DATABASE SYSTEMS

DESIGN IMPLEMENTATION AND MANAGEMENT

INTERNATIONAL EDITION

ROB • CORONEL • CROCKETT

Chapter 5
Entity Relationship (ER) Modelling

In this chapter, you will learn:

- The main characteristics of entity relationship components
- How relationships between entities are defined and refined and how those relationships are 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

The Entity Relationship (ER) Model

- ER model forms the basis of an ER diagram
- ERD represents conceptual database as viewed by end user
- ERDs depict database's main components:
  - Entities
  - Attributes
  - Relationships

A Recipe ERD

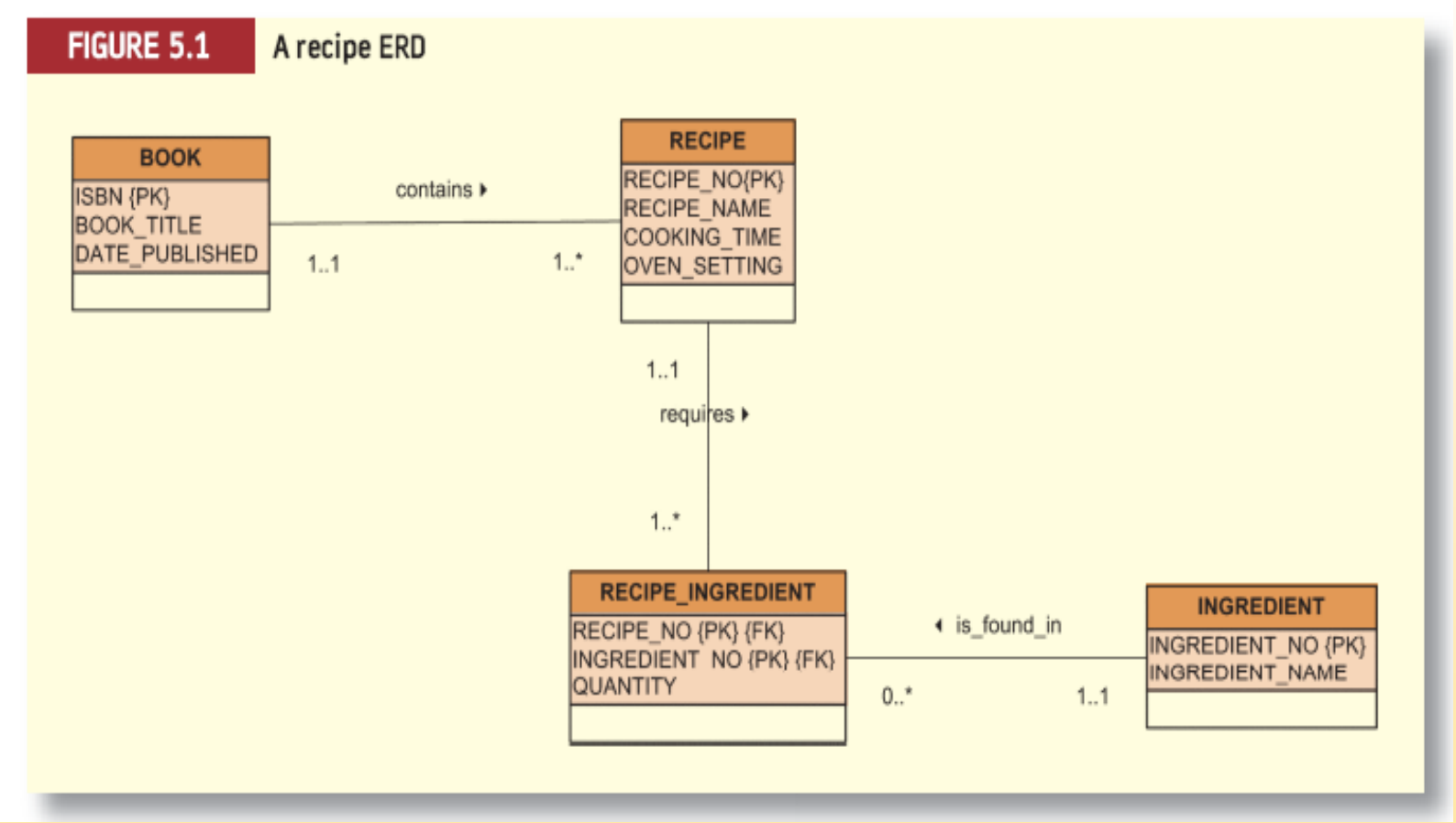


FIGURE 5.1
A recipe ERD
BOOK
ISBN {PK}
BOOK_TITLE
DATE_PUBLISHED
contains
1..1
1..*
RECIPE
RECIPE_NO{PK}
RECIPE_NAME
COOKING_TIME
OVEN_SETTING
1..1
requires
1..*
RECIPE_INGREDIENT
RECIPE_NO {PK} {FK}
INGREDIENT_NO {PK} {FK}
QUANTITY
is_found_in
0..*
1..1
INGREDIENT
INGREDIENT_NO {PK}
INGREDIENT_NAME

Entities

- Refers to entity set and not to single entity occurrence
- Corresponds to table and not to row in relational environment
- In UML notation, an entity is represented by a box that is subdivided into three parts.
- Entity name, a noun, is usually written in capital letters

Attributes

- In the UML model, the attributes are written in the attribute box below the entity rectangle

FIGURE 5.2 The attributes of the STUDENT entity

Domains

- Attributes have 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
- For example, a CAR entity may be represented by:
- CAR (CAR_REG, MOD_CODE, CAR_YEAR, CAR_COLOUR)

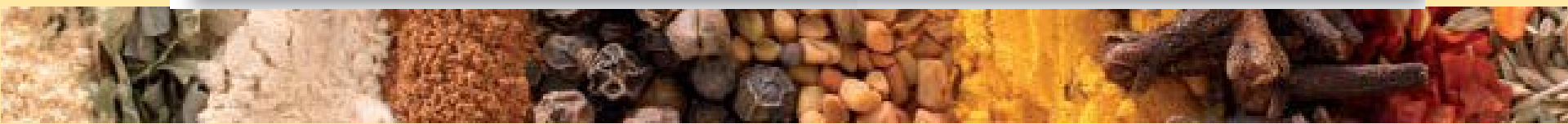
Composite Primary Keys

- Primary keys ideally composed of only single attribute
- Possible to use a composite key
  - Primary key composed of more than one attribute

Composite Primary Keys (continued)

FIGURE 5.3 The CLASS (entity) components and contents

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	LECT_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



Composite and Simple Attributes

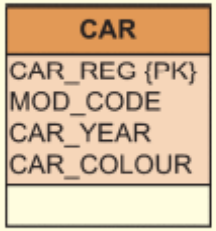
- Composite attribute can be subdivided
- Simple attribute cannot be subdivided

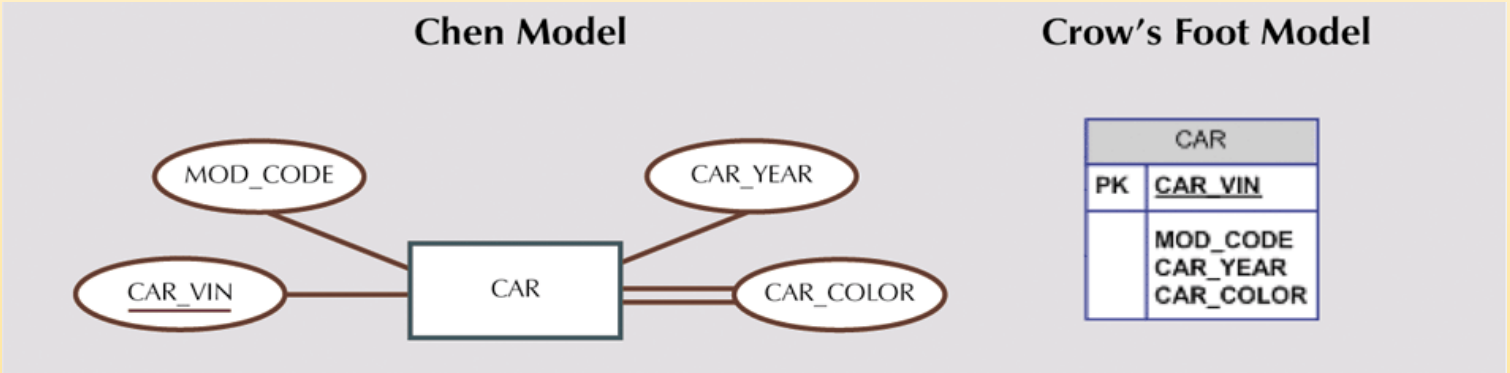
Single and Multi-Valued Attributes

- Single-value attribute can have only a single value
- Multi-valued attributes can have many values

Multivalued Attributes (continued)

FIGURE 5.4 The multivalued attribute in an entity





Resolving Multivalued Attribute Problems

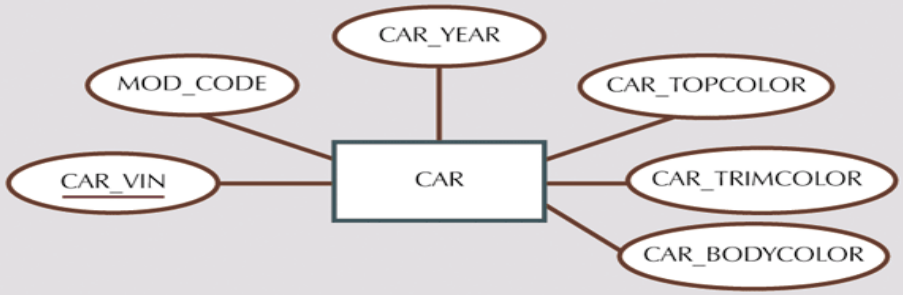
- Although conceptual model can handle M:N relationships and multi-valued attributes, you should not implement them in relational DBMS
  - Within original entity, create several new attributes, one for each of the original multi-valued attribute's components
    - Can lead to major structural problems in table
  - Create new entity composed of original multivalued attribute's components

Resolving Multivalued Attribute Problems (continued)

FIGURE 5.5 Splitting the multivalued attribute into new attributes

CAR
CAR_REG {PK}
MOD_CODE
CAR_YEAR
CAR_TOPCOLOUR
CAR_TRIMCOLOUR
CAR_BODYCOLOUR

Chen Model

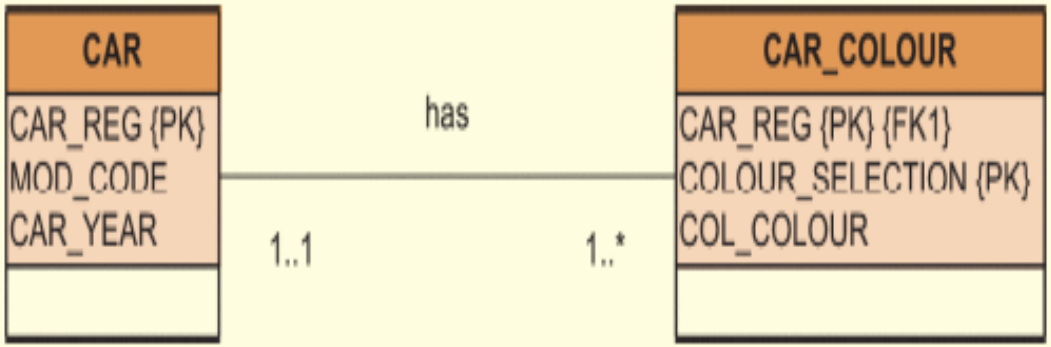


Crow's Foot Model

CAR	
PK	CAR_VIN
	MOD_CODE CAR_YEAR CAR_TOPCOLOR CAR_TRIMCOLOR CAR_BODYCOLOR

Resolving Multivalued Attribute Problems (continued)

FIGURE 5.6 A new entity set composed of a multivalued attribute's components



Resolving Multivalued Attribute Problems (continued)

TABLE 5.1 Components of the multivalued attribute

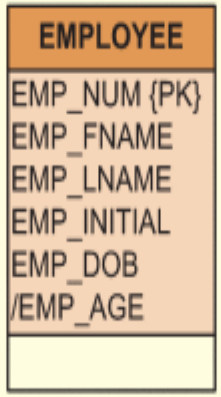
Section	Colour
Top	White
Body	Blue
Trim	Gold
Interior	Blue

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 5.7 Depiction of a derived attribute



Derived Attributes (continued)

TABLE 5.2 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

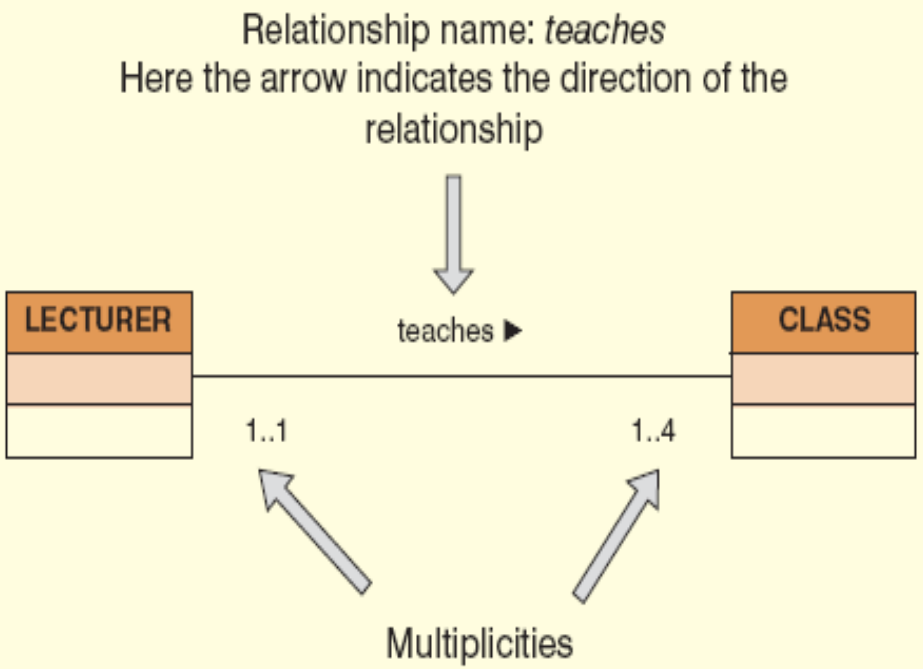
- Association between entities
- Participants are entities that participate in a relationship
- Relationships between entities always operate in both directions
- Relationship can be classified as 1:*
- Relationship classification is difficult to establish if know only one side of the relationship

Multiplicity

- **Multiplicity** refers to the number of instances of one entity that are associated with one instance of a related entity.
- **Cardinality** expresses minimum and maximum number of entity occurrences associated with one occurrence of related entity
- **Participation** - determines whether all occurrences of an entity participate in the relationship or not.

Multiplicity(continued)

FIGURE 5.8 Multiplicity in an ERD



Existence Dependence

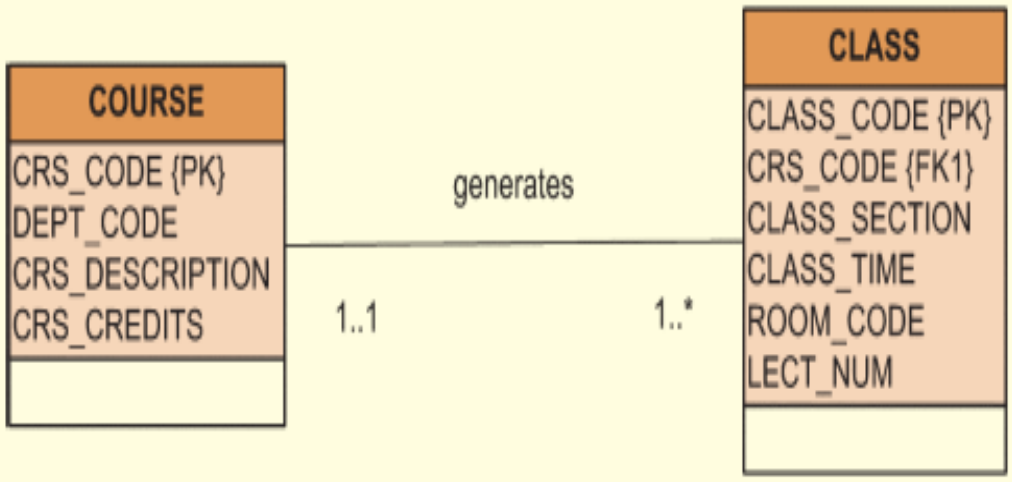
- Existence dependence
  - Exist in database only when it is associated with another related entity occurrence
- Existence independence
  - Entity can exist apart from one or more related entities
  - Sometimes refers to such an entity as strong or regular entity

Relationship Strength

- Weak (non-identifying) relationships
  - Exists if PK of related entity does not contain PK component of parent entity
- Strong (Identifying) Relationships
  - Exists when PK of related entity contains PK component of parent entity

Weak (Non-Identifying) Relationships

FIGURE 5.9 A weak non-identifying relationship between COURSE and CLASS



Weak (Non-Identifying) Relationships (continued)

FIGURE 5.10 Weak (non-identifying) relationship between COURSE and CLASS

Database name: CH05_Tiny College

Table name: COURSE

Primary key: CRS_CODE

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

Weak (Non-Identifying) Relationships (continued)

Table name: CLASS

Primary key: CLASS_CODE

Foreign key: CRS_CODE

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	LECT_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

Strong (Identifying) Relationships

FIGURE 5.11 A strong (non-identifying) relationship between COURSE and CLASS

Database name: CH05_Tiny_College_Alt

Table name: COURSE

Primary key: CRS_CODE

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

Table name: CLASS

Primary keys: CRS_CODE and CLASS_SECTION

Foreign key: CRS_CODE

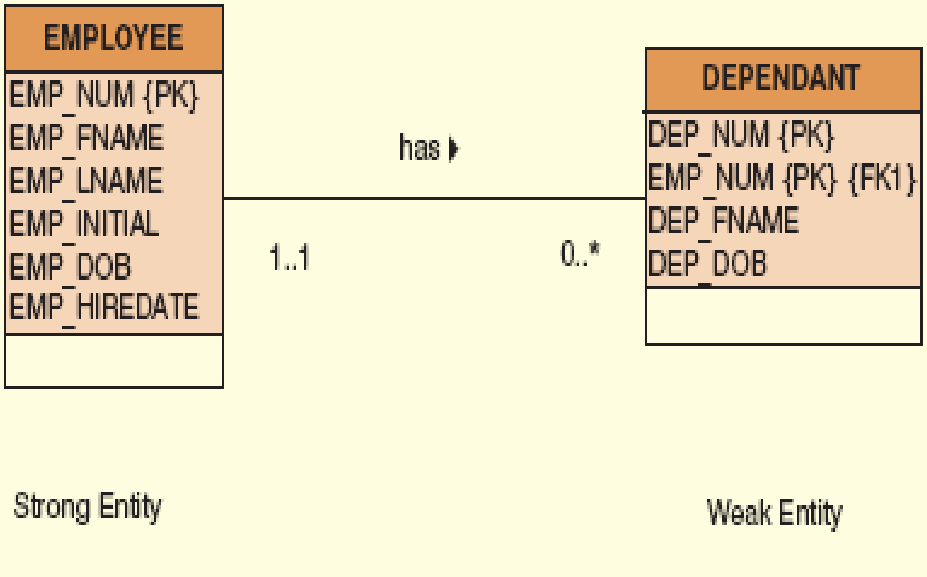
CRS_CODE	CLASS_SECTION	CLASS_TIME	ROOM_CODE	LECT_NUM
ACCT-211	1	MWF 8:00-8:50 a.m.	BUS311	105
ACCT-211	2	MWF 9:00-9:50 a.m.	BUS200	105
ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
ACCT-212	1	MWF 10:00-10:50 a.m.	BUS311	301
ACCT-212	2	Th 6:00-8:40 p.m.	BUS252	301
CIS-220	1	MWF 9:00-9:50 a.m.	KLR209	229
CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
CIS-220	3	MWF 10:00-10:50 a.m.	KLR209	229
CIS-420	1	W 6:00-8:40 p.m.	KLR209	162
MATH-243	1	Th 6:00-8:40 p.m.	DRE155	325
QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114
QM-261	2	TTh 1:00-2:15 p.m.	KLR200	114
QM-362	1	MWF 11:00-11:50 a.m.	KLR200	162
QM-362	2	TTh 2:30-3:45 p.m.	KLR200	162

Weak Entities

- 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

Weak Entities (continued)

FIGURE 5.12 A weak entity in an ERD



Weak Entities (continued)

FIGURE 5.13 A weak entity in a strong relationship

Database name: CH05_ShortCo

Table name: EMPLOYEE

Primary key: EMP_NUM

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: DEPENDANT

Primary keys: EMP_NUM and DEP_NUM

Foreign key: EMP_NUM

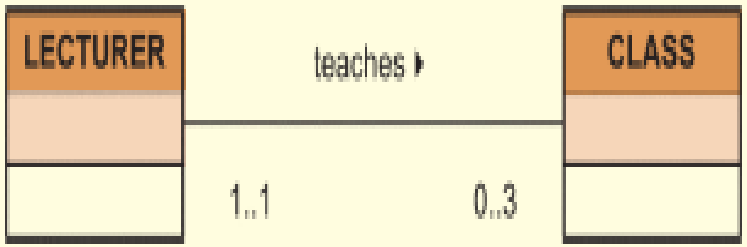
EMP_NUM	DEP_NUM	DEP_FNAME	DEP_DOB
1001	1	Annelise	05-Dec-97
1001	2	Jorge	30-Sep-02
1003	1	Suzanne	25-Jan-04
1006	1	Carlos	25-May-01
1008	1	Michael	19-Feb-95
1008	2	George	27-Jun-98
1008	3	Katherine	18-Aug-03

Relationship Participation

- Optional participation
  - One entity occurrence does not require corresponding entity occurrence in particular relationship
- Mandatory participation
  - One entity occurrence requires corresponding entity occurrence in particular relationship

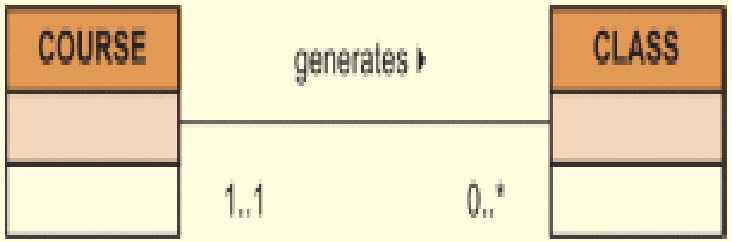
Relationship Participation (continued)

FIGURE 5.14 An optional CLASS entity in the relationship LECTURER teaches CLASS



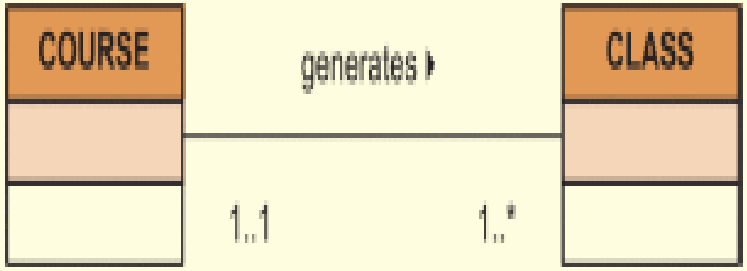
Relationship Participation (continued)

FIGURE 5.15 Class is optional to COURSE



Relationship Participation (continued)

FIGURE 5.16 COURSE and CLASS in a mandatory relationship



Relationship Participation (continued)

TABLE 5.3 Multiplicity

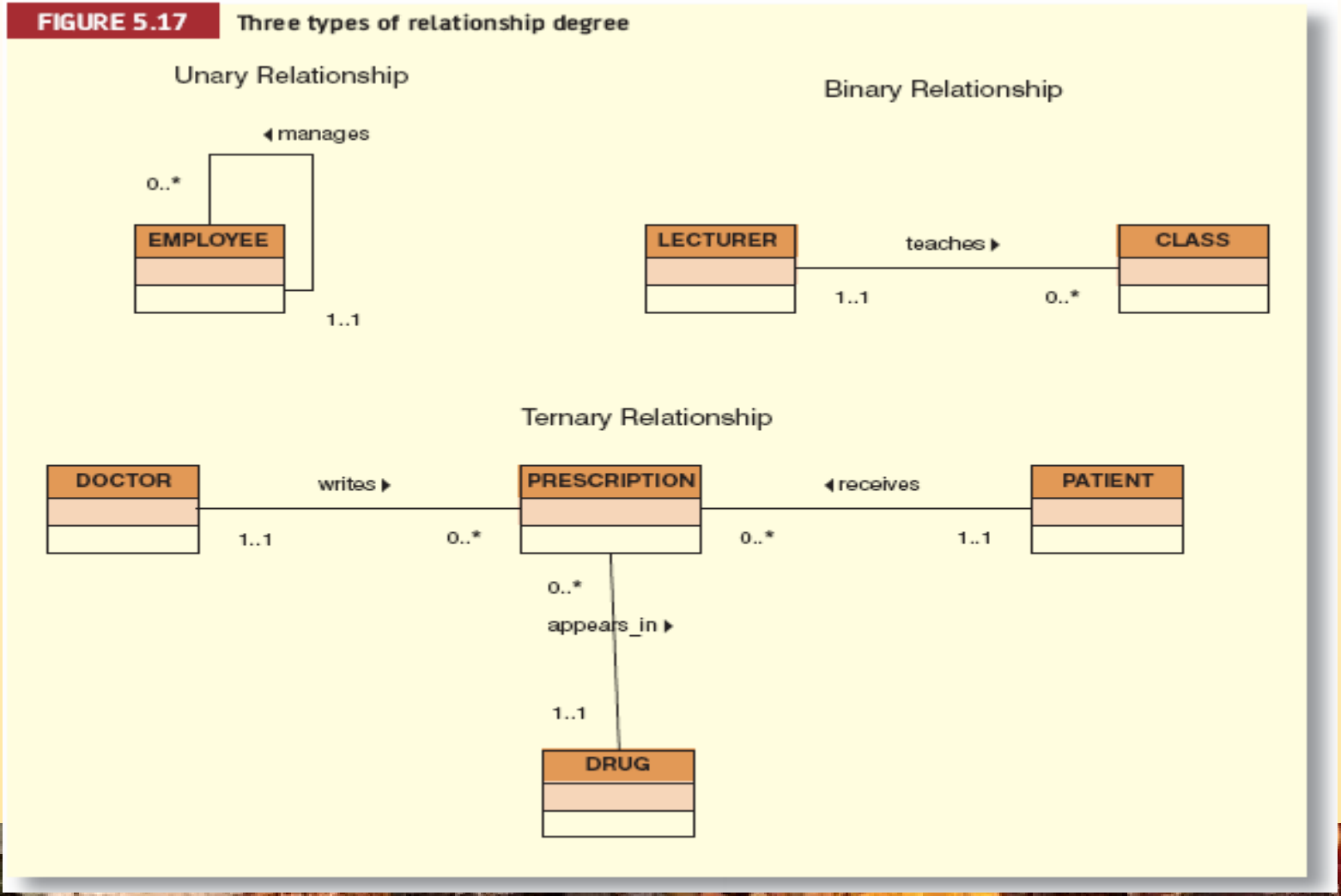
Multiplicity	Description
0..1	A minimum of zero and a maximum of one instance of this class are associated with an instance of the other related class (indicates an optional class).
0..*	A minimum of zero and a maximum of many instances of this class are associated with an instance of the other related class (indicates an optional class).
1..1	A minimum of one and a maximum of one instance of this class are associated with an instance of the other related class (indicates a mandatory class).
1..*	A minimum of one and a maximum of many instances of this class are associated with an instance of the other related class (indicates a mandatory class).
1	Exactly one instance of this class is associated with an instance of the other related class (indicates a mandatory class). In other words equivalent to 1..1.
*	Many instances of this class are associated with an instance of the other related class. Equivalent to 0..*.

Relationship Degree

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

Relationship Degree (continued)

FIGURE 5.17 Three types of relationship degree



Relationship Degree (continued)

FIGURE 5.18 The implementation of a ternary relationship

Database name: Ch05_Clinic

Table name: Drug

Primary key: DRUG_CODE

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

Primary key: PAT_NUM

PAT_NUM	PAT_TITLE	PAT_LNAME	PAT_FNAME	PAT_INITIAL	PAT_DOB	PAT_AREACODE	PAT_PHONE
100	Mr.	Kolmycz	George	D	15-Jun-1942	0191	324-5456
101	Ms.	Lewis	Rhonda	G	19-Mar-2005	0191	324-4472
102	Mr.	Vandam	Rhett		14-Nov-1958	0879	675-8993
103	Ms.	Jones	Anne	M	16-Oct-1974	0191	898-3456
104	Mr.	Lange	John	P	08-Nov-1971	0879	504-4430
105	Mr.	Williams	Robert	D	14-Mar-1975	0191	890-3220
106	Mrs.	Smith	Jeanine	K	12-Feb-2003	0191	324-7883
107	Mr.	Diante	Jorge	D	21-Aug-1974	0191	890-4567
108	Mr.	Wiesenbach	Paul	R	14-Feb-1966	0191	897-4358
109	Mr.	Smith	George	K	18-Jun-1961	0879	504-3339
110	Mrs.	Genkazi	Leighla	W	19-May-1970	0879	569-0093
111	Mr.	Washington	Rupert	E	03-Jan-1966	0191	890-4925
112	Mr.	Johnson	Edward	E	14-May-1961	0191	898-4387
113	Ms.	Smythe	Melanie	P	15-Sep-1970	0191	324-9006
114	Ms.	Brandon	Marie	G	02-Nov-1932	0879	882-0845
115	Mrs.	Saranda	Hermine	R	25-Jul-1972	0191	324-5505
116	Mr.	Smith	George	A	08-Nov-1965	0191	890-2984

Relationship Degree (continued)

Table name: Doctor

Primary keys: DOC_ID

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

Primary key: DRUG_CODE, DOC_ID and PAT_NUM, PRES_DATE

Foreign keys: DRUG_CODE, DOC_ID and PAT_NUM,

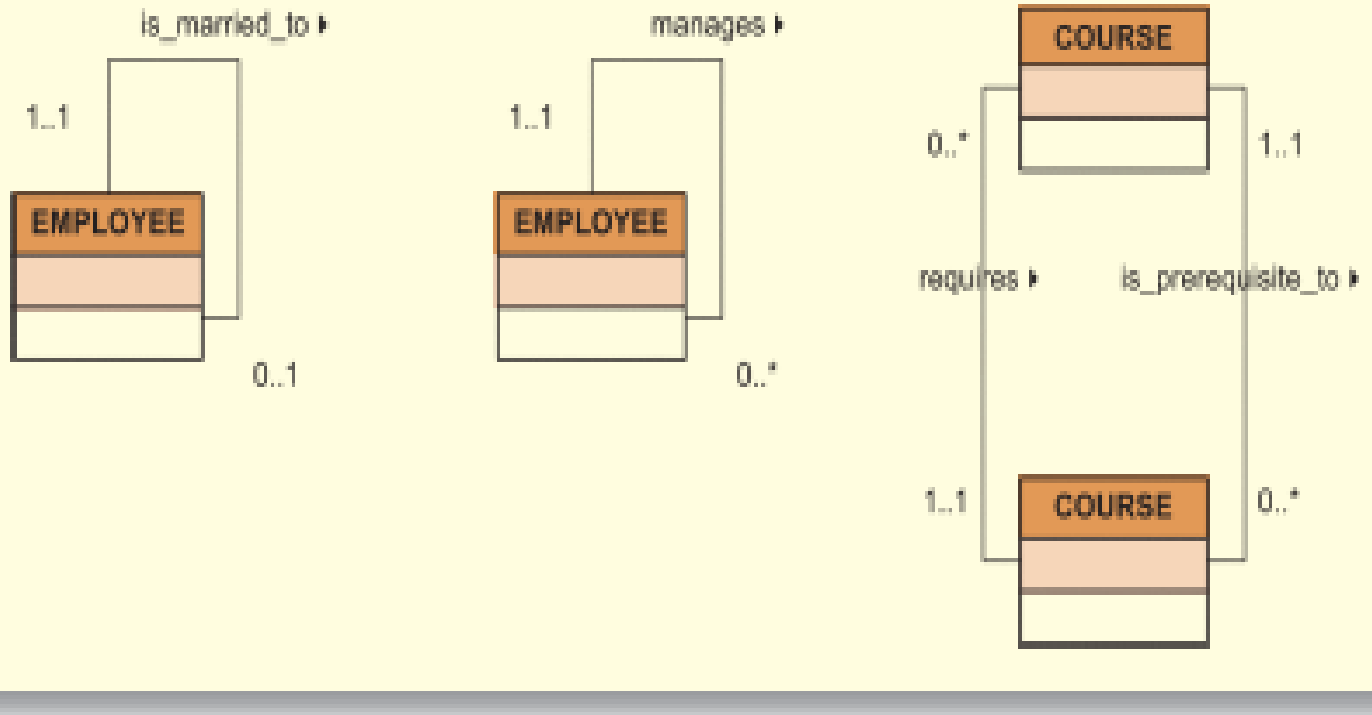
DOC_ID	PAT_NUM	DRUG_CODE	PRES_DOSAGE	PRES_DATE
32445	102	DRZ	2 tablets every four hours -- 50 tablets total	12-Nov-07
32445	113	OLE	1 teaspoon with each meal -- 250 ml total	14-Nov-07
34409	101	KO15	1 tablet every six hours -- 30 tablets total	14-Nov-07
36221	109	DRO	2 tablets with every meal -- 60 tablets total	14-Nov-07
38995	107	KO15	1 tablet every six hours -- 30 tablets total	14-Nov-07

Recursive Relationships

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

Recursive Relationships (continued)

FIGURE 5.19 An ER representation of a recursive relationship



Recursive Relationships (continued)

FIGURE 5.20 The 1:1 recursive relationship 'EMPLOYEE is married to EMPLOYEE'

Database name: Ch05_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 5.21 Another Unary relationship 'PART contains PART'

Database name: Ch05_PartCo

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

Recursive Relationships (continued)

FIGURE 5.22 Implementation of the *:* recursive 'PART contains PART' relationship

Database name: Ch05_PartCo

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	432.00
AB-121	Cotter pin, copper	1,034.00
C-130	Rotor assembly	36.00
E129	2.5 cm steel shank	128.00
X10	10.25 cm rotor blade	345.00
X34AW	2.5 cm hex nut	879.00

Recursive Relationships (continued)

FIGURE 5.23 Implementation of the *:* recursive 'COURSE requires COURSE' relationship

Database name: Ch05_TinyUniversity

Table name: COURSE

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 5.24 Implementation of the 1:* 'EMPLOYEE manages EMPLOYEE' recursive relationship

Database name: Ch05_PartCo

Table name: EMPLOYEE_V2

EMP_CODE	EMP_LNAME	EMP_MANAGER
101	Wacklell	102
102	Orincone	
103	Jones	102
104	Rebalioh	102
105	Robertson	102
106	Deltona	102

Composite Entities

- Also known as bridge entities
- Composed of primary keys of each of the entities to be connected
- May also contain additional attributes that play no role in connective process

Composite Entities (continued)

FIGURE 5.25 Converting the *:* relationship into two 1:* relationships

Database name: Ch05_UniversityTry

Table name: STUDENT

STU_NUM	STU_LNAME
321452	Bowser
324257	Smithson

Table name: ENROL

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

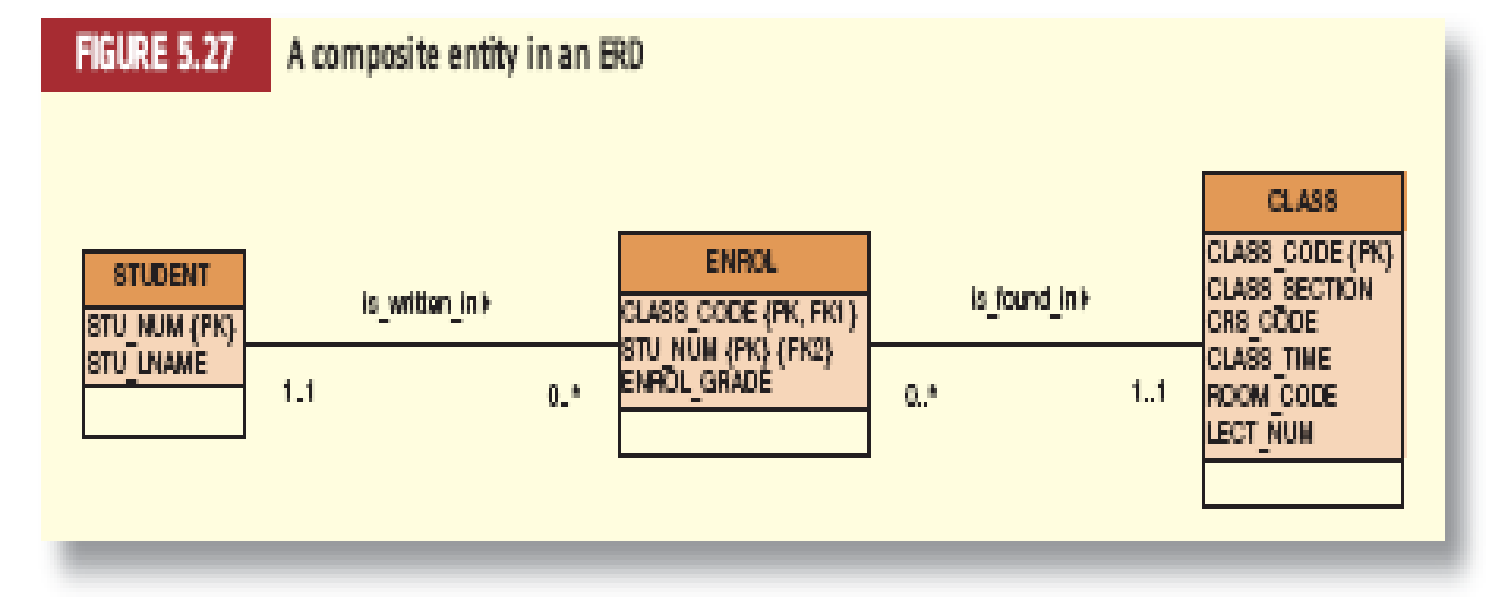
Table name: CLASS

CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	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

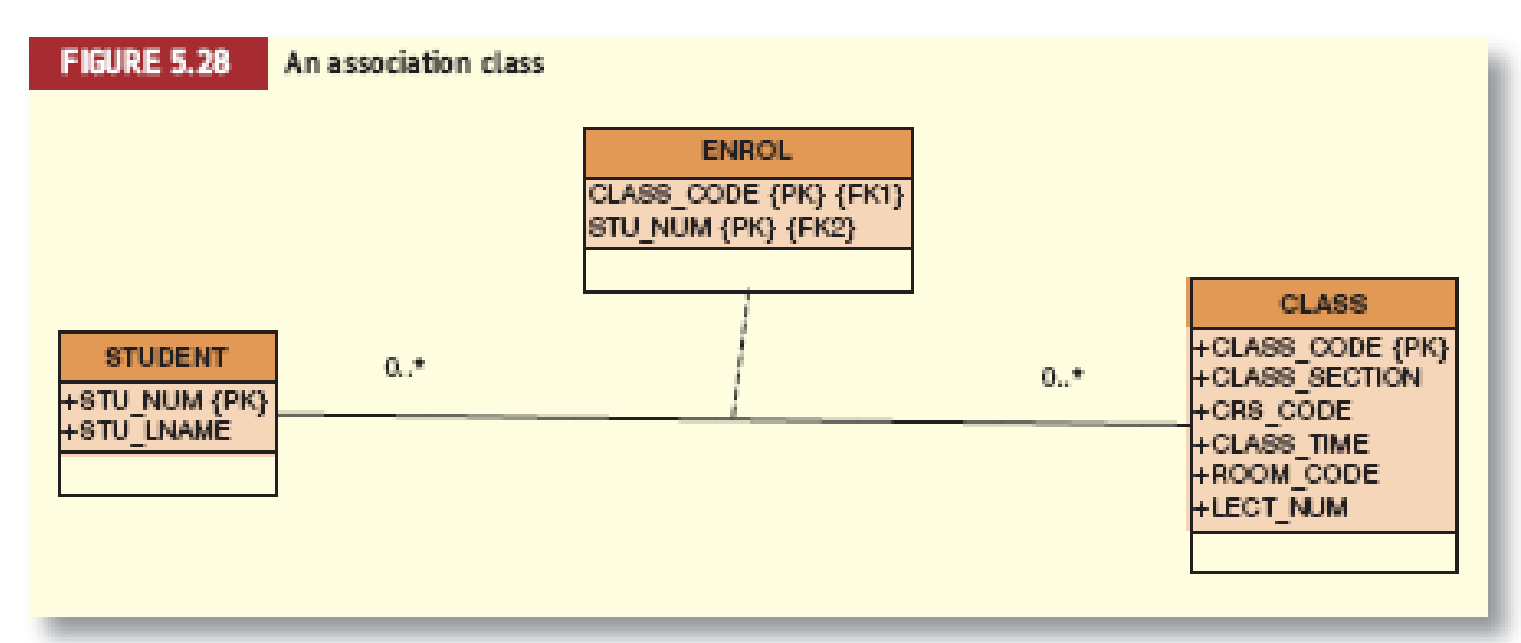
Composite Entities (continued)

FIGURE 5.26 The *:* relationship between STUDENT and CLASS

Composite Entities (continued)



Association Class



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 (continued)

- 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 (continued)

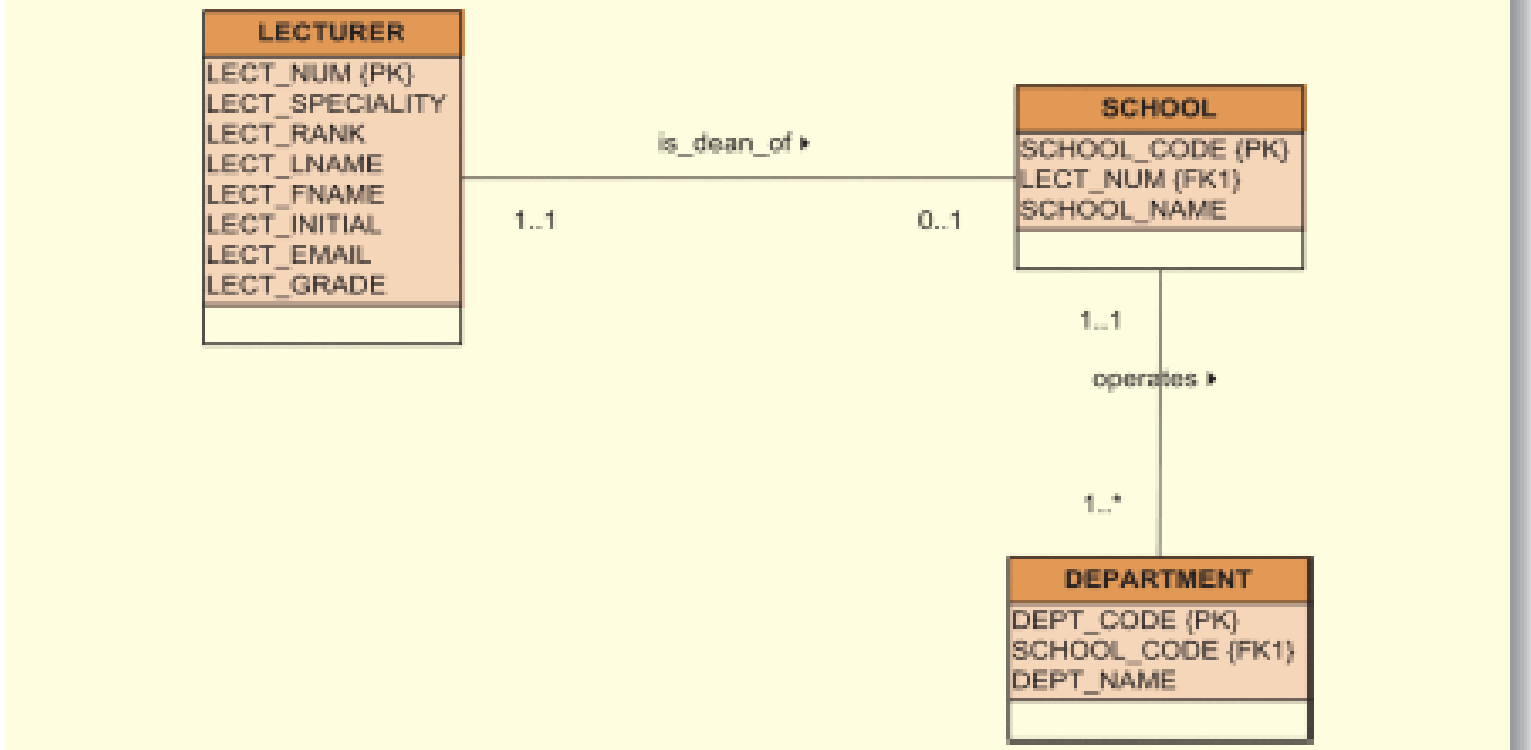
- Tiny University
  - Tiny University is divided into several schools
    - Each school is composed of several departments
  - Each department may offer courses
  - Each department may have many lecturers assigned to it
  - Each lecturer may teach up to four classes; each class is section of course
  - Student may enroll in several classes, but (s)he takes each class only once during any given enrollment period

Developing an ER Diagram (continued)

- Tiny University (continued)
  - 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

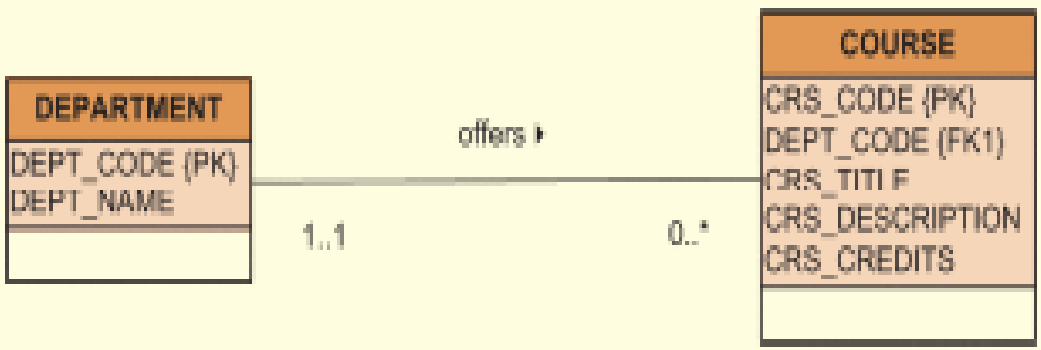
Developing an ER Diagram (continued)

FIGURE 5.29 The first Tiny University segment

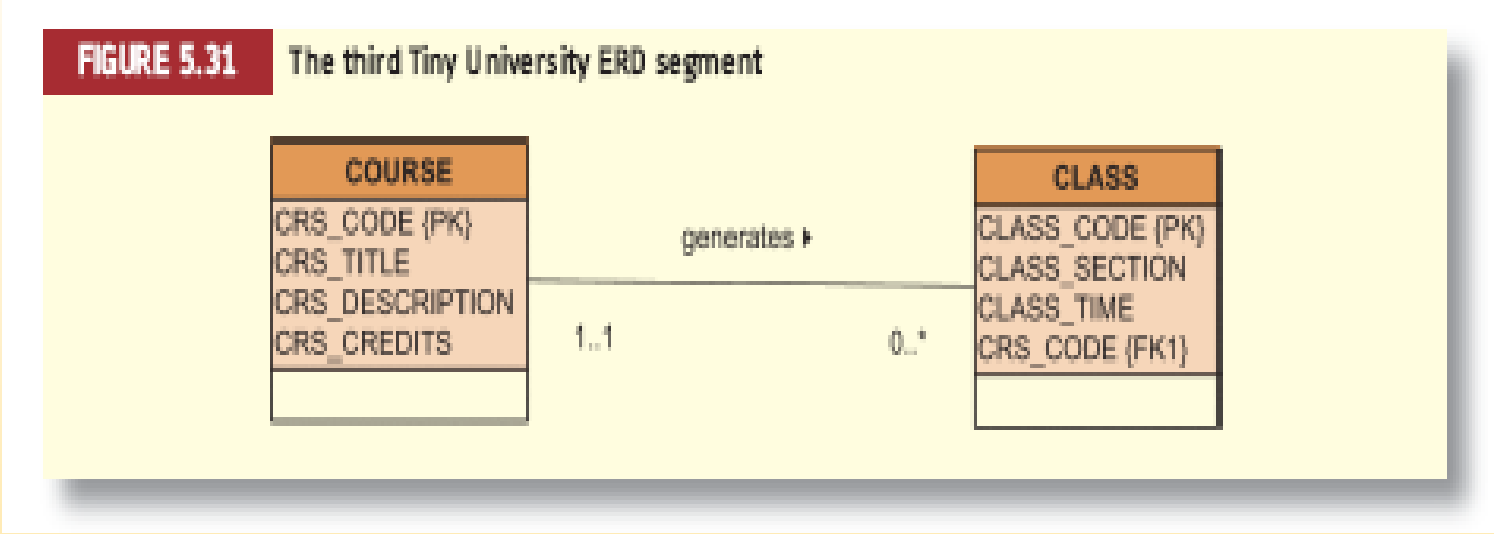


Developing an ER Diagram (continued)

FIGURE 5.30 The second Tiny University ERD segment

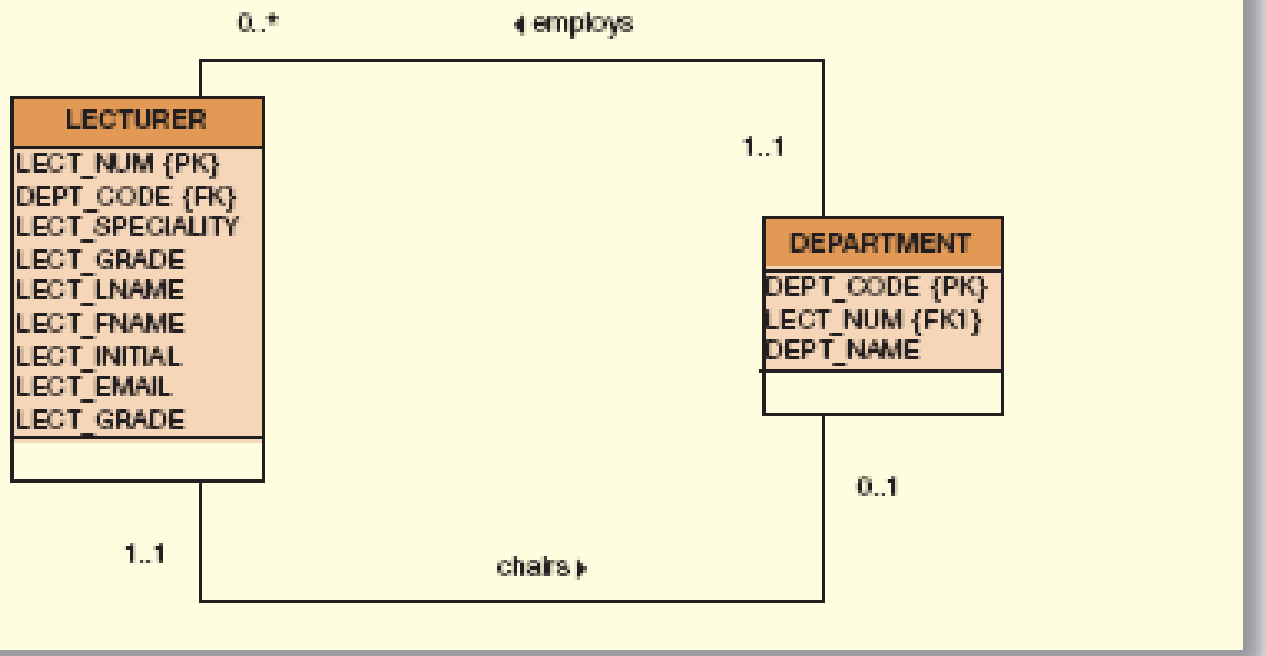


Developing an ER Diagram (continued)



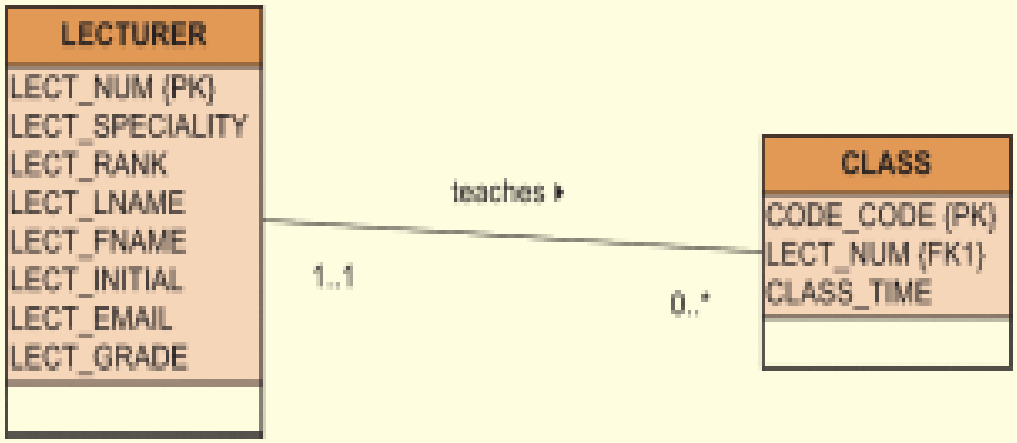
Developing an ER Diagram (continued)

FIGURE 5.32 The fourth Tiny University ERD segment

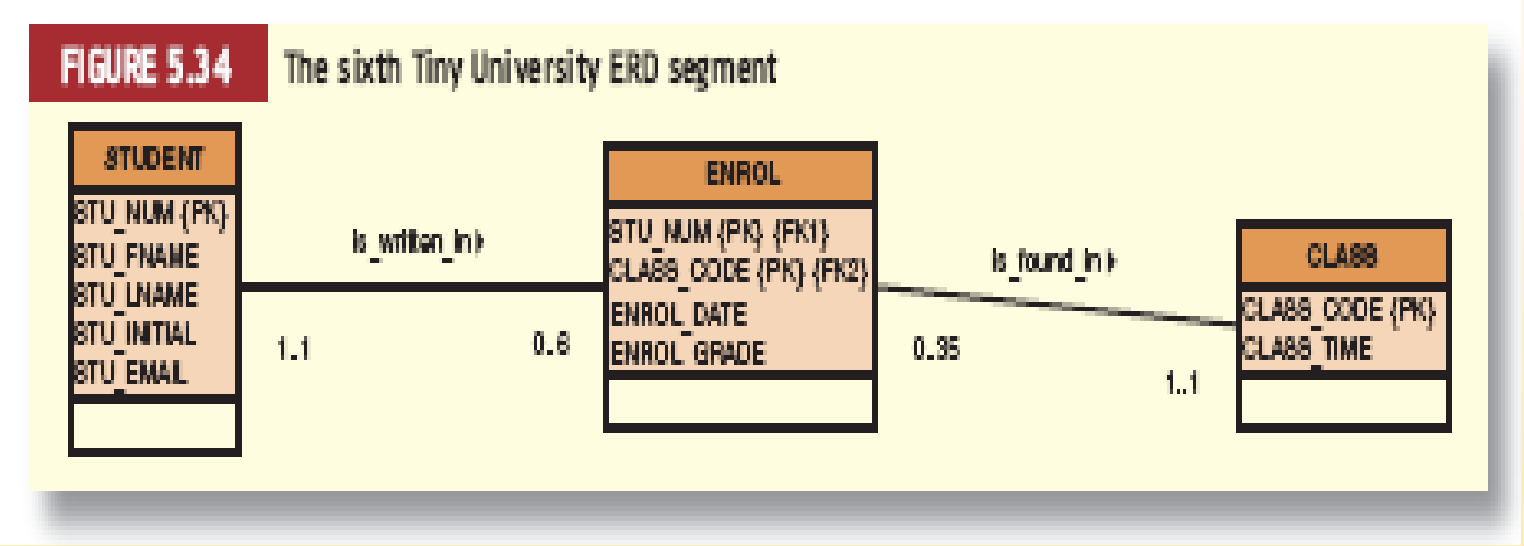


Developing an ER Diagram (continued)

FIGURE 5.33 The fifth Tiny University ERD segment

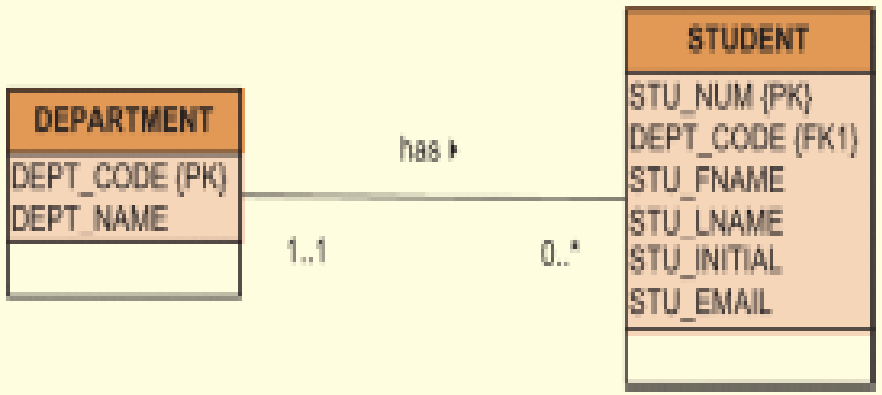


Developing an ER Diagram (continued)

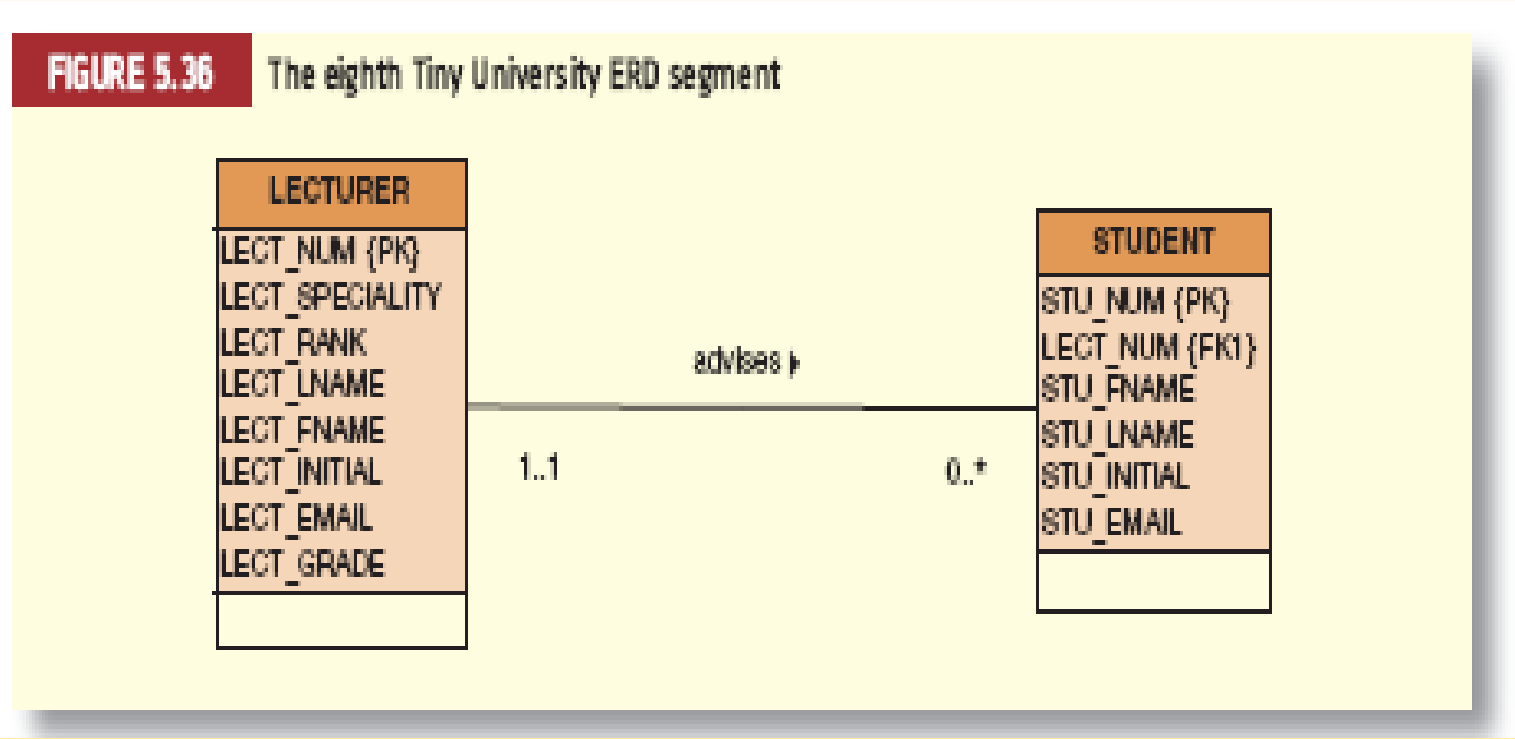


Developing an ER Diagram (continued)

FIGURE 5.35 The seventh Tiny University ERD segment

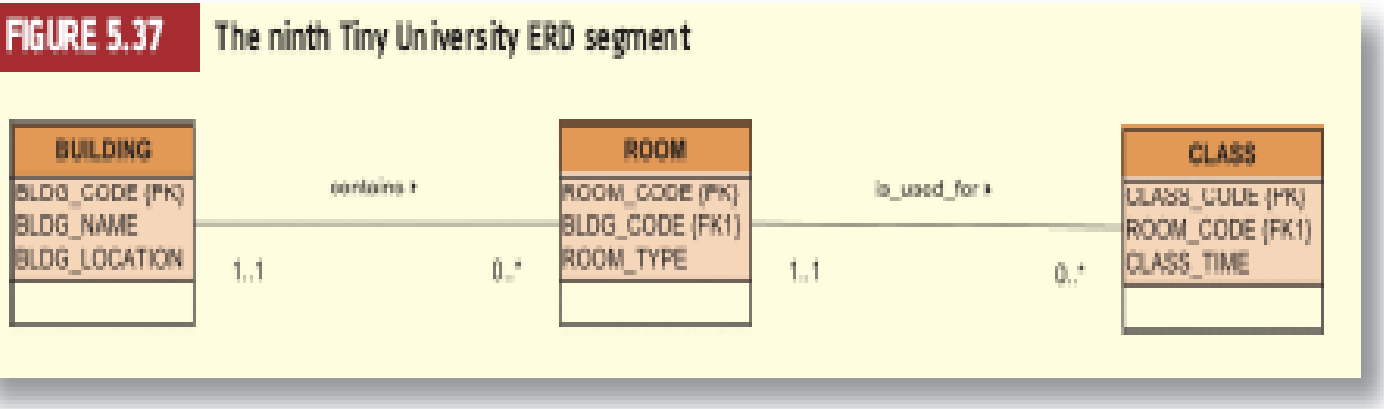


Developing an ER Diagram (continued)



Developing an ER Diagram (continued)

FIGURE 5.37 The ninth Tiny University ERD segment



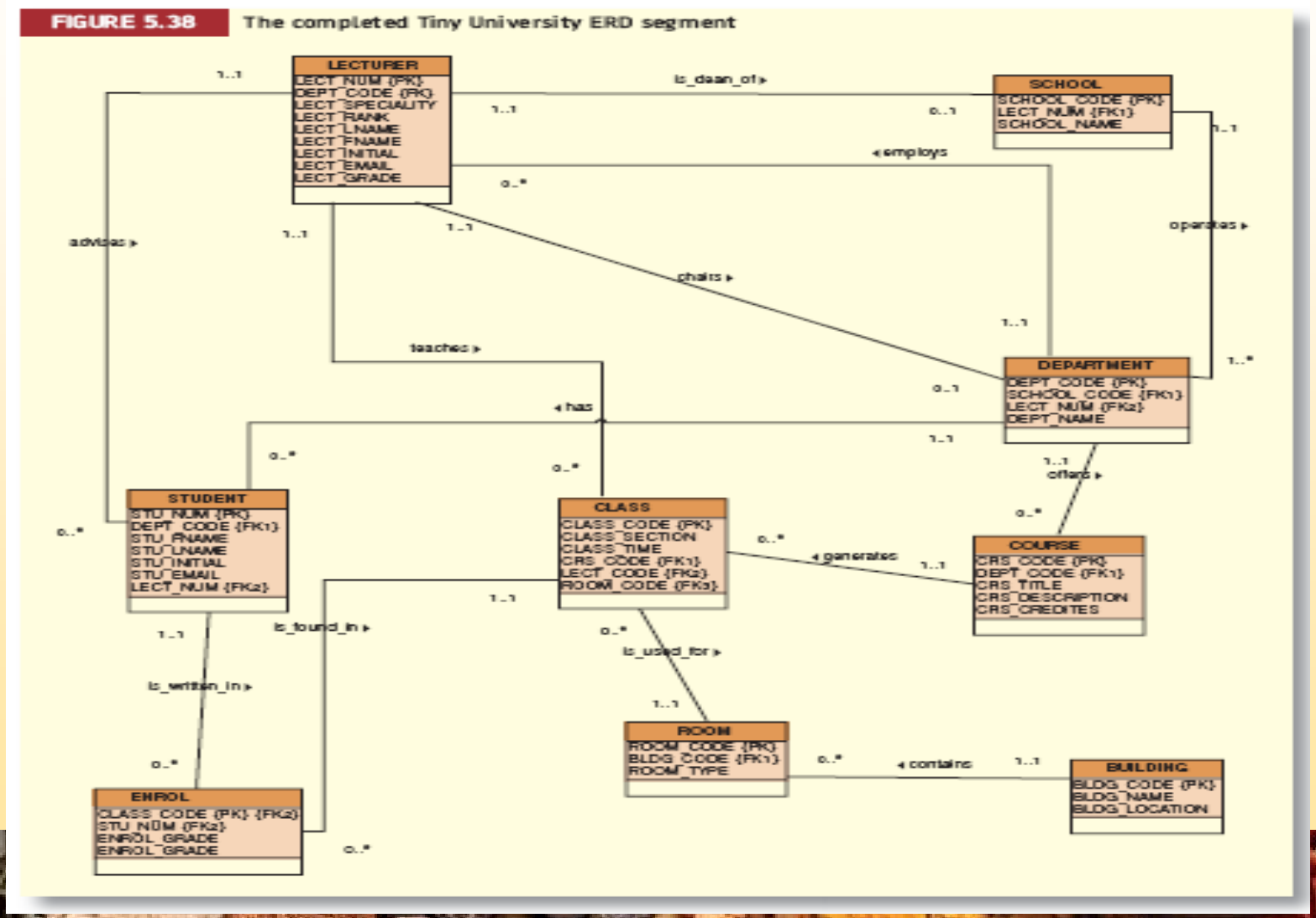
Developing an ER Diagram (continued)

TABLE 5.4 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	enrols in	1..*	CLASS
BUILDING	contains	1..*	ROOM
ROOM	is used for	1..*	CLASS

Note: ENROL is the composite entity that implements the relationship STUDENT enrols in CLASS.

Developing an ER Diagram (continued)



Database Design Challenges: Conflicting Goals

- Database design must conform to design standards
- High processing speeds are often a top priority in database design
- Quest for timely information might be focus of database design

Database Design Challenges: Conflicting Goals (cont.)

FIGURE 5.39 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	Ramirez	James	347
346	Jones	Anne	349
347	Ramirez	Louise	345
348	Delaney	Robert	
349	Shapiro	Anton	346

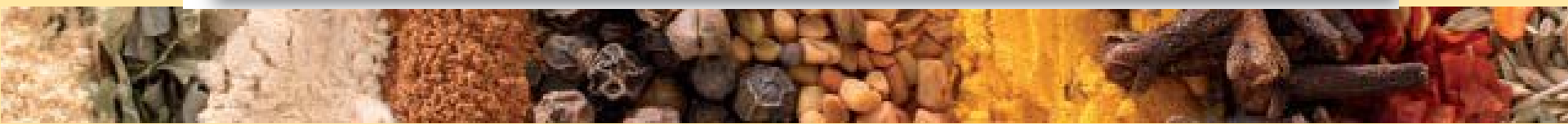
Second implementation

Table name: EMPLOYEE

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

Table name: MARRIED_V1

EMP_NUM	EMP_SPOUSE
345	347
346	349
347	345
349	346



Database Design Challenges: Conflicting Goals (cont.)

Third implementation

Table name: MARRIAGE

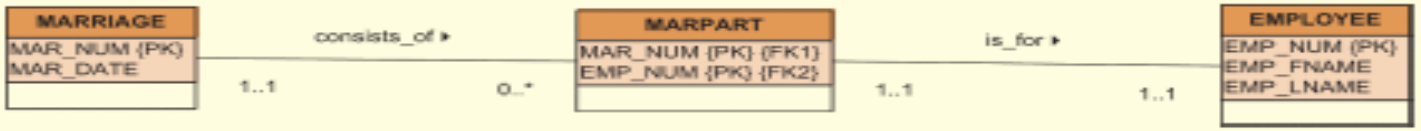
MAR_NUM	MAR_DATE
1	04-Mar-03
2	02-Feb-99

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	Ramirez	James
346	Jones	Anne
347	Ramirez	Louise
348	Delaney	Robert
349	Shapiro	Anton



Summary

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

Summary (continued)

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