ER-to-Relational Mapping Outline

- **ER-to-Relational Mapping Algorithm**
  - Step 1: Mapping of Regular Entity Types
  - Step 2: Mapping of Weak Entity Types
  - Step 3: Mapping of Binary 1:1 Relation Types
  - Step 4: Mapping of Binary 1:N Relationship Types.
  - Step 5: Mapping of Binary M:N Relationship Types.
  - Step 6: Mapping of Multivalued attributes.
  - Step 7: Mapping of N-ary Relationship Types.

ER-to-Relational Mapping Algorithm

Mapping of Regular Entity Types.

- For entity type E in ER schema, **set up a relation R** that includes all simple attributes of E.

- Choose key attributes of E as primary key for R.

- Example: **Relations** EMPLOYEE, DEPARTMENT, and PROJECT in the relational schema corresponding to the regular entities in the ER diagram.

- SSN, DNUMBER, and PNUMBER are primary keys for relations EMPLOYEE, DEPARTMENT, and PROJECT.

FIGURE 7.1 *from elmasri navathe*

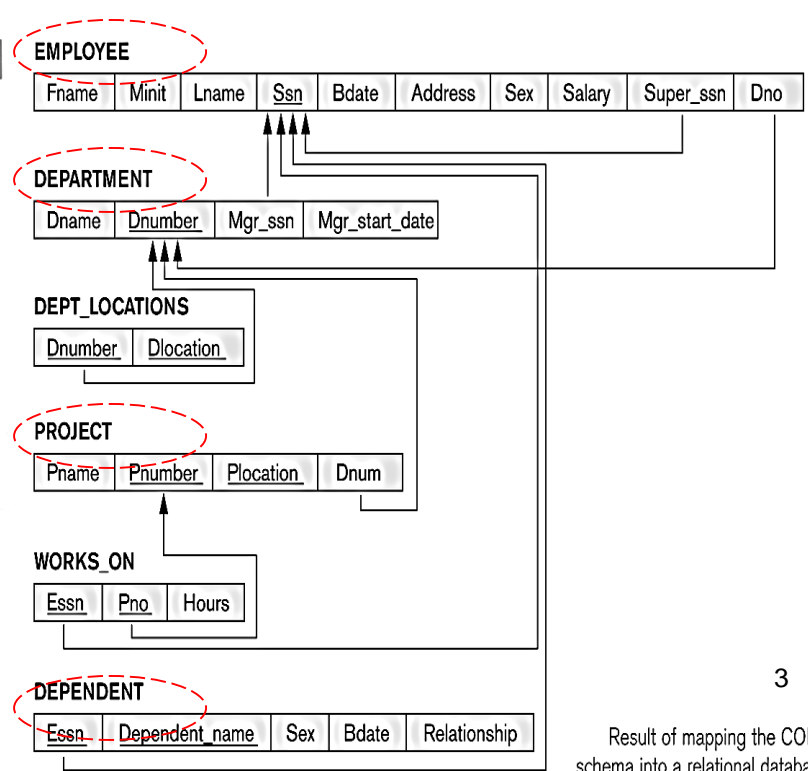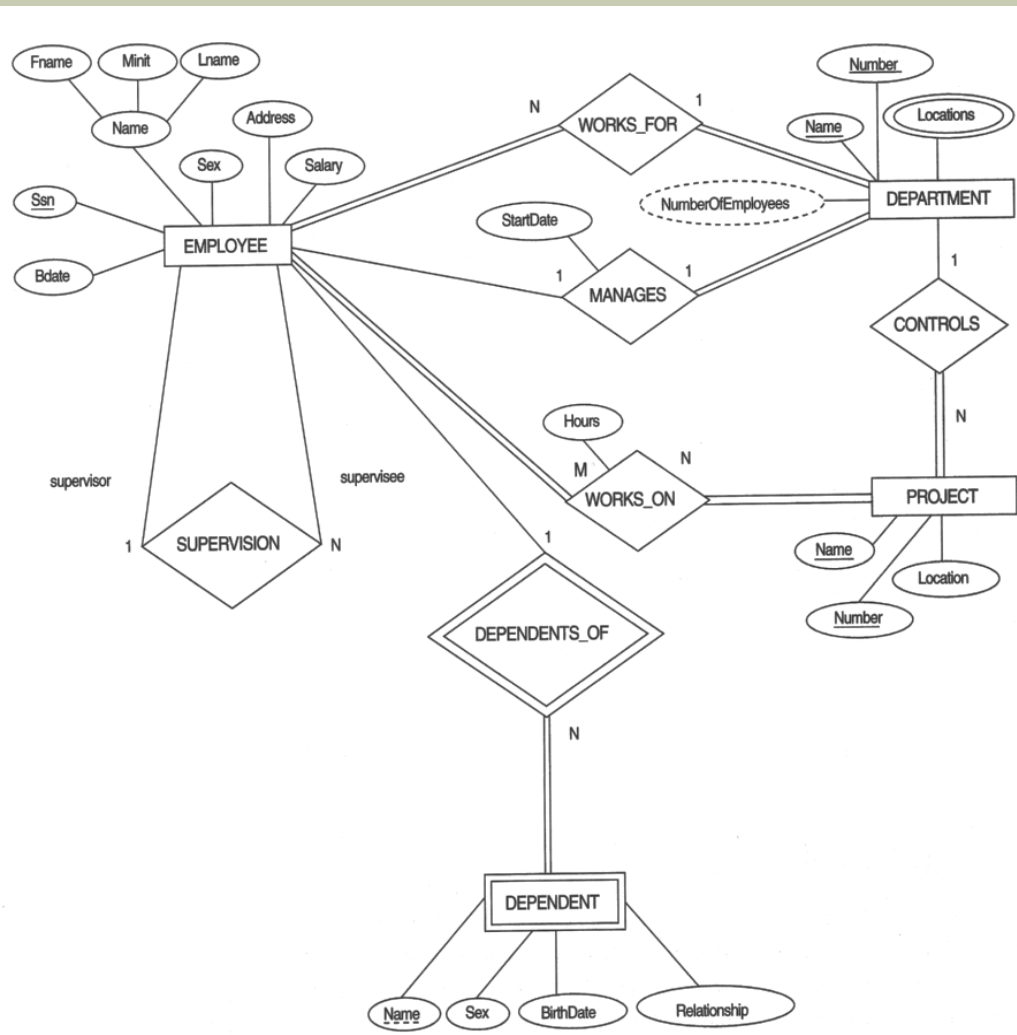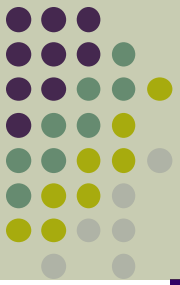# The ER conceptual schema diagram for the COMPANY database.

Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

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Weak Entity Types

Mapping of Weak Entity Types

- For weak entity type W with owner entity type E, **set up a relation R** & include all simple attributes into R.

- Include as foreign key of R the primary key attribute(s) of relation(s) that correspond to the owner entity type(s).

- Primary key of R is the *combination of* the primary key(s) of the owner(s) and the partial key of the weak entity type W, if any.

- **Ex: rel** DEPENDENT for weak entity type DEPENDENT.
  - Include SSN of EMPLOYEE relation as foreign key attribute of DEPENDENT (renamed to ESSN).
  - primary key of DEPENDENT relation is combination {ESSN, DEPENDENT_NAME} because DEPENDENT_NAME is partial key of DEPENDENT.

FIGURE 7.1 *from elmasri navathe*

The ER conceptual schema diagram for the COMPANY database.

Figure 7.2
Result of mapping the COMPANY ER
schema into a relational database schema.
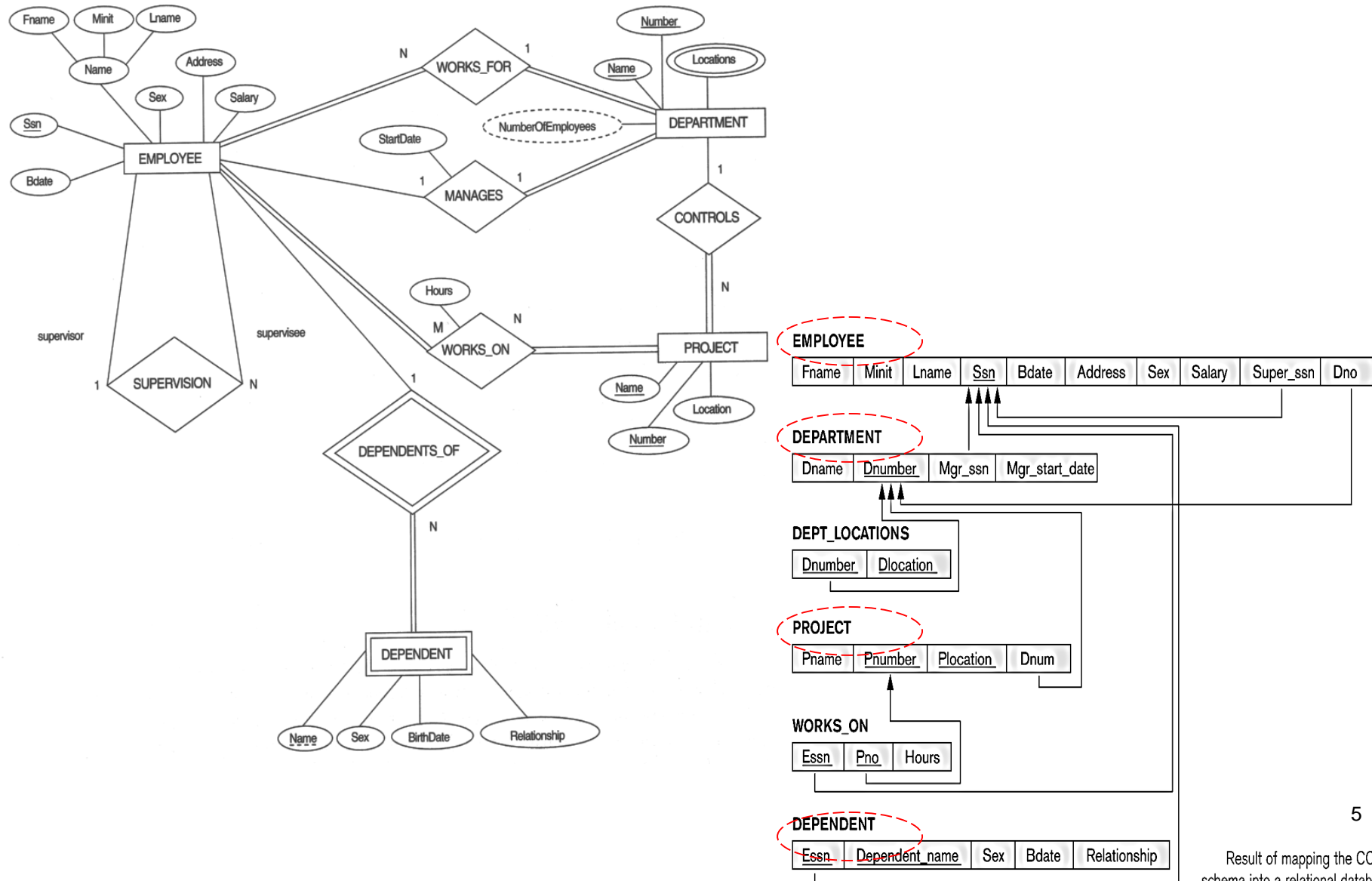
ER-to-Relational Mapping Algorithm

- **Step 3: Mapping of Binary 1:1 Relation Types**
  - For each binary 1:1 relationship type R in ER schema, identify relations S and T, entity types participating in R.
- One approach (**Foreign Key approach**):
  - Choose one of relations -say S- and include as a foreign key in S the primary key of T. <u>It is better to choose an entity type with total participation in R in the role of S. (WHY?)</u>

  - Example: 1-to-1 relation MANAGES is mapped by choosing the participating entity type DEPARTMENT to serve in the role of S, because its participation in the MANAGES relationship type is total.
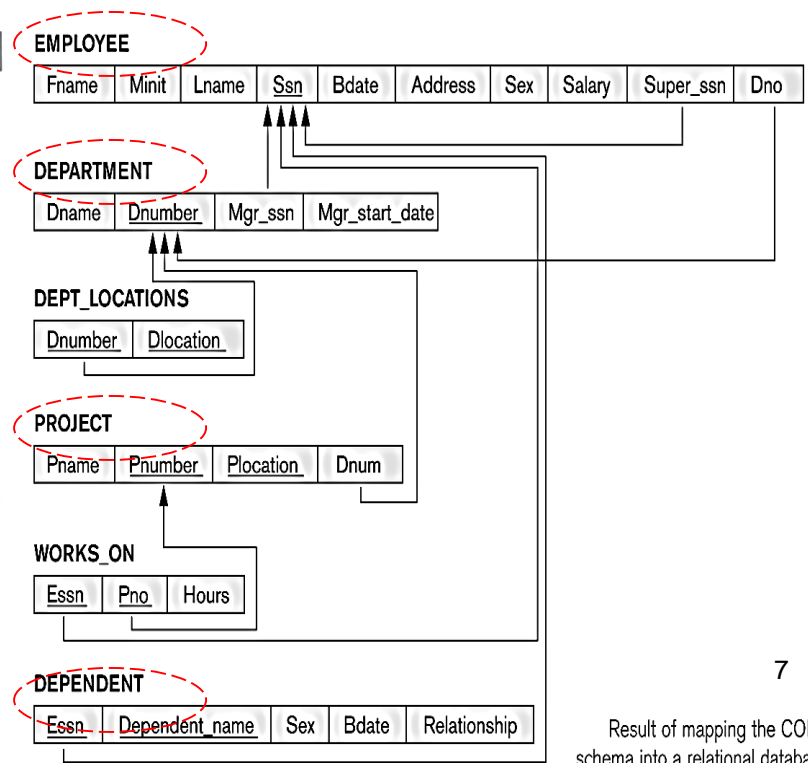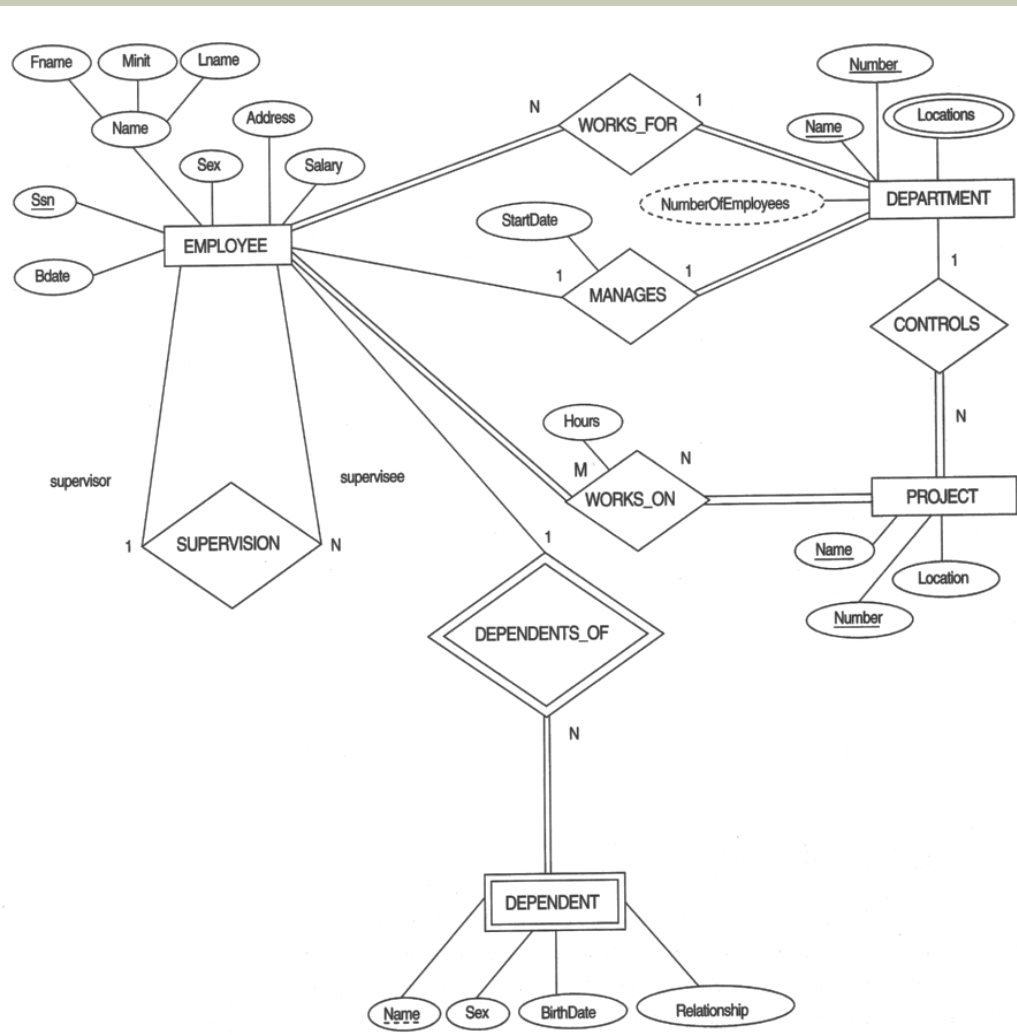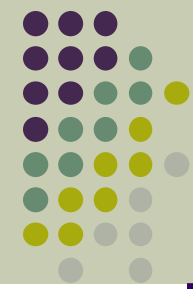
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Figure 7.2
Result of mapping the COMPANY ER
schema into a relational database schema.

ER-to-Relational Mapping Algorithm

Step 4: Mapping of Binary 1:N Relationship Types.

- For each regular binary 1:N relationship type R (*from T to S*), identify the relation S that represent the participating entity type at the N-side of the relationship type.

- Include as foreign key in S the primary key of the relation T that represents the other entity type participating in R.

- Include any simple attributes of the 1:N relation type as attributes of S.

Example: 1-to-N relationship types WORKS_FOR, CONTROLS, and SUPERVISION in the figure.

- For WORKS_FOR we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the EMPLOYEE relation and call it DNO.

FIGURE 7.1 *from elmasri navathe*

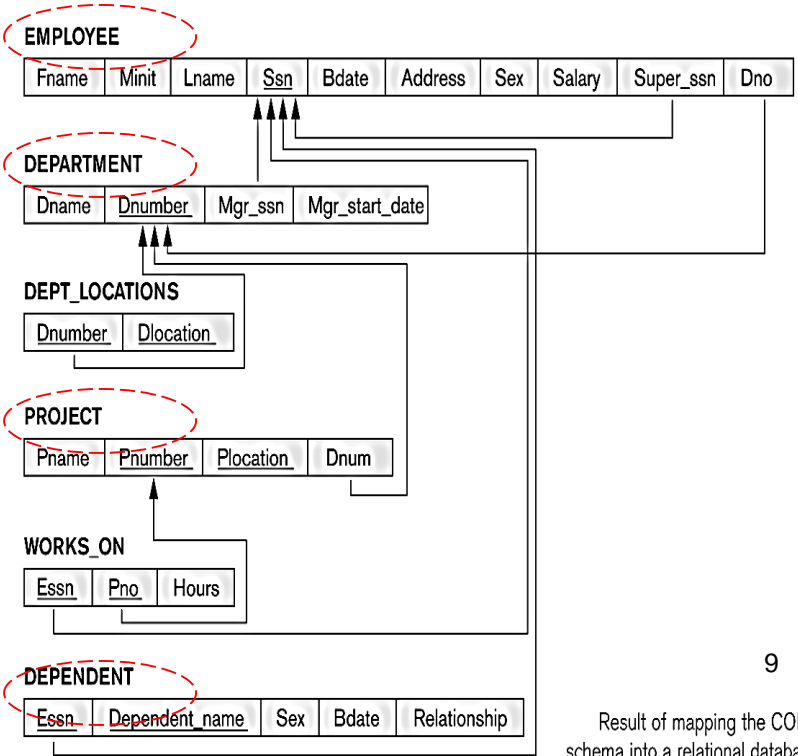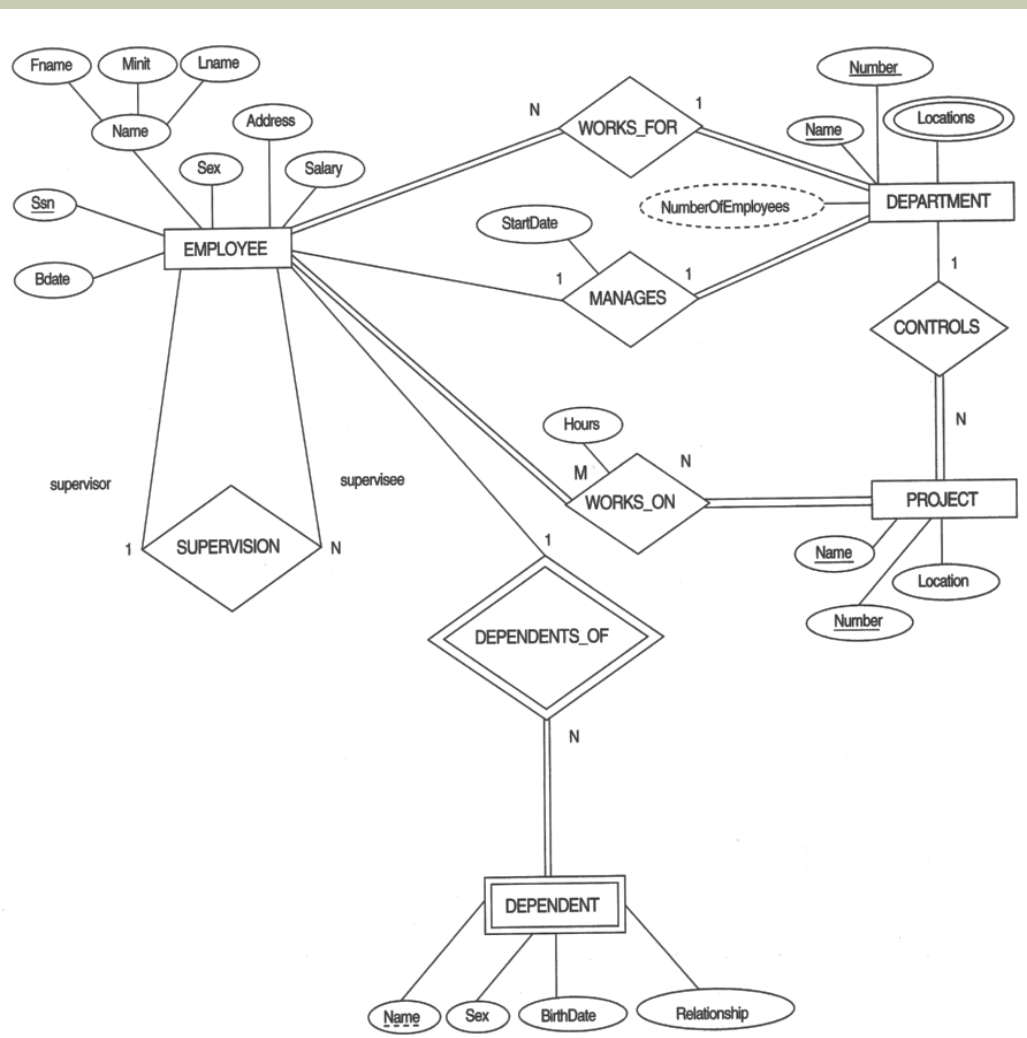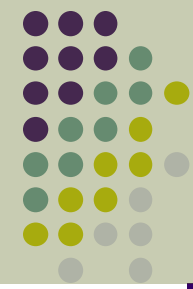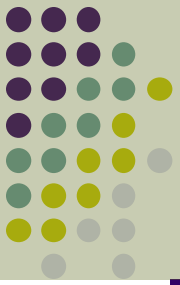# The ER conceptual schema diagram for the COMPANY database.

Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

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M:N Relationship Types

Step 5: **Mapping of Binary M:N Relationship Types.**

- For each regular binary M:N relationship type R, ***set up a new relation S*** to represent R.

- Include as foreign key attributes in S primary keys of the relations that represent participating entity types; *they form primary key* of S.

- Include any simple attributes of the M:N relationship type (or simple components of composite attributes) as attributes of S.

- Example: The M:N relationship type WORKS_ON from the ER diagram is mapped by creating a relation WORKS_ON in the relational database schema.

- The primary keys of the PROJECT and EMPLOYEE relations are included as foreign keys in WORKS_ON and renamed PNO and ESSN, respectively. Attribute HOURS in WORKS_ON represents the HOURS attribute of relation type. The primary key of the WORKS_ON relation is combination of the foreign key attributes {ESSN, PNO}.

FIGURE 7.1 *from elmasri navathe*

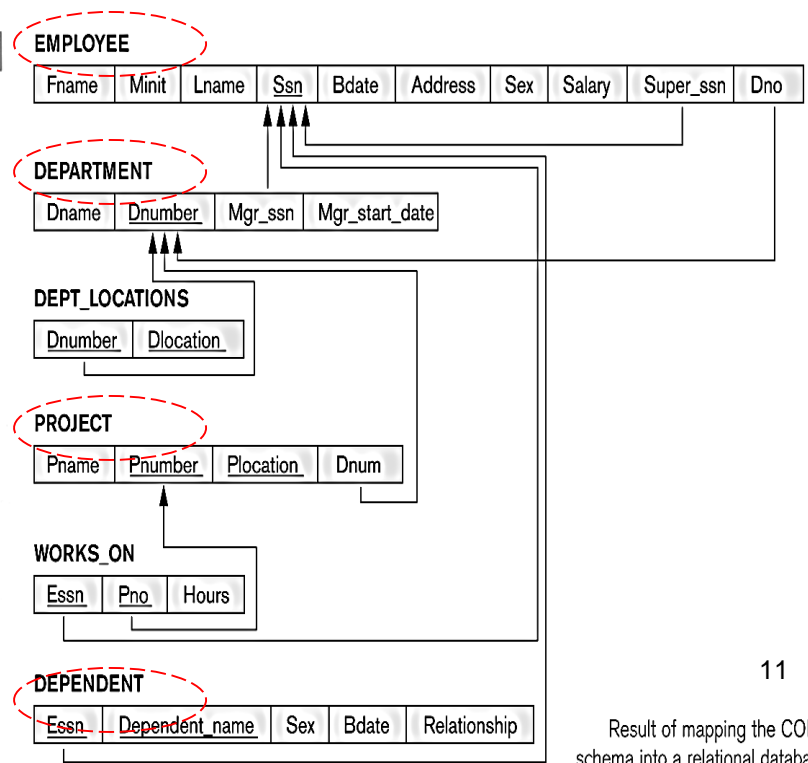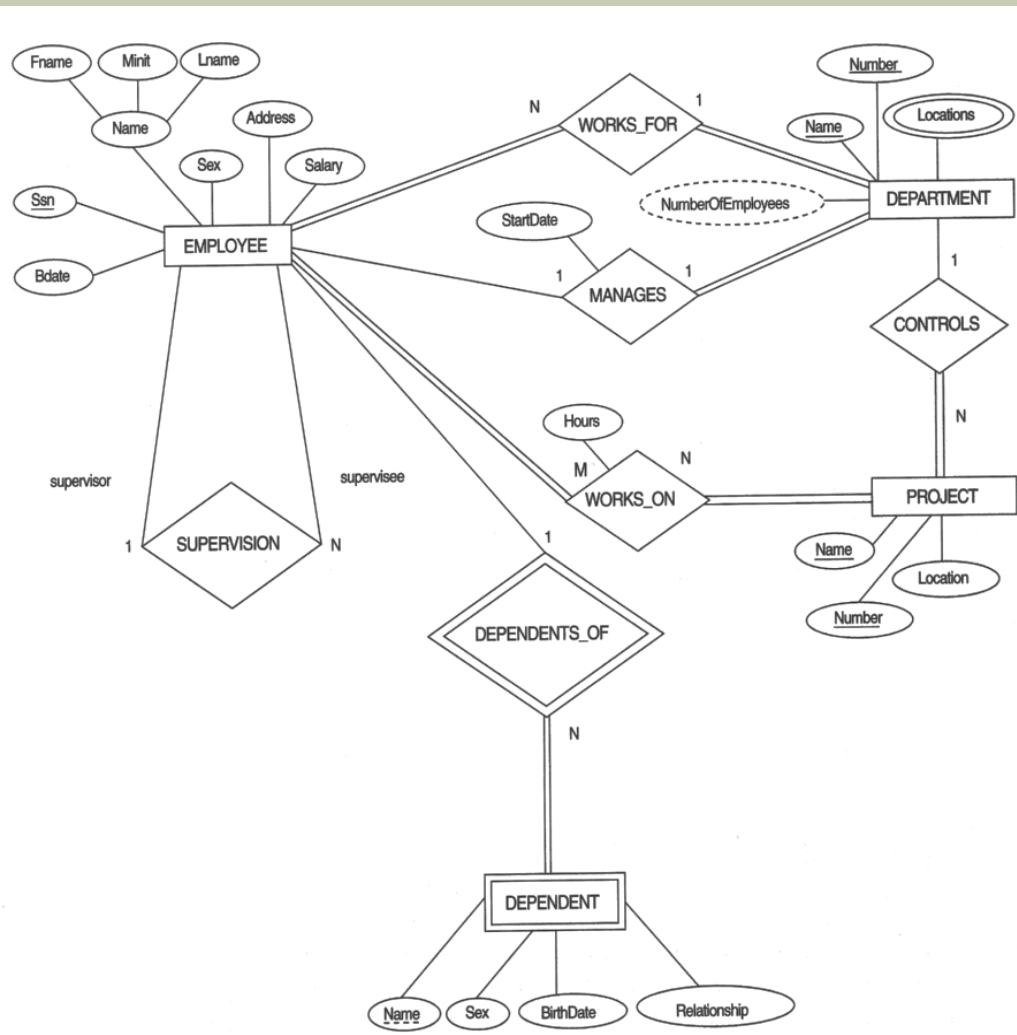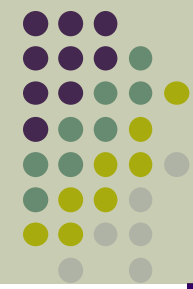# The ER conceptual schema diagram for the COMPANY database.

Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

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ER-to-Relational Mapping Algorithm

- **Step 6: Mapping of Multivalued attributes.**
  - For each multivalued attribute A, <u>**set up a new relation R**</u>.
  - This relation R will include an attribute corresponding to A, plus the primary key attribute K-as a foreign key in R-of the relation that represents the entity type of relationship type that has A as an attribute.
  - The primary key of R is the combination of A and K. If the multivalued attribute is composite, we include its simple components.

  - **Example:** The relation DEPT_LOCATIONS is created.
    Attribute DLOCATION represents multivalued attribute LOCATIONS of DEPARTMENT,
    while DNUMBER-as foreign key-represents the primary key of the DEPARTMENT relation.
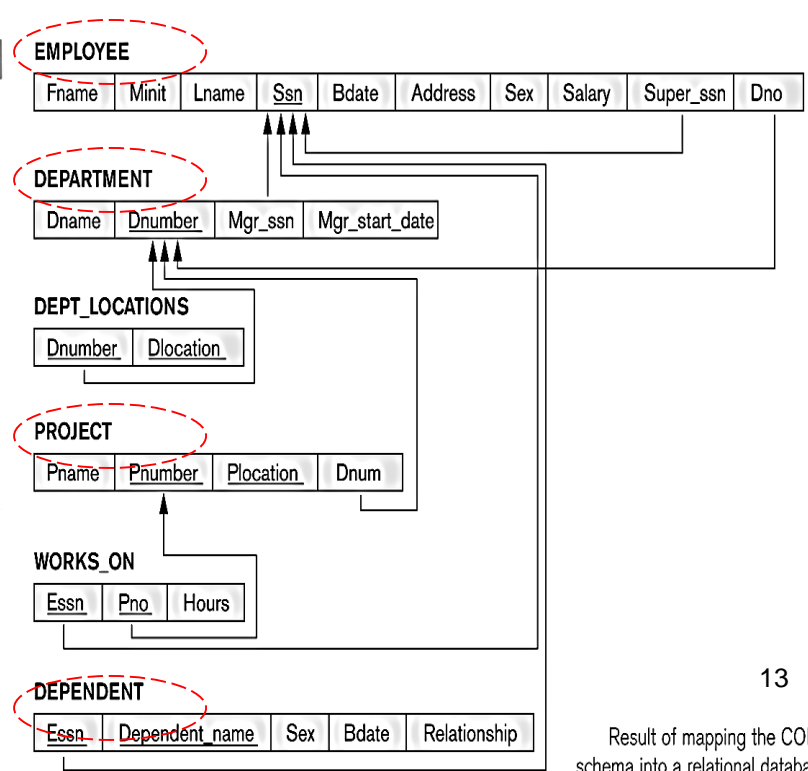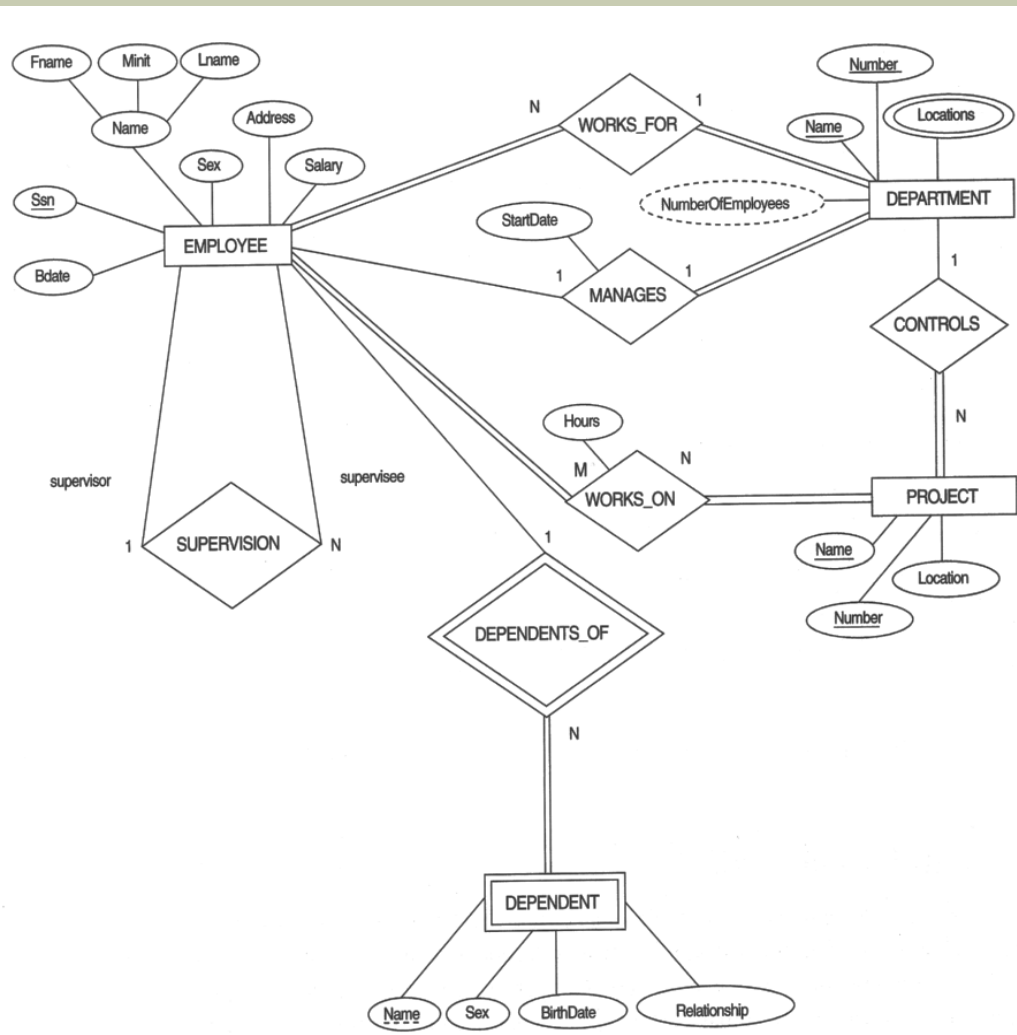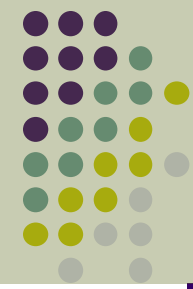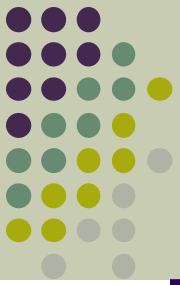 - The primary key of R is the combination of {DNUMBER, DLOCATION}.

Figure 7.2
Result of mapping the COMPANY ER schema into a relational database schema.

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N-ary Relationship Types

- ## **Step 7**: **Mapping of N-ary Relationship Types.**
  - For each n-ary relationship type R, where n>2, **set up a new relation** S to represent R.
  - Include as <u>foreign key attributes</u> in S the primary keys of the relations that represent the participating entity types.
  - Also include any simple attributes of the n-ary relationship type (or simple components of composite attributes) as attributes of S.

  - **Example:** The relationship type SUPPY in the ER on the next slide.

    This can be mapped to the relation SUPPLY shown in the relational schema, whose primary key is the combination of the three foreign keys {SNAME, PARTNO, PROJNAME} in case the cardinalities are N:N:N
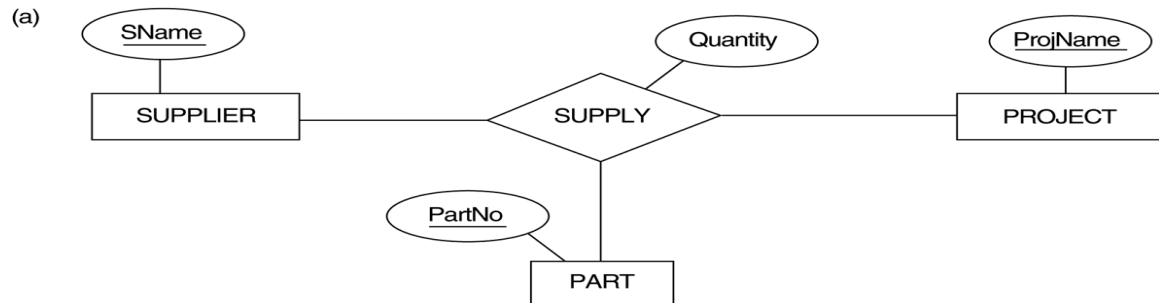
Note that PK depends on the cardinalities of SUPPLY

Summary of Mapping constructs and constraints

Table 7.1 Correspondence between ER and Relational Models

ER Model	Relational Model
Entity type	"Entity" relation
1:1 or 1:N relationship type	Foreign key (or "relationship" relation)
M:N relationship type	"Relationship" relation and two foreign keys
n-ary relationship type	"Relationship" relation and n foreign keys
Simple attribute	Attribute
Composite attribute	Set of simple component attributes
Multivalued attribute	Relation and foreign key
Value set	Domain
Key attribute	Primary (or secondary) key

Example-1

- Dünya üzerindeki gemi limanları ve gemi hareketlerini tutan bir veri tabanı tasarımı.
- Limanların hangi ülkede hangi okyanusta olduğu saklanıyor. Limanların sadece isimleri saklanıyor. Farklı ülkelerde aynı isimde limanlar olabilir.
- **Bir geminin bir limanı ziyaret ile ilgili sadece giriş ve çıkış tarihleri saklanmalı. Gemi aynı limana çok defalar uğrayabilir**. Her geminin bağlı olduğu bir liman vardır.
- Gemilerin tipleri *(denizaltı, yolcu, tekne, savaş gemisi gibi.)* var, hangi tiplerin varolduğu listelenebilmeli..
- Gemi hareketleri, geminin tarihçesi ile tutulmalı. Bu tarihçe bilgisi geminin hangi gün va zamanda hangi enlem boylamda bulunduğu bilgilerinden örnekler saklamaktadır. Gemi tabiki aynı noktada farklı zamanlarda bulunabilir.
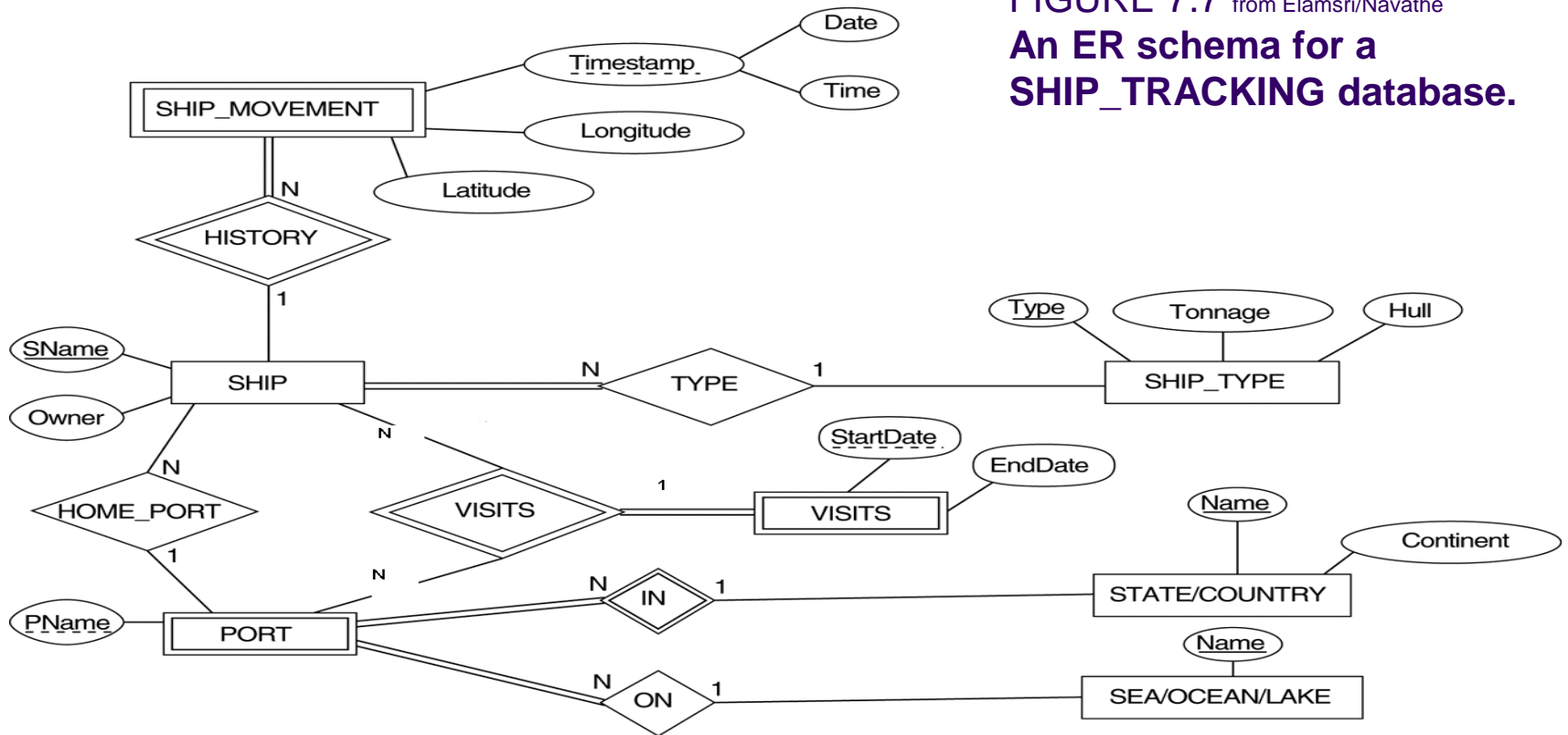
Example-1: ER

FIGURE 7.7 from Elamsri/Navathe
An ER schema for a SHIP_TRACKING database.

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Example-1: Relations

SHIP [Sname, Owner, scName, Pname, Type]

PORT[scName, Pname, solName]

STATE/COUNTRY [Name, Continent]

SEA/OCEAN/LAKE [Name]

SHIP_MOVEMENT [Sname, Date, Time, Longitude, Latitude]

SHIP_TYPE [Type, Tonnage, Hull]

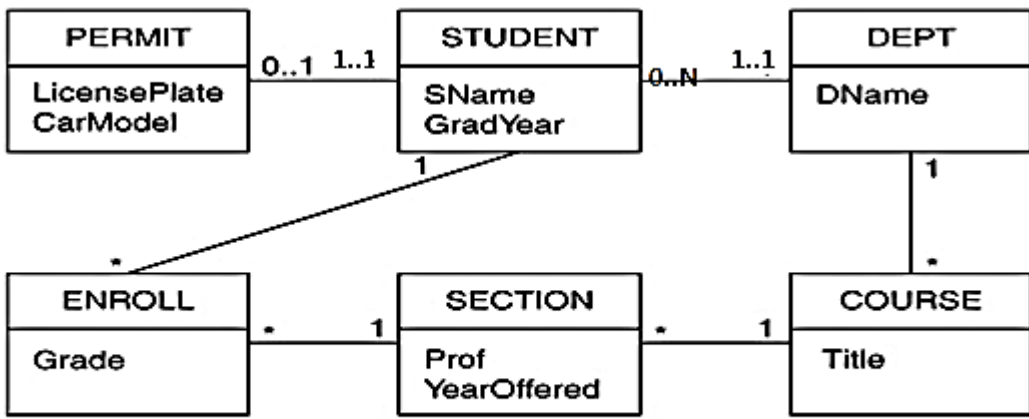VISITS [scName, Pname, Sname, startDate, EndDate]

Example-2

Figure 3-1
A class diagram for the university database

PERMIT(PermitId, LicensePlate, CarModel, *StudentId*)
STUDENT(SId, SName, GradYear, *MajorId*)
DEPT(DId, DName)
ENROLL(EId, Grade, *StudentId*, *SectionId*)
SECTION(SectId, YearOffered, Prof, *CourseId*)
COURSE(CId, Title, *DeptId*)

PERMIT(*StudentId*, LicensePlate, CarModel)
STUDENT(SId, SName, GradYear, *MajorName*)
DEPT(DName)
ENROLL(*StudentId*, *SectionId*, Grade)
SECTION(SectId, YearOffered, Prof, Title)
COURSE(Title, *DeptName*)