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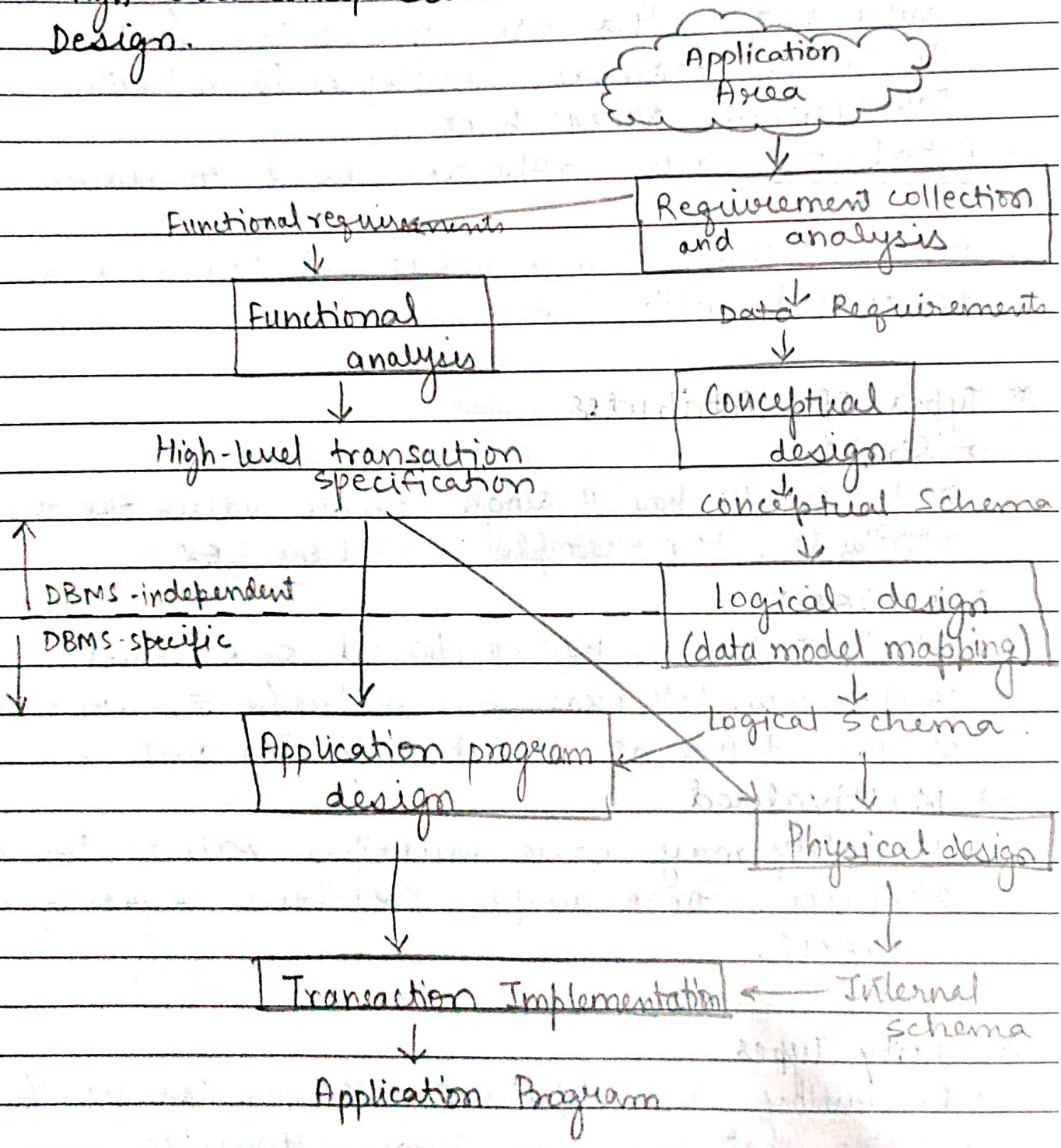
Chapter -3
Data Modeling Using the Entity-Relationship (ER) Model.

* High-level Conceptual Data Models for Database Design.



* Read section 3.1 from book. for the description of the diagram.

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* Entities and Attributes.
  - Basic ~~model~~ concept represented by the ER model is entity.
  - Entities are specific objects or things in the mini-world that are represented in the database. Example: Employee John Smith, Department Research, etc.
  - Attributes are properties used to describe an entity.
  - Each attribute has a value set (or data type) associated with it.

* Types of Attributes
  → Simple
  Each entity has a single atomic value for the attribute. For example: SSN or SEX.
  → Composite
  Attribute may be composed of several components. For example: Address ⇒ It consists of the House no, Street, City, Zip Code.
  → Multivalued
  An entity may have multiple values for that attribute. For example Previous Degree of a STUDENT.

* Entity Types
  - An entity type defines a collection (or set) of entities that have the same attributes.
  - An entity type is represented in ER diagrams as a rectangular box.

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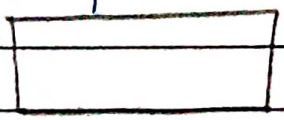
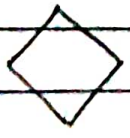
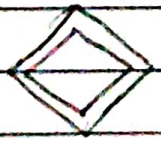
* Entity Set
  - The collection of all entities of a particular entity type in the database at any point in time is called an entity set or entity collection.

- Attribute names are enclosed in ovals and attached to entity type by a straight line.
- Multivalued attributes are enclosed in double ovals.

* Key attributes of an Entity Type.
- An entity type usually has one or more attributes whose values are distinct for each individual entity in the entity set. This attribute is called a key attribute.
- In ERD notation, each key attribute has its name underlined.
- A key attribute may be composite.

ER - Diagram Notations

Symbol	Meaning.
	Entity - Type
	Weak Entity Type
	Relationship Type
	Identifying Relationship Type
	Attribute

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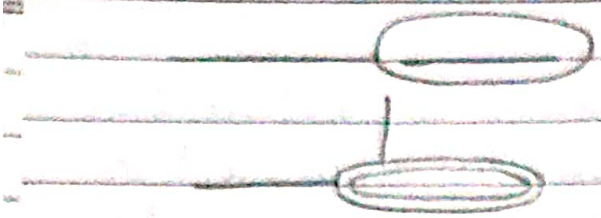


Key Attribute

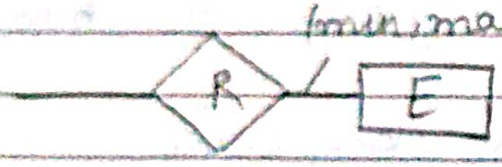
Multivalued Attribute

Composite Attribute

Derived Attribute

Total participation of E_2 in R

Cardinality Ratio 1:N for $E_1 : E_2$ in R

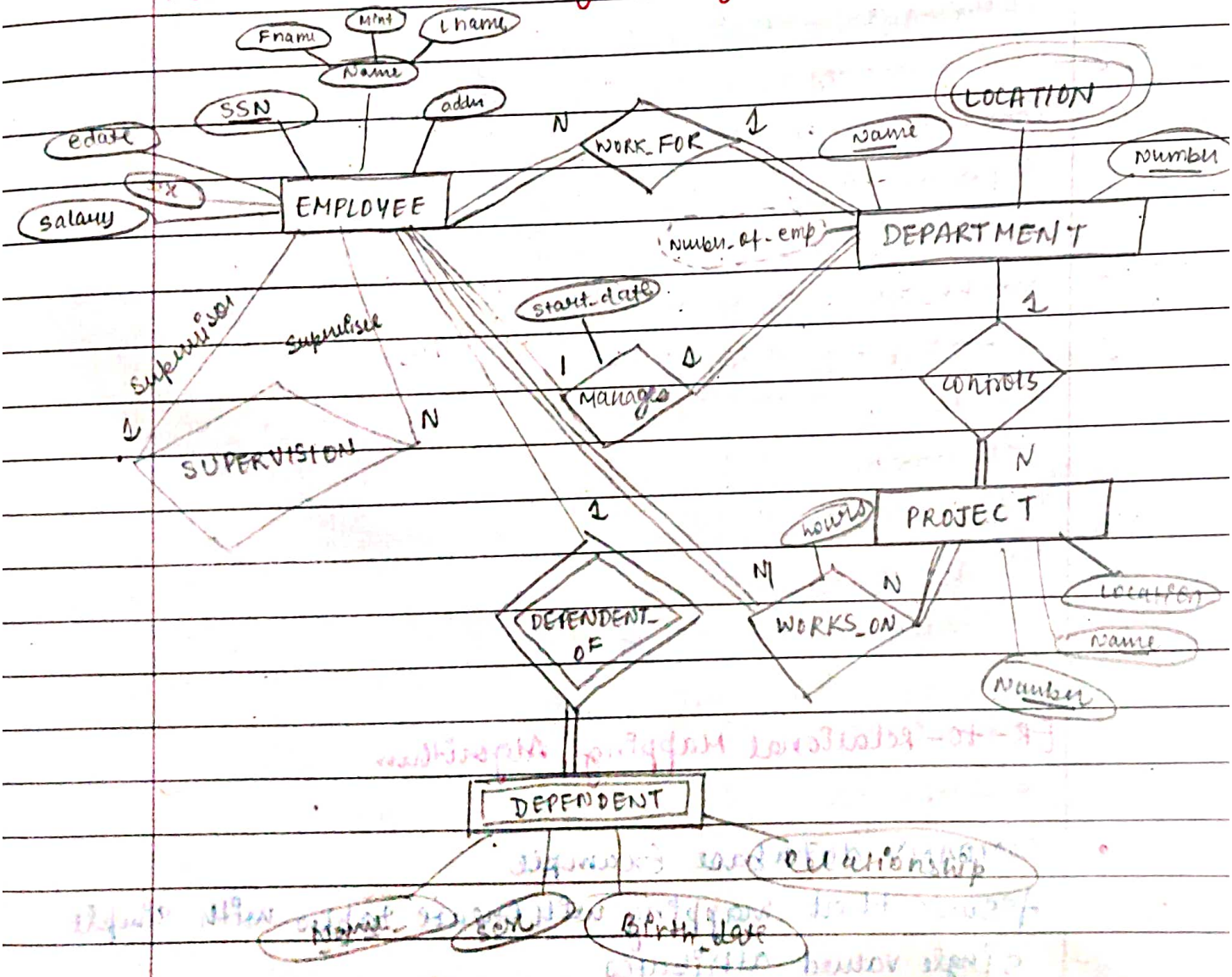


Structural Constraint (min,max) on Participation E in R.

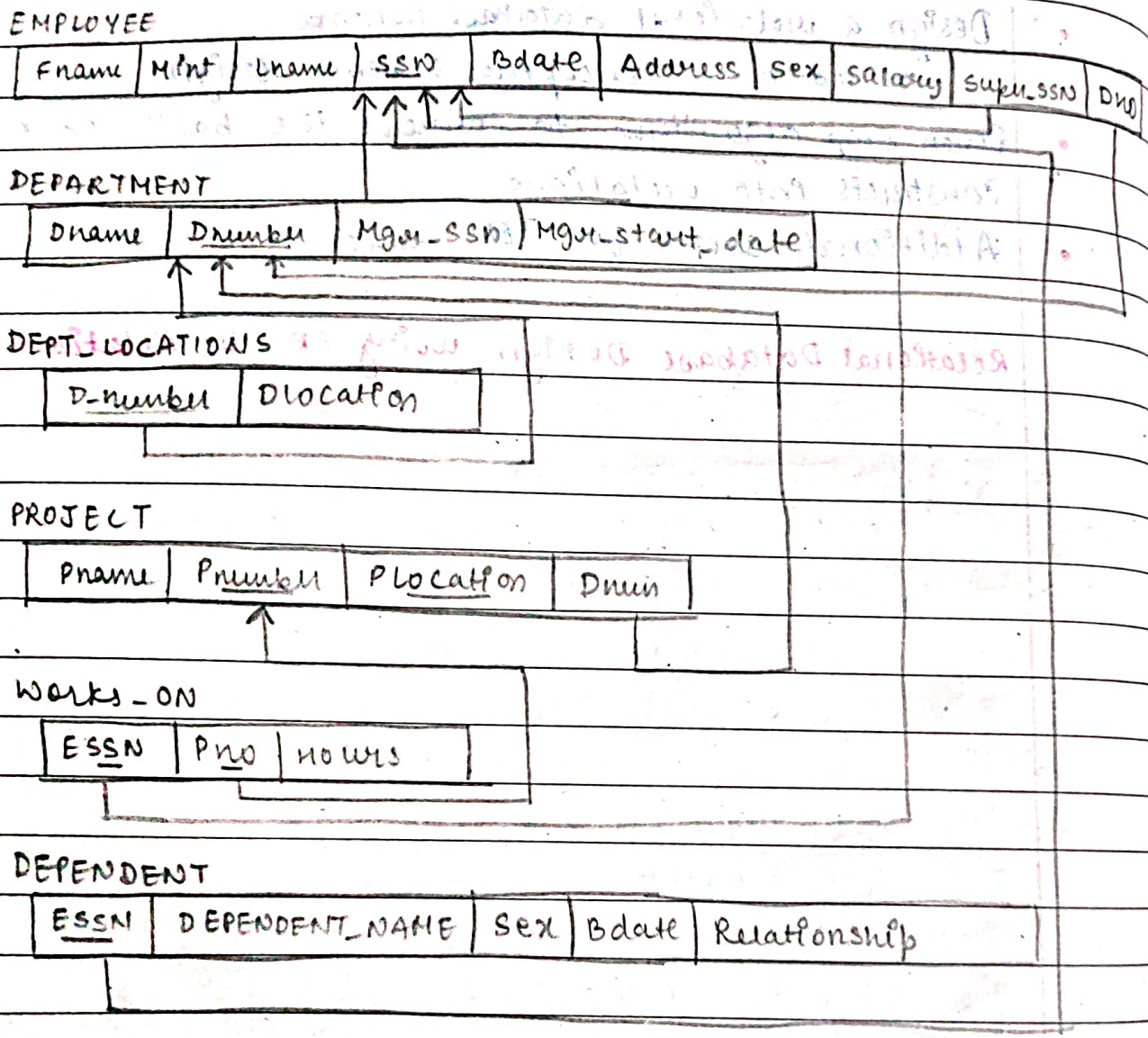
Relational Database Design by ER- and EER to Relational Mapping

- Design a relational database schema
  Based on a conceptual schema design
- Seven step algorithm to convert the basic ER model constructs into relations
- Additional steps for EER model.

Relational Database Design using ER-to-Relational Mapping



Result of mapping the COMPANY ER schema into a relational database schema



ER-to-Relational Mapping Algorithm

- COMPANY database Example
  Assume that mapping will create tables with simple single valued attributes
- **Step 1 :** Mapping of Regular Entity Types
  For each regular entity type, create a relation R that includes all the simple attribute of E
  → Called entity relation

→ Each tuple represent an entity instance.

Step 2: Mapping of weak Entity types

→ For each weak entity type, create a relation R and include all simple attributes of the entity type as attributes of R

→ Include primary key attribute of owner as foreign key attributes of R

Step 3: Mapping of Binary 1:1 Relationship types

→ For each binary 1:1 relationship type identify relations that correspond to entity types participating in R

→ Possible approaches:

- Foreign key approach
- Merged relationship approach
- Crossreference or relationship relation approach

Step 4: Mapping of Binary 1:N Relationship types

→ For each regular binary 1:N relationship type

- Identify relation that represents participating entity type at N-side of relationship type
- Include primary key of other entity type as foreign key in S
- Include simple attributes of 1:N relationship type as attributes of S.

→ Alternative approach

- use the relationship relation (cross-reference) option as in the third option for binary 1:1 relationships.

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Step 5 : Mapping of Binary M : N relationship types

→ For each binary M : N relationship type
- create a new relations
- Include primary key of participating entity types as foreign key attributes in S
- Include any simple attributes of M : N relationship type

Step 6 : Mapping of Multivalued attributes

→ For each multivalued attributes
- create a new relation
- Primary key of R is the combination of A and K.
- If the multivalued attribute is composite, include its simple components

Step 7 : Mapping of N-ary relationship Types

→ For each n-ary relationship type R
- create a new relation S to represent R
- Include primary key of participating entity type as foreign key
- Include any simple attribute as attributes

Discussion and Summary of Mapping for ER model constructs

ER MODEL	RELATIONAL MODEL
Entity type	Entity relation
1 : 1 or 1 : N relationship	Foreign key
M : N relationship	Relationship relation & 2 foreign key
n-ary relationship	Relationship relation & n foreign key
simple attribute	attribute
Composite attribute	Set of simple component attribute
Multivalued attribute	Relation and foreign key
Value set	Domain
Key attribute	Primary (or secondary) key

- In a relational schema relationship types are not represented explicitly
- Represented by having two attributes A and B: one a primary key and other a foreign key

Mapping EER Model constructs to Relations

Extending ER-to-relational mapping algorithm

Mapping of Specialization or Generalization

Step 8: Option for Mapping Specialization or Generalization

- **Option 8A:** Multiple relations - Superclass & subclasses
  → For any specialization (total or partial, disjoint or overlapping)
- **Option 8B:** Multiple relations - subclass relation only
  → Subclasses are total
  → Specialization has disjointedness constraint.
- **Option 8C:** Single relation with one type attribute
  → Type or discriminating attribute indicates subclass of tuple
  → Subclasses are disjoint
  Potential for generating many NULL values if many specific attributes exist in the subclasses
- **Option 8D:** Single relation with multiple type attribute
  → Subclasses are overlapping
  → Will also work for a disjoint specialization

Mapping of Shared Subclasses (Multiple Inheritance)

Apply any of the options discussed in step 8 to a shared class.

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Mapping of categories (Union Types)

Step 9: Mapping of Union Types (categories)

→ Defining superclasses have different keys

→ Specify a new key attribute

- Surrogate key