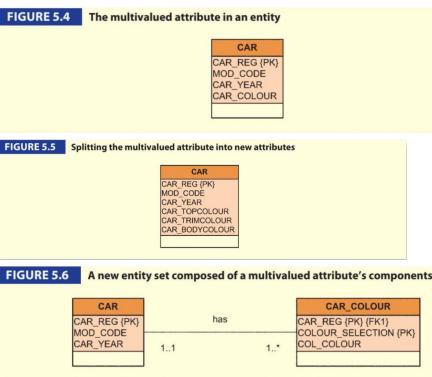
3

## 4 Attributes (cont'd.)

- Composite attribute can be subdivided
- Simple attribute cannot be subdivided
- Single-value attribute can have only a single value
- Multivalued attributes can have many values
- M:N relationships and multivalued attributes should not be implemented
  - Create several new attributes for each of the original multivalued attributes' components
  - Create new entity composed of original multivalued attributes' components
- Derived attribute: value may be calculated from other attributes
  - Need not be physically stored within database

4

## 5 Attributes (cont'd.)



5

## 7 Relationships

- Association between entities
- Participants are entities that participate in a relationship
- Relationships between entities always operate in both directions
- Relationship can be classified as 1:M
- Relationship classification is difficult to establish if only one side of the relationship is known

7

**Connectivity and Cardinality (Multiplicity)**

- Connectivity
  - Describes the relationship classification
- Cardinality (Multiplicity)
  - Expresses minimum and maximum number of entity occurrences associated with one occurrence of related entity
- Established by very concise statements known as business rules

**FIGURE 4.7** Connectivity and cardinality in an ERD

SOURCE: Course Technology/Cengage Learning

8

**FIGURE 4.7** Connectivity and cardinality in an ERD

SOURCE: Course Technology/Cengage Learning

**FIGURE 5.8** Multiplicity in an ERD

Relationship name: teaches  
Here the arrow indicates the direction of the relationship

Multiplicities

9

**Relationship Participation**

- **Optional**
  - One entity occurrence (row) does not require a corresponding occurrence (row) in related entity
  - Shown by drawing a small circle on side of optional entity on ERD
  - The existence of *optionality* indicates that the minimum cardinality is 0 for the optional entity.
- **Mandatory**
  - One entity occurrence (row) requires a corresponding occurrence (row) in related entity
  - If no optionality symbol is shown on ERD, it is mandatory
  - The existence of mandatory relationship indicates that the minimum cardinality is 1 for the mandatory entity

**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.

10

**Chen model**

**Relationship Participation (Con't.)**

**FIGURE 4.12** An optional CLASS entity in the relationship "PROFESSOR teaches CLASS"

SOURCE: Course Technology/Cengage Learning

An Optional CLASS Entity in the Relationship "PROFESSOR teaches CLASS" (If PROFESSOR conducts research without teaching CLASSES).

**FIGURE 5.15** An optional CLASS entity in the relationship LECTURER teaches CLASS

CLASS is optional to the PROFESSOR  
PROFESSOR is mandatory to the CLASS

SOURCE: Course Technology/Cengage Learning

11

**Relationship Participation (Con't.)**

**FIGURE 4.13** CLASS is optional to COURSE

SOURCE: Course Technology/Cengage Learning

**FIGURE 5.16** CLASS is optional to COURSE

12

**Chen model**

**Relationship Participation (Con't.)**

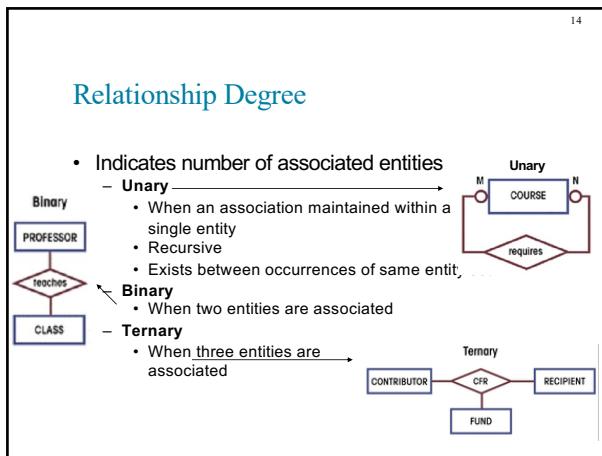
**FIGURE 4.14** COURSE and CLASS in a mandatory relationship

SOURCE: Course Technology/Cengage Learning

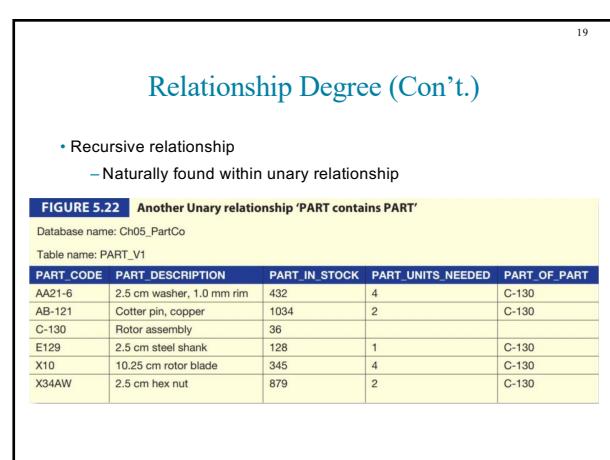
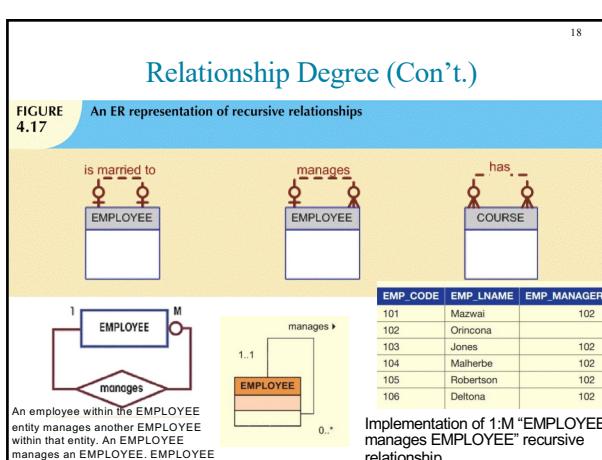
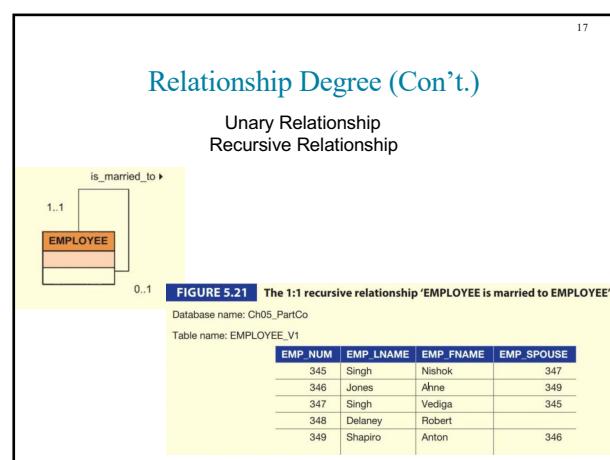
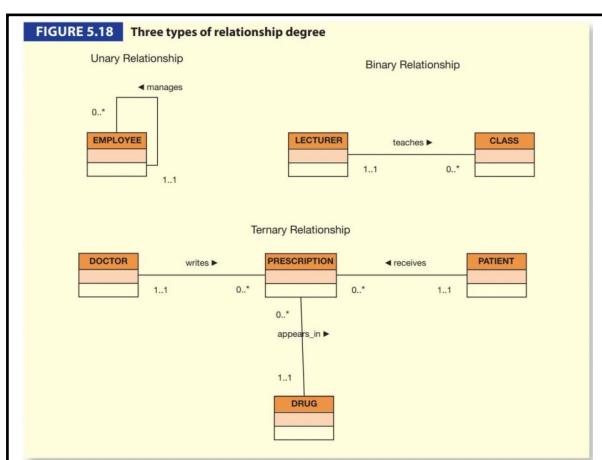
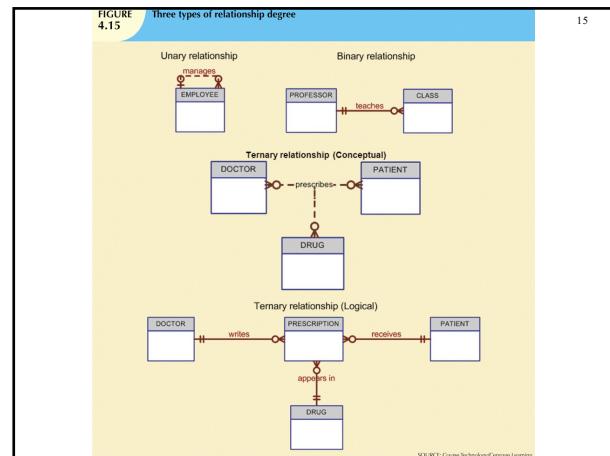
**FIGURE 5.17** COURSE and CLASS in a mandatory relationship

SOURCE: Course Technology/Cengage Learning

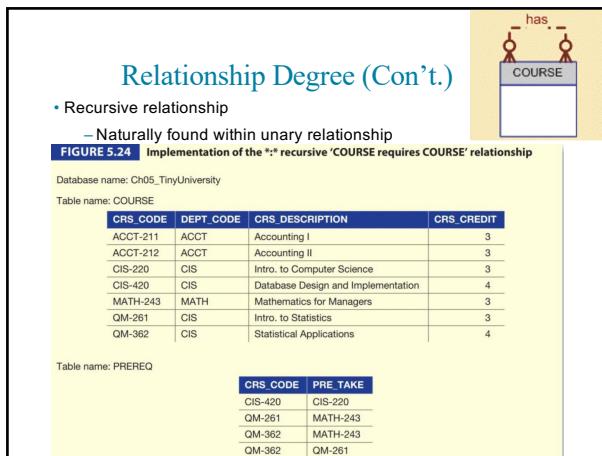
13



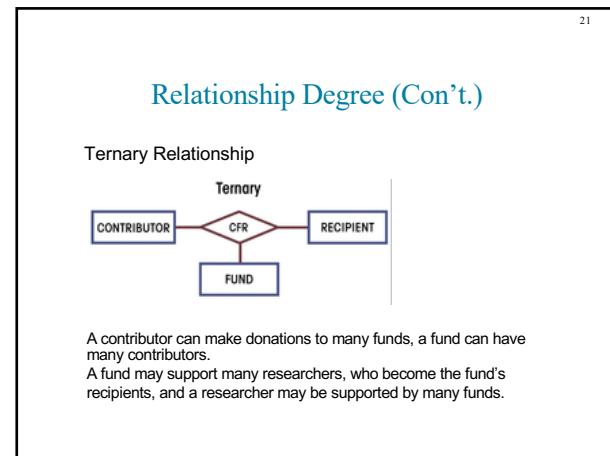
14



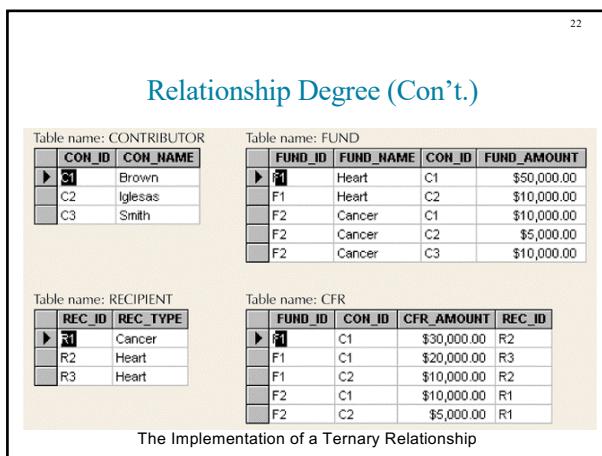
18



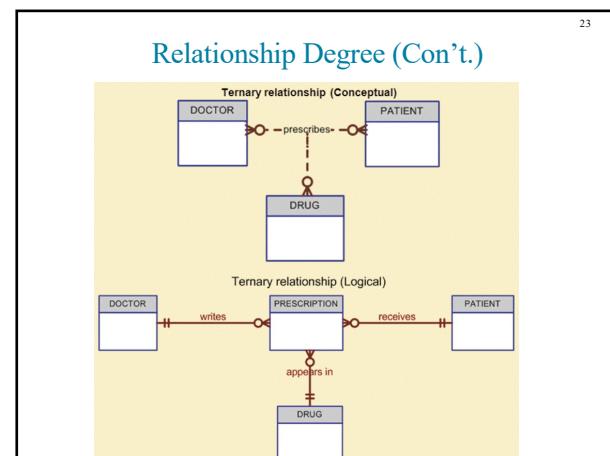
20



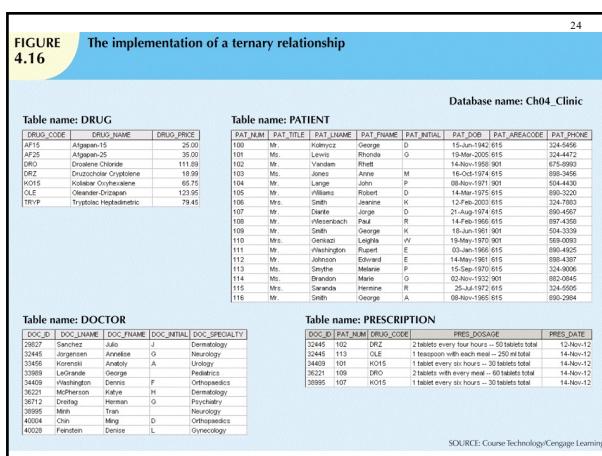
21



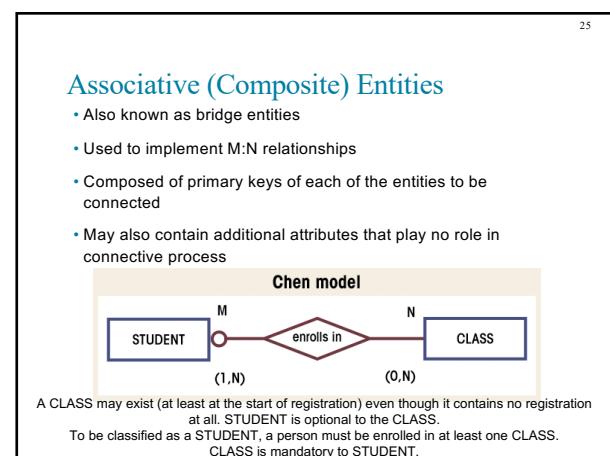
22



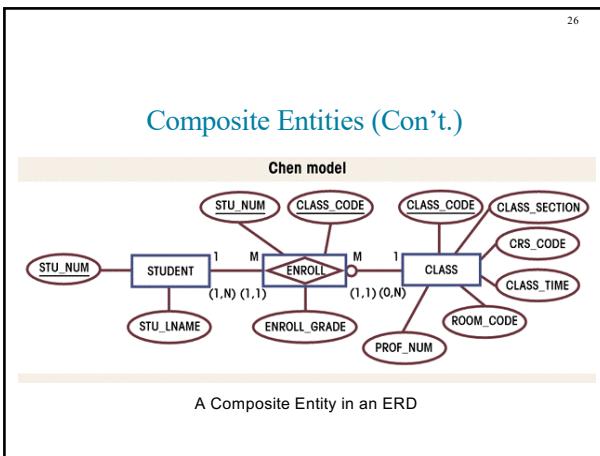
23



24



25



26

**Composite Entities (Con't.)**

**FIGURE 4.23 Converting the M:N relationship into two 1:M relationships**

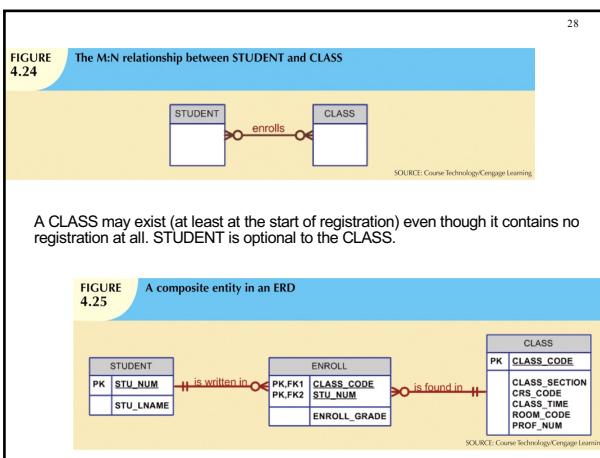
Table name: STUDENT		Database name: Ch04_CollegeTry	
STU_NUM	STU_LNAME	321452	Brower
		324257	Smithson

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	
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	GM-261	1	MWF 8:00-8:50 a.m.	KLR200	114

SOURCE: Course Technology/Cengage Learning

27

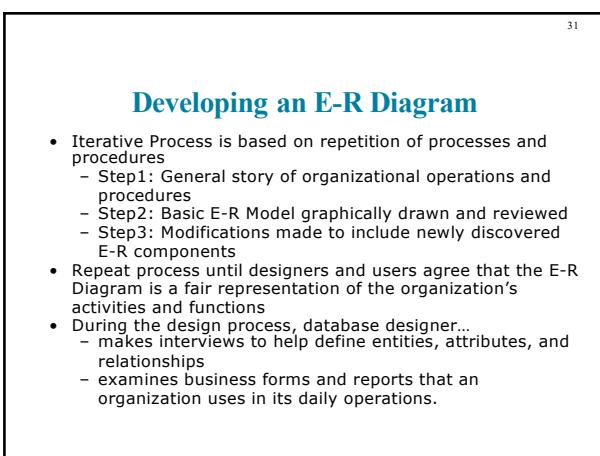


28

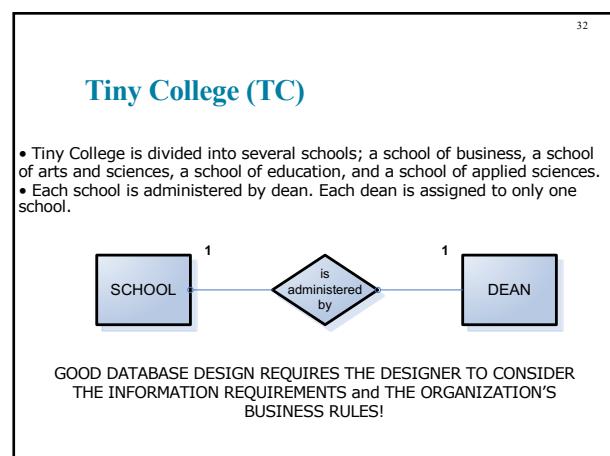
## Developing an ER Diagram

- Database design is an iterative process
  - 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

29

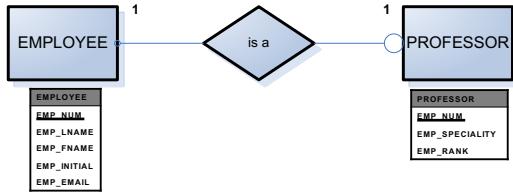


31



32

- In the Tiny College's operational environment, employees have some common characteristics (name, address, phone, etc.)
- The professors have some professional characteristics (academic degree, academic rank, etc.) None of other employees (secretaries, drivers, mechanics, etc.) is required to have such academic attributes.

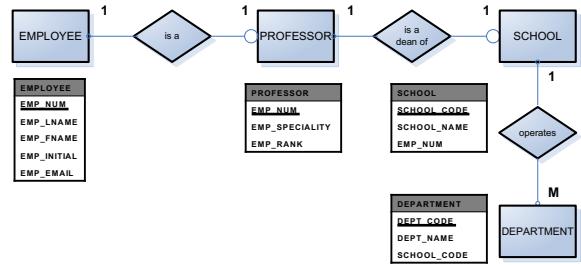


- 1:1 relationship. EMPLOYEE is a PROFESSOR.
- Not all employees are professor, so PROFESSOR is optional to EMPLOYEE (Employee is not required to be a professor).

33

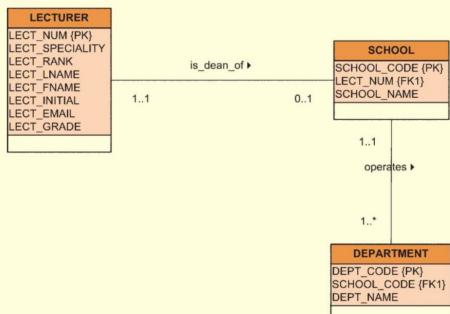
## First ERD Segment Established

- Deans hold professional rank (position, status) and may teach a class.
- Each school is composed of several departments.



34

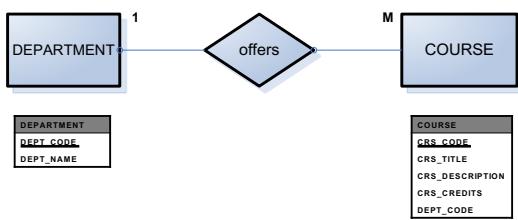
**FIGURE 5.30** The first Tiny University segment



36

## Second ERD Segment Established

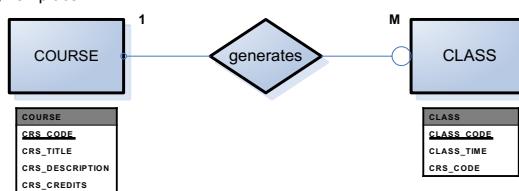
- Each department offers several courses.
- Note that the relationship is based on the way Tiny College operates. If Tiny College had some departments that were classified as "research only", such departments would not offer courses and, therefore, the COURSE entity would be optional to the DEPARTMENT entity.



37

## Third ERD Segment Established

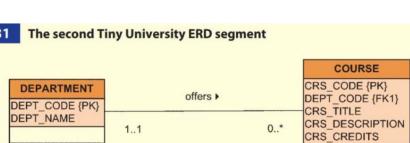
- CLASS is a section of a COURSE. A department may offer several sections (classes) of the same course.
- Each of those classes is taught by a professor at a given time and in a given place.



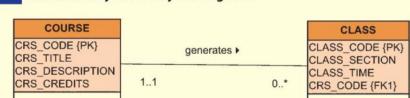
- However, because a course may exist in Tiny College's course catalog even when it is not offered as a class in a current term. CLASS is optional to COURSE.

38

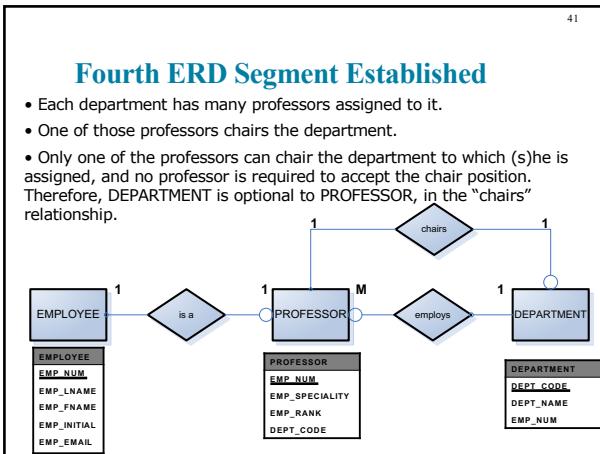
**FIGURE 5.31** The second Tiny University ERD segment



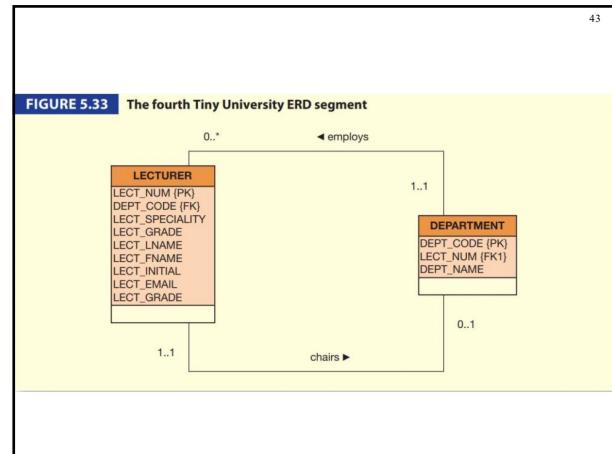
**FIGURE 5.32** The third Tiny University ERD segment



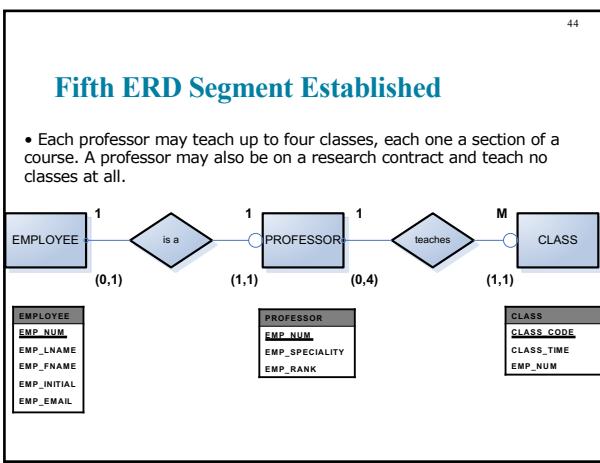
40



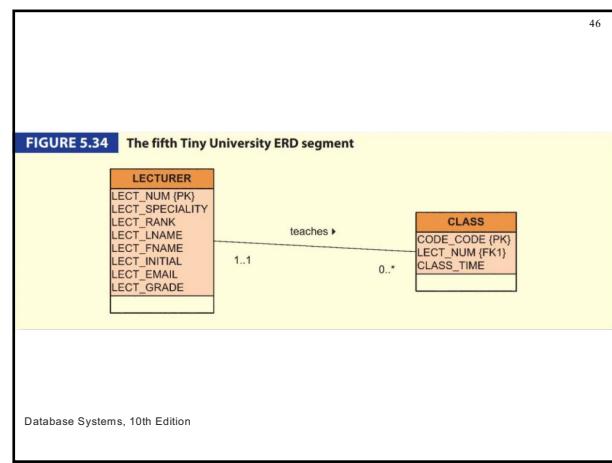
41



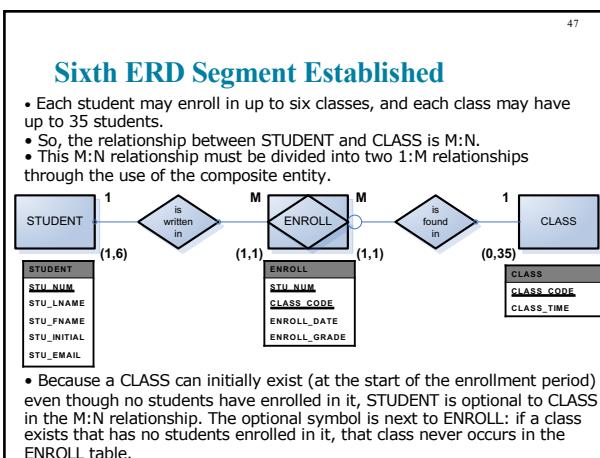
43



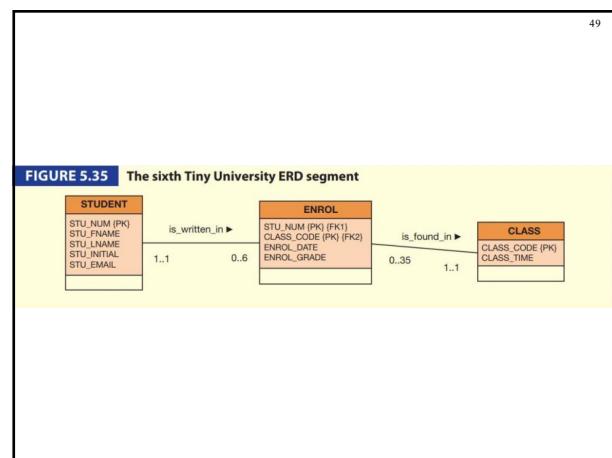
44



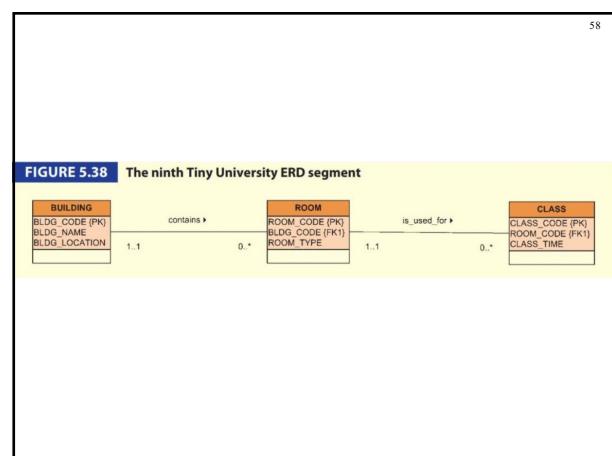
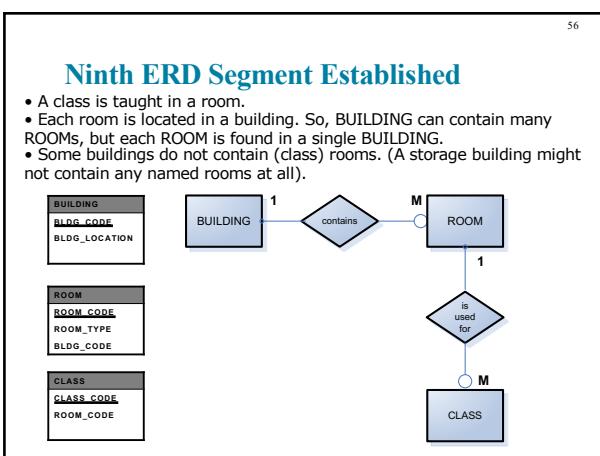
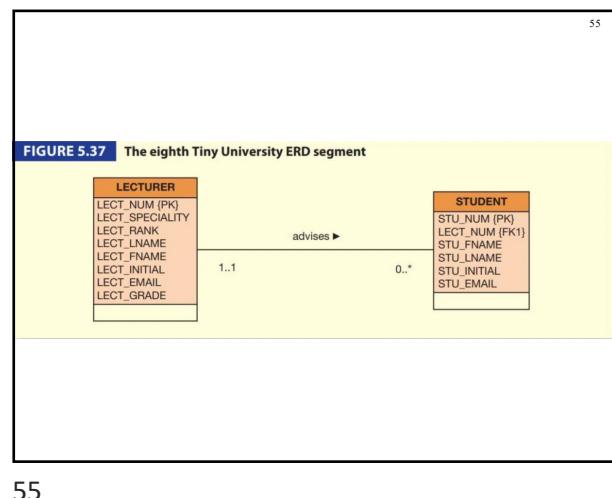
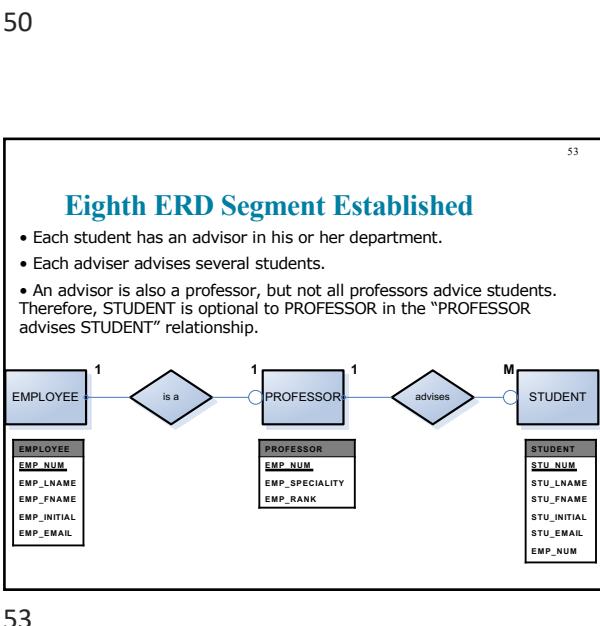
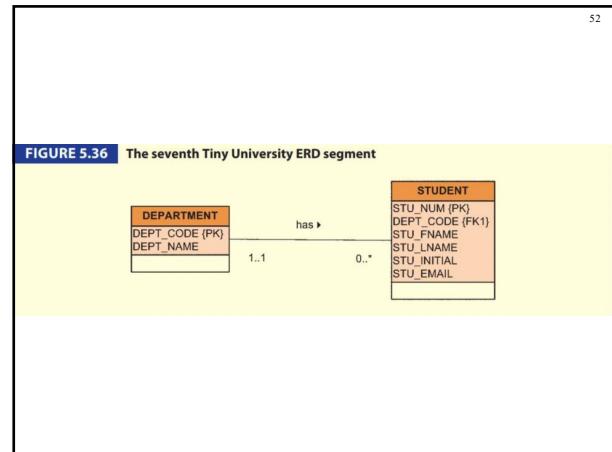
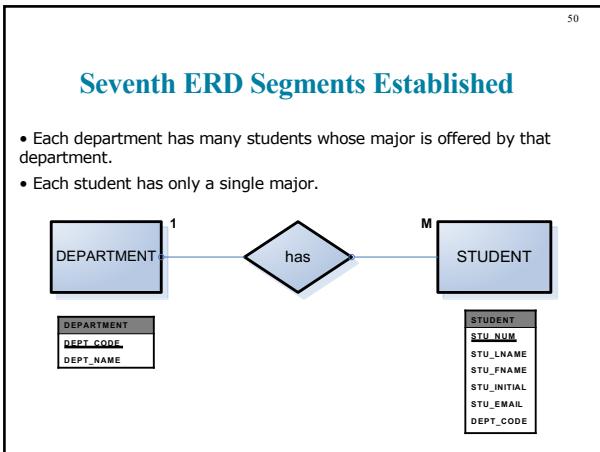
46



47

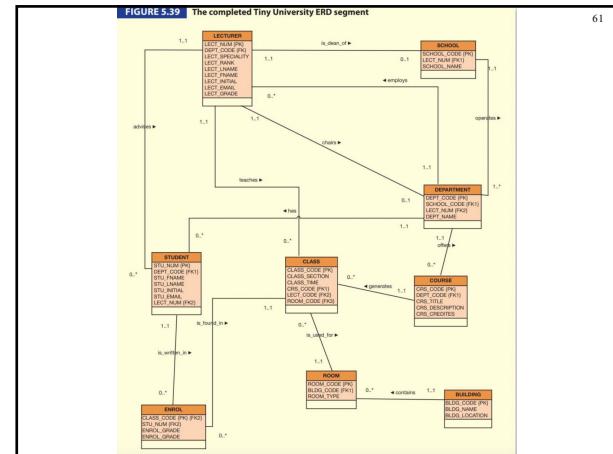


49

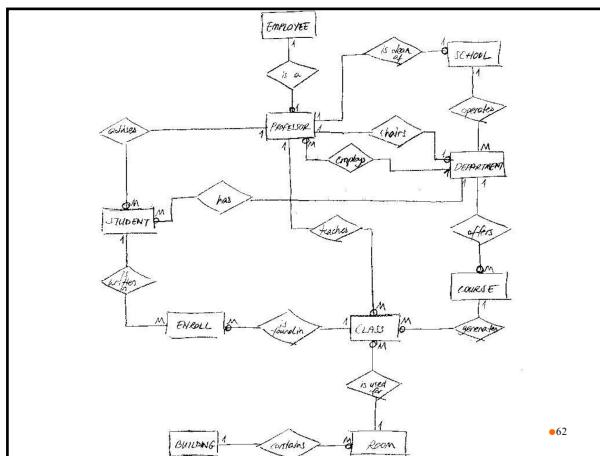


Components of the ERM			
Entity	Relationship	Connectivity	Entity
SCHOOL	operates	1..*	DEPARTMENT
DEPARTMENT	has	1..*	STUDENT
DEPARTMENT	employs	1..*	LECTURER
DEPARTMENT	offers	1..*	COURSE
COURSE	generates	1..*	CLASS
LECTURER	is dean of	1..1	SCHOOL
LECTURER	chairs	1..1	DEPARTMENT
LECTURER	teaches	1..*	CLASS
LECTURER	advises	1..*	STUDENT
STUDENT	enrolls in	1..*	CLASS
BUILDING	contains	1..*	ROOM
ROOM	is used for	1..*	CLASS

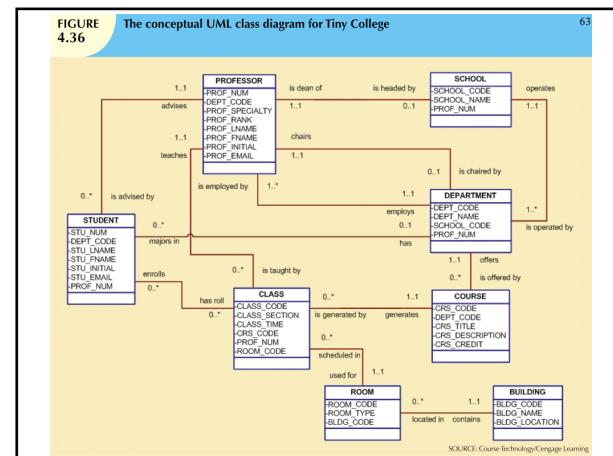
59



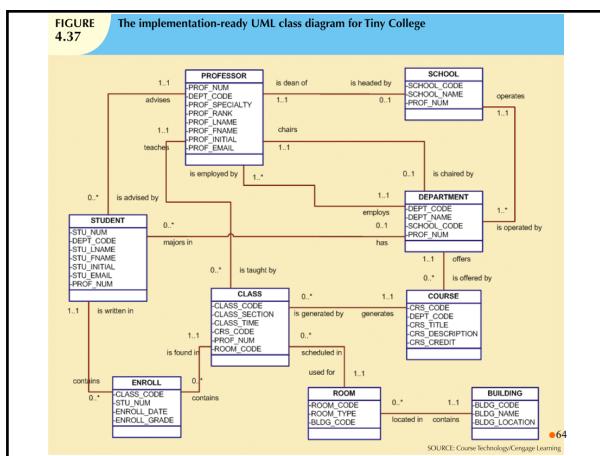
61



62



63



64

## Database Design Challenges: Conflicting Goals

- Database designers must make design compromises
    - Conflicting goals: design standards, processing speed, information requirements
  - Important to meet logical requirements and design conventions
  - Design is of little value unless it delivers all specified query and reporting requirements
  - Some design and implementation problems do not yield “clean” solutions

## Database Design Challenges: Conflicting Goals

- Database must be designed to conform to design standards
- High-speed processing may require design disagreements
- Search for timely information may be the focus of database design
- Other concerns
  - Security
  - Performance
  - Shared access
  - Integrity

**FIGURE 5.50 Various implementations of the 1:1 recursive relationship**

Database name: Ch05\_PartCo  
Table name: EMPLOYEE\_V1

First implementation

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_SPOUSE
345	Singh	Nishok	347
346	Jones	Anne	349
347	Singh	Vediga	345
348	Delaney	Robert	
349	Shapiro	Anton	346

Second implementation

Table name: EMPLOYEE

EMP_NUM	EMP_LNAME	EMP_FNAME
345	Singh	Nishok
346	Jones	Anne
347	Singh	Vediga
348	Delaney	Robert
349	Shapiro	Anton

Table name: MARRIED\_V1

EMP_NUM	EMP_SPOUSE
345	347
346	349
347	345
349	346

Third implementation

Table name: MARRIAGE

MAR_NUM	MAR_DATE
1	04-Mar-13
2	02-Feb-09

Table name: MARPART

MAR_NUM	EMP_NUM
1	345
1	347
2	346
2	349

Table name: EMPLOYEE

EMP_NUM	EMP_LNAME	EMP_FNAME
345	Singh	Nishok
346	Jones	Anne
347	Singh	Vediga
348	Delaney	Robert
349	Shapiro	Anton

```

    erDiagram
        MARRIAGE ||--o{ MARPART : "consists_of"
        MARPART ||--o{ EMPLOYEE : "is_for"
    }
  
```

The ER diagram illustrates three tables: MARRIAGE, MARPART, and EMPLOYEE. The MARRIAGE table has attributes MAR\_NUM (PK) and MAR\_DATE. The MARPART table has attributes MAR\_NUM (PK) and EMP\_NUM (FK). The EMPLOYEE table has attributes EMP\_NUM (PK), EMP\_FNAME, and EMP\_LNAME. A relationship 'consists\_of' connects MARRIAGE and MARPART. A relationship 'is\_for' connects MARPART and EMPLOYEE.