COMPUTER SCIENCE

Database Management System

ER Model

Lecture_3

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TOPICS TO BE COVERED
01
Foreign Key Concepts
02
ER to RDBMS Conversions

ER MODEL Concept

Foreign key Concept

Referential Integrity Constraints.

Referenced Relation

1. ON DELETE NO ACTION
2. ON DELETE CASCADE
3. ON DELETE SET NULL.

ERMODEL ⟶ RDBMS.

In ER MODEL

Multivalued Attribute
Composite Attribute
Weak Entity Concept

In RDBMS

No Multivalued Attribute
No Composite Attribute
No Weak entity Concept

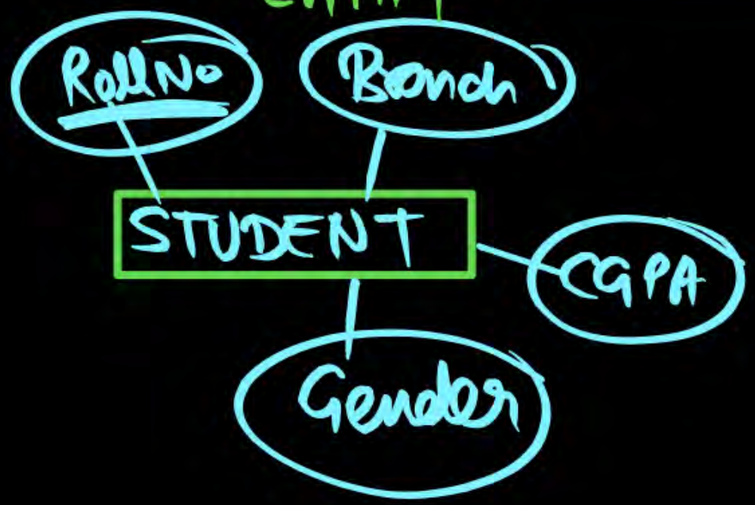
ERMODEL → RDBMS.

1

Entity set → Relation (Table)

key Attribute → Primary key

Entity → Table

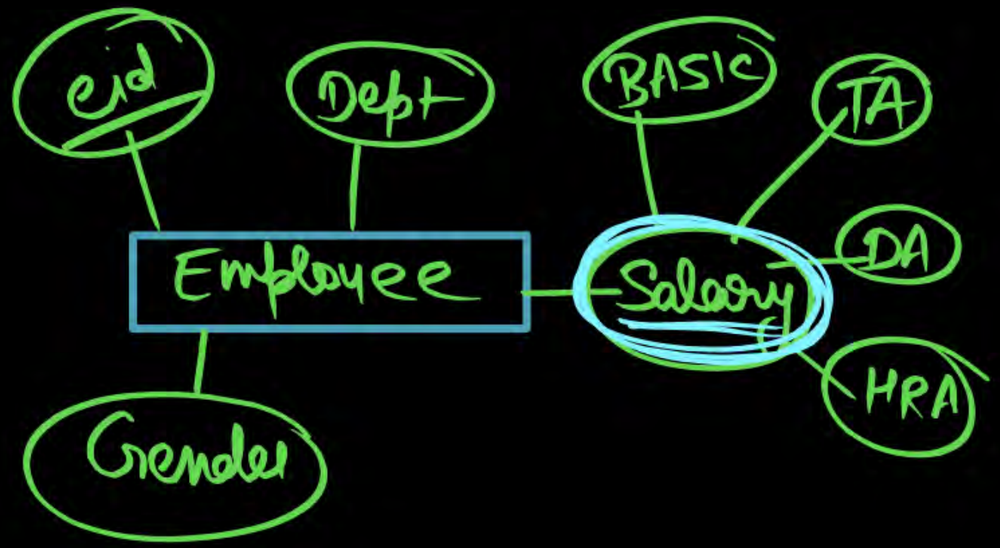


STUDENT

RollNo	Branch	CGPA	Gender

ERMODEL → RDBMS.

2. Composite Attribute → Set of Simple Component.



Employee.

eid	Dept	Gender	Basic	TA	DA	HRA

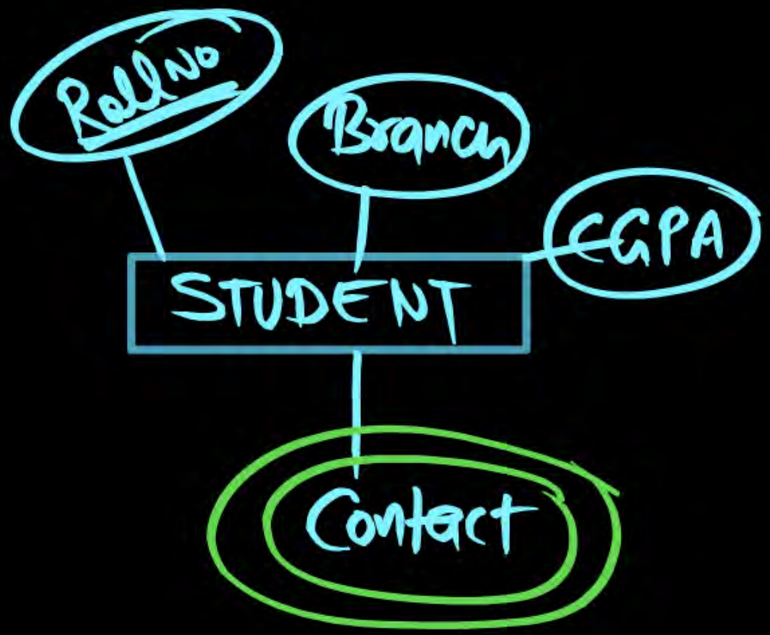
ERMODEL → RDBMS.

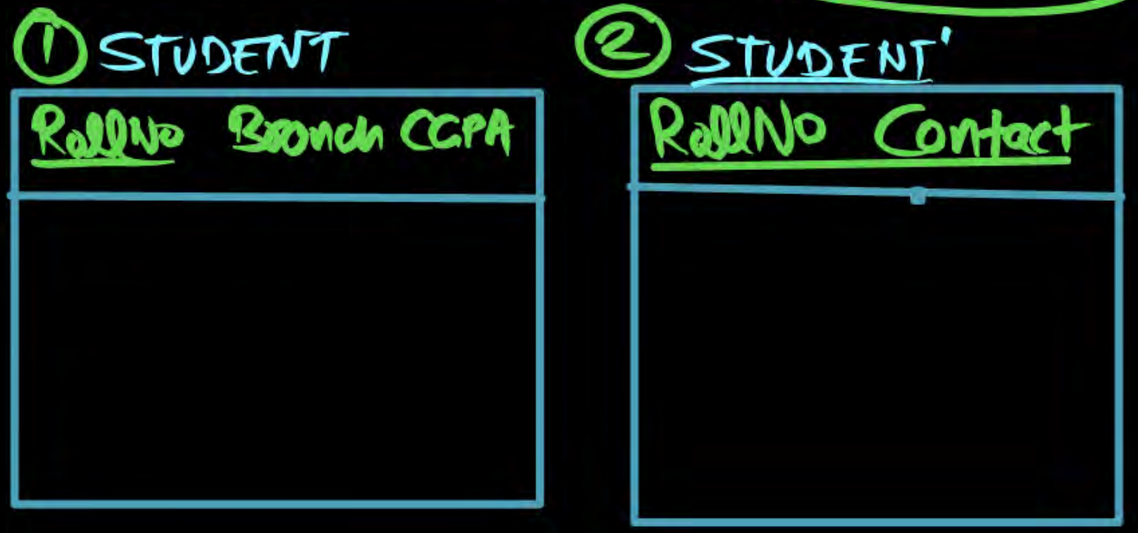
(3) Multivalued Attribute.

→ 2 Table

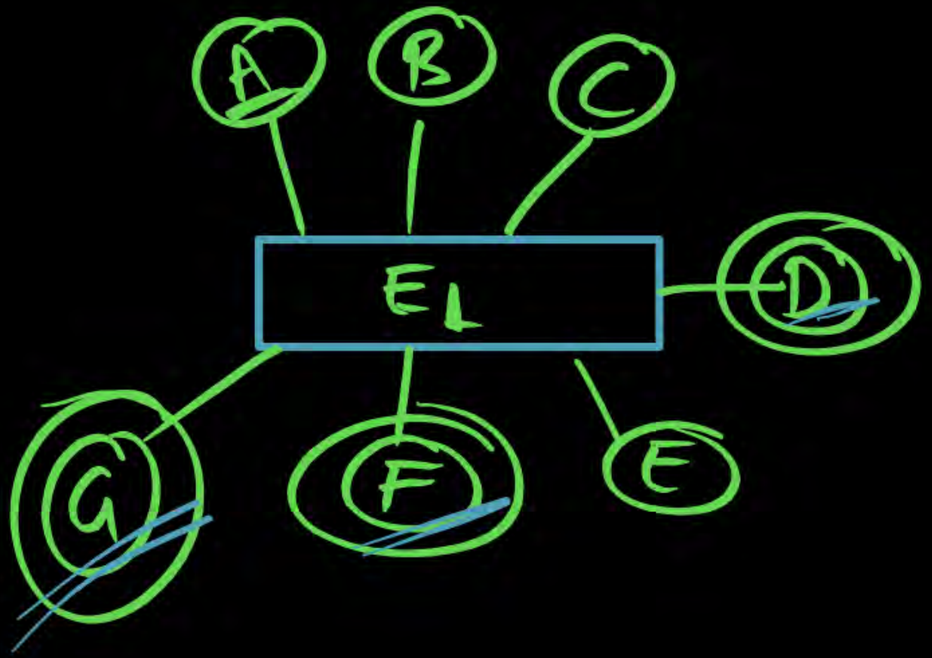
① key Attribute + All other Attribute

② key Attribute + ALL Multivalued Attribute

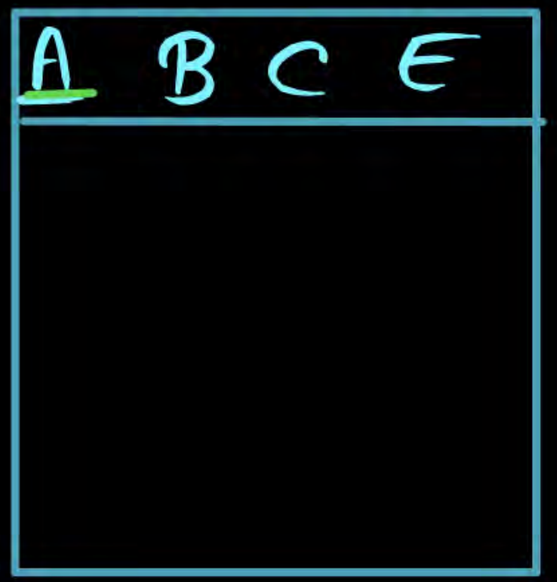


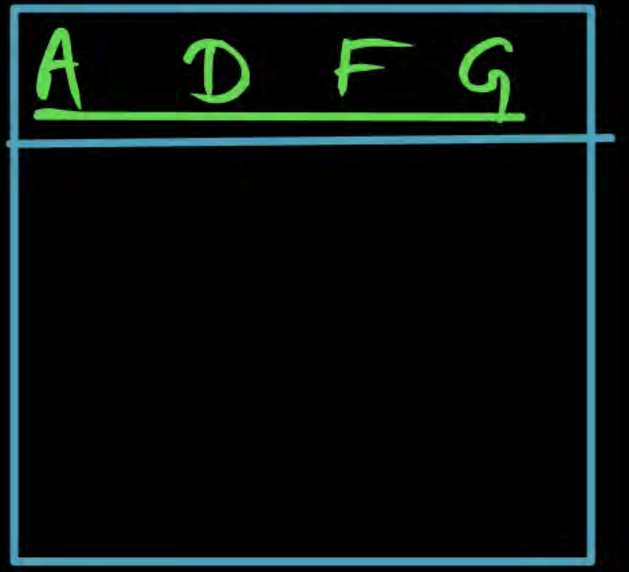


ERMODEL ⟶ RDBMS.



2 Table





ERMODEL ⟶ RDBMS.

① Entity Set ⟶ Relation.

② Composite Attribute ⟶ Set of Simple Component

③ Multivalued Attribute ⟶ 2 Table
- ⟶ key + All other Attribute
- ⟶ key + All Multivalued Attribute.

ER to RDBMS conversion.

ER		RDBMS
① One to Many (1:M)	⟶	2 Table Required (Relationship set Merge with many side)
② Many to One (M:1)	⟶	2 Table Required (Relationship set merge with many side)
③ Many to Many (M:N)	⟶	3 Table Required (Separate Table for Relationship set)
④ One to One (1:1)	⟶	2 Table Required (Relationship set merge any side)

ER to RDBMS conversion.

2 Table Required

F.k

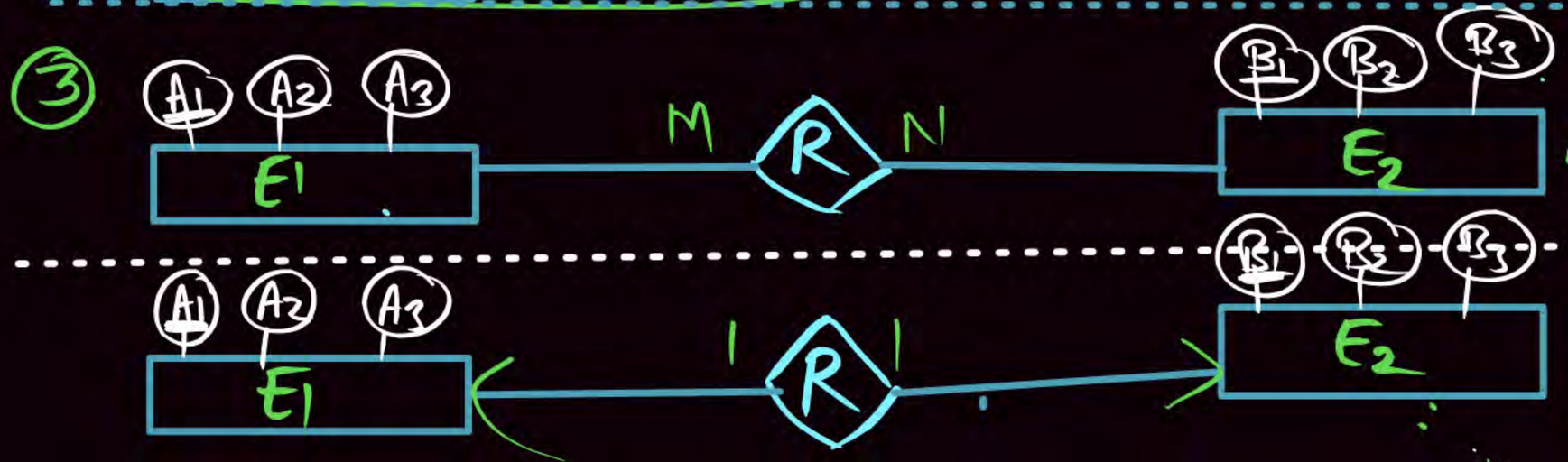
$E_1(\underline{A_1}\ A_2\ A_3)$ $RE_2(\underline{B_1}\ B_2\ B_3\ A_1)$

& 1 foreign key

2 Table Required & 1 Foreign key.

F.k

$E_1R(\underline{A_1}\ A_2\ A_3\ \underline{B_1})$ $E_2(\underline{B_1}\ B_2\ B_3)$



3 Table Required & 2 Foreign key

F.k F.k

$E_1(\underline{A_1}\ A_2\ A_3)$ $R(\underline{A_1}\ \underline{B_1})$ $E_2(\underline{B_1}\ B_2\ B_3)$

2 Table Required & 1 Foreign key.

$E_1R(A_1\ A_2\ A_3\ B_1)$ & $E_2(B_1\ B_2\ B_3)$

OR

$E_1(A_1\ A_2\ A_3)$ & $RE_2(B_1\ B_2\ B_3\ A_1)$

1 : M
M : 1
} 2 Table & Relationship set Merge with many side.

M : N } 3 Table & Separate Table for Relationship set

1 : 1 } 2 Table & Relationship merge with Any side

Participation Constraint

1. Partial Participation (—)
2. Total / FULL Participation (═)

Double Line

(I) Partial Participation.

ER to RDBMS conversion.

2 Table

FK

$E_1(\underline{a_1}\, a_2)$ $RE_2(\underline{b_1}\, b_2\, a_1)$

2 Table F.k

$E_1R(\underline{a_1}\, a_2\, b_1)$ $E_2(\underline{b_1}\, b_2)$

2 table F.k F.k

$E_1R(a_1\, a_2\, b_1)$ & $E_2(b_1\, b_2)$

OR

$E_1(a_1\, a_2)$ & $RE_2(b_1\, b_2\, \underline{a_1})$

3 Table $E_1(\underline{a_1}\, a_2)$ $R(\underline{a_1}\, \underline{b_1})$ $E_2(\underline{b_1}\, b_2)$

(II) Total (Full) Participation (═)

ER to RDBMS conversion. [1:M]

1 to many

① 

2 Table.

---

② 

2 Table

③ 

1 Table

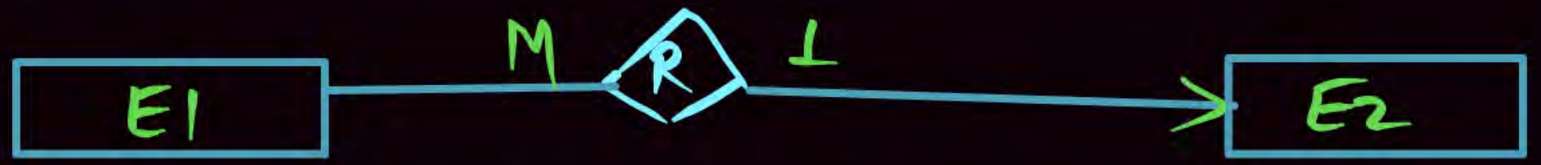
---

④ 

1 Table.

ER to RDBMS conversion. [M:1]

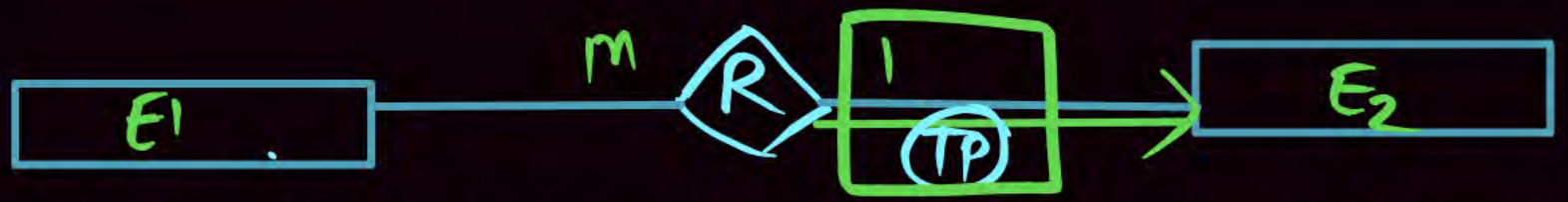
Many to 1

① 

2 Table

② 

2 Table

③ 

1 Table

④ 

1 Table

ER to RDBMS conversion. [1:1]

One to One

① 

2 Table.

---

② 

1 Table

③ 

1 Table

---

④ 

1 Table.

ER to RDBMS conversion. [M:N]

many to many.

① 

3 Table.

---

② 

2 Table

③ 

2 Table

---

④ 

1 Table.

Summary.

Note

① If Total Participation (=) at both side (in 1:M, M:1, 1:1 & M:N) then Only 1 Table (Relation) Required.

② If Total Participation at 'One Side' (in 1 to M, 1:1 & M to 1) then Only 1 Table (Relation) Required.

③ If Total Participation at any of One Side in Many to Many then 2 Table (2 Relation) are Required

④ All other Case are Same as Normal Case (As usual).

Q.

The term in list A have been mapped to list B so that is corresponds to the mapping process of ER MODEL into relational. Which of the following represent the mapping process? [MCQ]

List-A	List-B
A. Entity type – 4	1. Primary key (or alternate key)
B. Key attributes – 1	2. Child table
C. Composite attribute - 3	3. Set of simple component attributes
D. Multivalued attribute -2	4. Relation

A. A-3, B-1, C-4, D-2

B. A-4, B-1, C-3, D-2

C. A-3, B-2, C-2, D-4

D. A-4, B-1, C-2, D-3

Mapping [Cardinality constraints of relationship set]

(For binary relationship)

Partial participation on both side of binary relationship

- One to Many : Merge relationship set towards many side. So, 2 relational tables.
- Many to one : Merge relationship set towards many side. So, 2 relational tables.
- One to one : Merge relationship set any one side. So, 2 relational tables.
- Many to Many : Separate table for each entity set and relationship set. so, 3 relational tables.

FULL (Total) Participation

Mapping [Cardinality constraints of relationship set]

(For binary relationship)

1 Full participation on both side of relationship

1 : 1
1 : M
M : 1
M : N

Merge the entity sets and Relationship into single Relational table so, 1 relational table.

M : 1
1 : M
M : N
1 : 1

Both side 1 Table

Mapping [Cardinality constraints of relationship set]

(For binary relationship)

Full participation on "one" side of many to one relationship

2. Merge the entities and relationship set into single relational table. So, 1 table.

1 : M
M : 1
1 : 1

TP at One Side
1 Table.

Mapping [Cardinality constraints of relationship set]

(For binary relationship)

(9) Full participation on any "one" side in one-to-one relationship

Merge the entity sets and relationship set into single table. So, 1 table.

Mapping [Cardinality constraints of relationship set]

(For binary relationship)

Full participation on any "Many" side of Many-to-Many relationship

(3) Merge relationship set towards any "Many" side of relationship. So, 2 table.

M : N TP at Any Side ⇒ 2 Table.

Mapping [Cardinality constraints of relationship set]

(For binary relationship)

Full participation on "Many" side of Many-to-one relationship

Merge relationship set towards many side. So, 2 relational tables.

No Changes (as usual)

Self-Referential Relationship Set

(Recursive entity set)

Entities of entity set (E) related to some other entity of same entity set (E).

Recursive
Entity set

Self-referential relationship set

- Binary relationship set
- 1: M, M:1, 1:1, M:N can be any of the relationship

Q.

Consider the following entity relationship diagram(ERD), where two entities E1 and E2 have a relation R of cardinality 1:m

The attributes of E1 are A11, A12 and A13 where A11 is the key attribute. The attributes of E2 are A21, A22, A23 where A21 is the key attribute and A23 is a multi-valued attribute. Relation R does not have any attribute. A relational database containing minimum number of tables with each tables satisfying the requirements of the third normal from (3NF) is designed form the above ERD. The number of tables in the database is

[GATE-2004 : 2 Marks]

A 2

B 3

C 5

D 4

$E_1(\underline{A_{11}}\ A_{12}\ A_{13})$

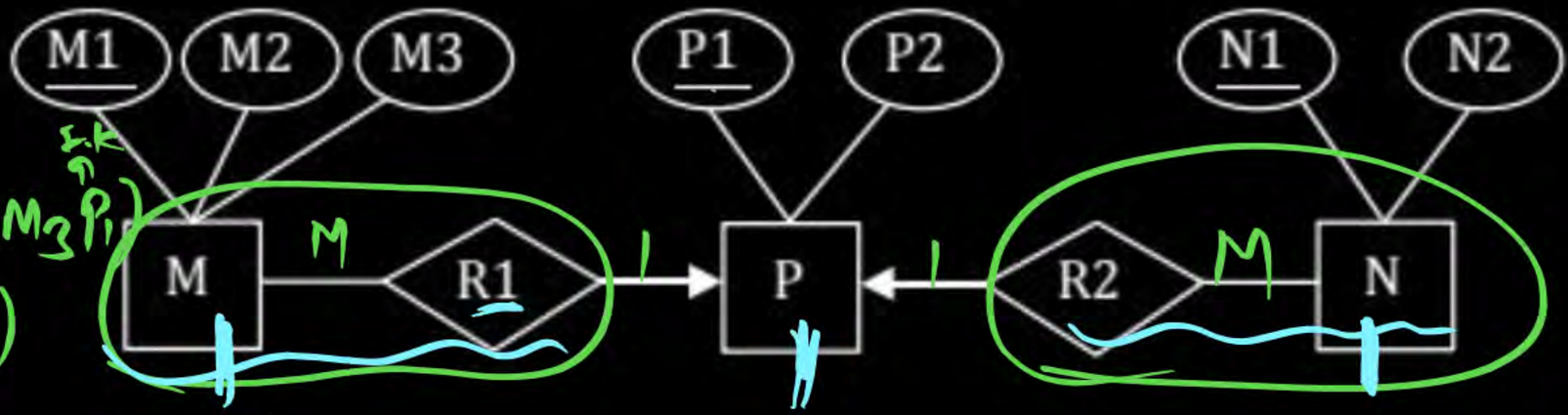
$RE_2(A_{21}\ A_{22}\ A_{11})$

$E_2'(\underline{A_{21}\ A_{23}})$

Q.

Common Data for Question

Consider the following ER Diagram



MR1 (M1 M2 M3 P1)

P(P1 P2)

NR2 (N1 N2 P1)

(i) The minimum number of tables needed to represent M, N P, R1, R2 is

[GATE-2008 : 2 Marks]

A 2

Ans (B)

B 3

C 4

D 5

(ii) Which of the following is a correct attribute set for one of the table for the correct answer to the above question?

GATE-2008 : 2 Marks]

A. {M1, M2, M3, P1}

B. {M1, P1, N1, N2}

C. {M1, P1, N1}

D. {M1, P1}

Ans (A)

ER MODEL ⇒ Conceptual Design

RDBMS

E-R Model:

Entity Relationship Diagrams used to represent Diagrammatic design [High Level Design] of Databases.

DB Design Steps:

1. Requirement: What type of data stored and what operation required etc.
2. Conceptual and Logical: [ER Diagram]
3. ER Diagram to RDBMS table design and apply normalization.
4. Physical DB Design (Indexing Design)
5. User interface Design && Security Design

High Level Design

Low Level Design

Main Components in ERD:

1. Attributes
2. Entity Sets
3. Relationship Sets

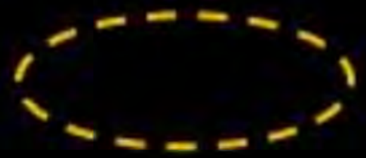
Attribute

Attributes:

Key Attributes:

Multi valued Attribute:

Derived Attribute:

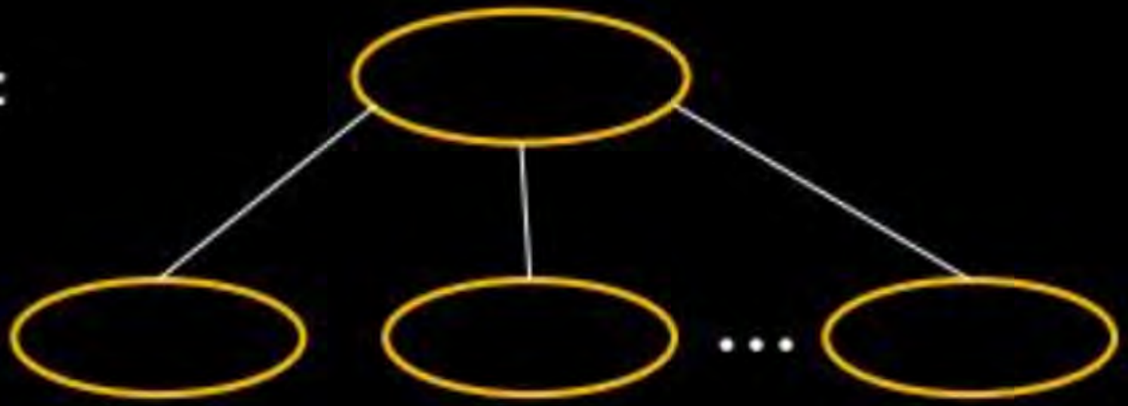


Value derived from
Other stored value

Example:

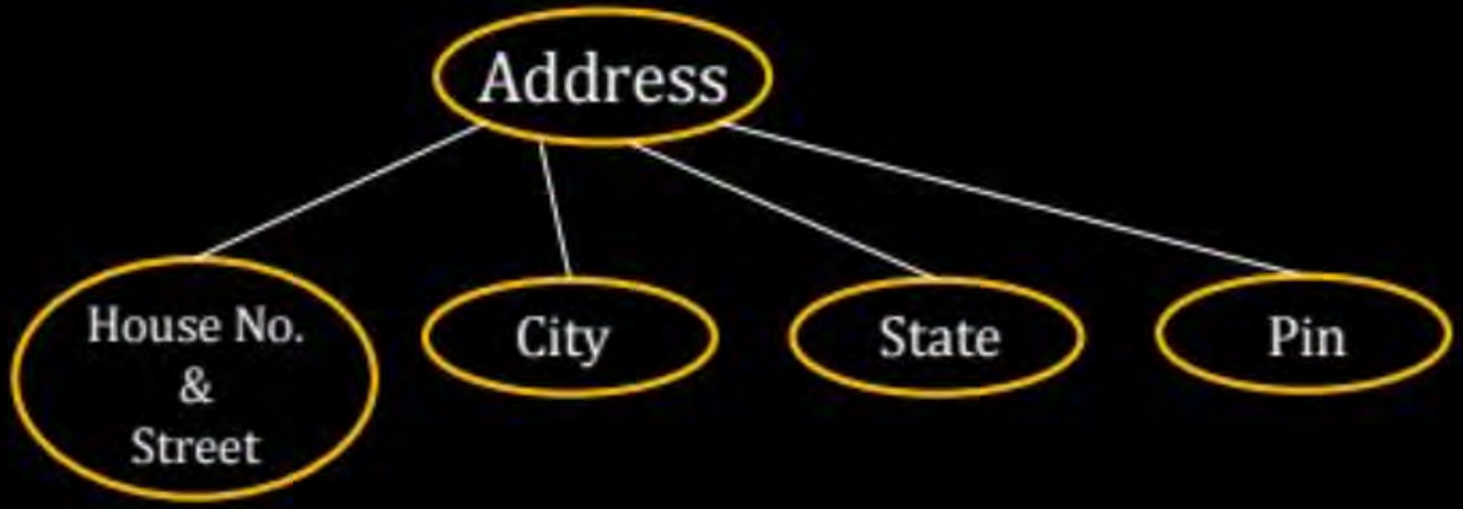
Attribute

Composite Attribute:



Attribute Which can represent as two or more attributes

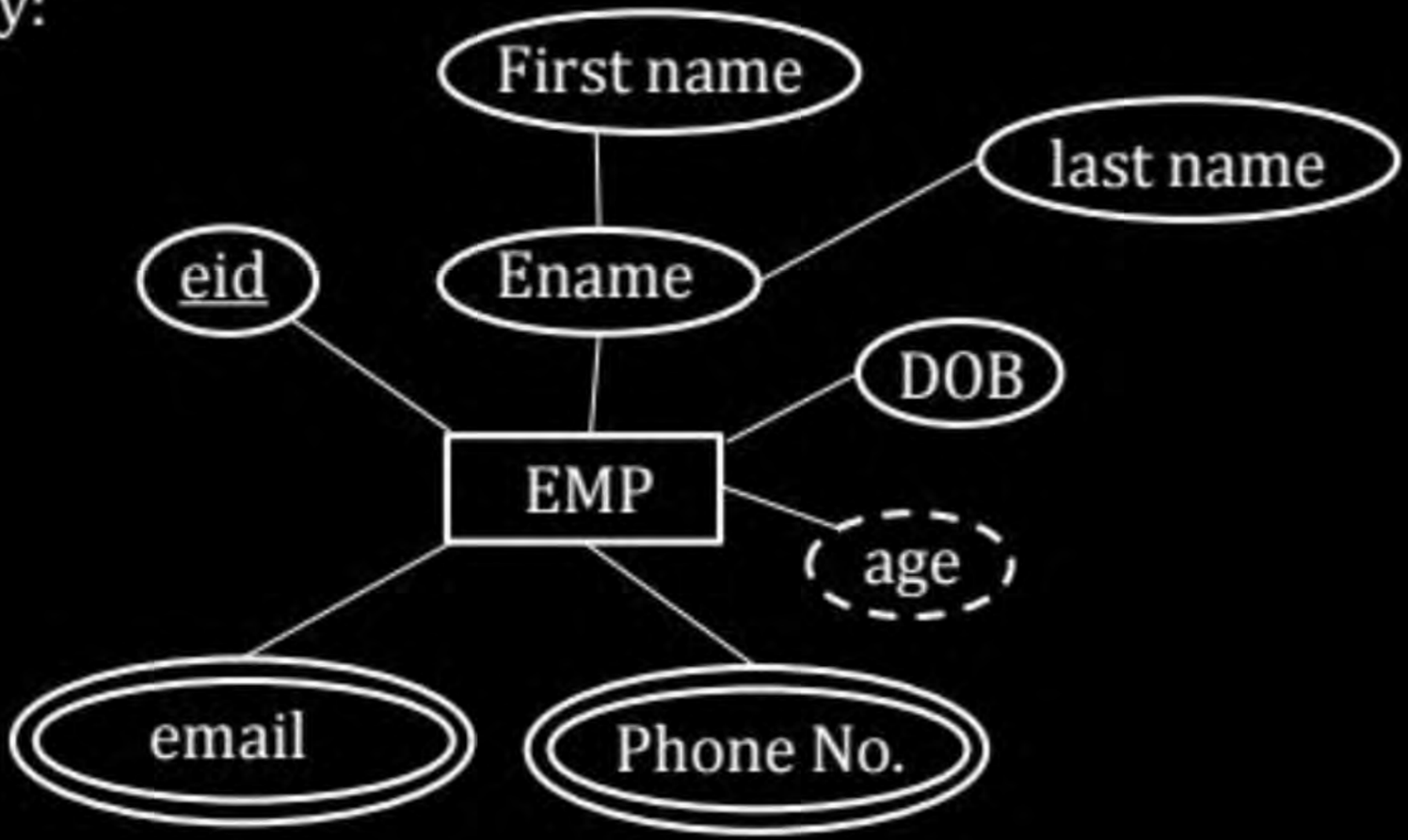
Example:



Entity Set:

Set of similar entities (recorded/objects).

Represented by:



Relationship Set:

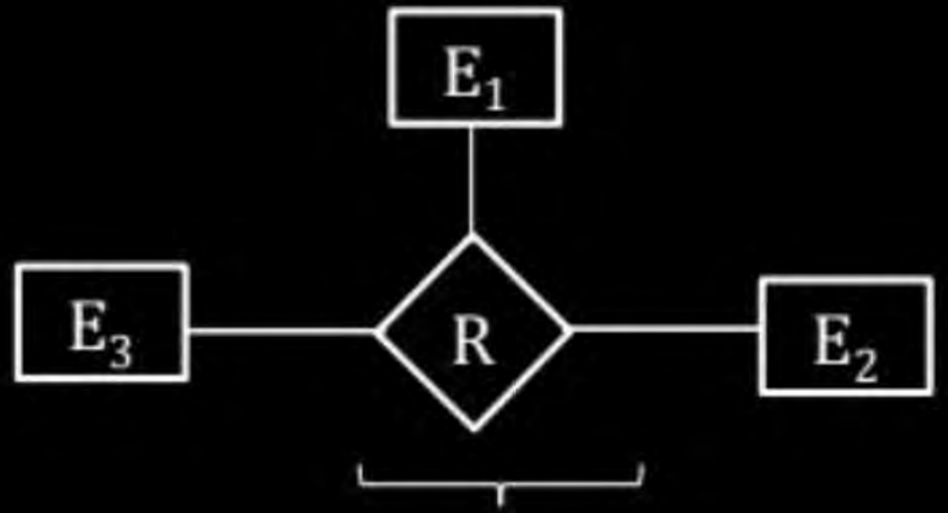
Used to relate two or more entity set.

Represented by:

1.

Binary Relationship

2.



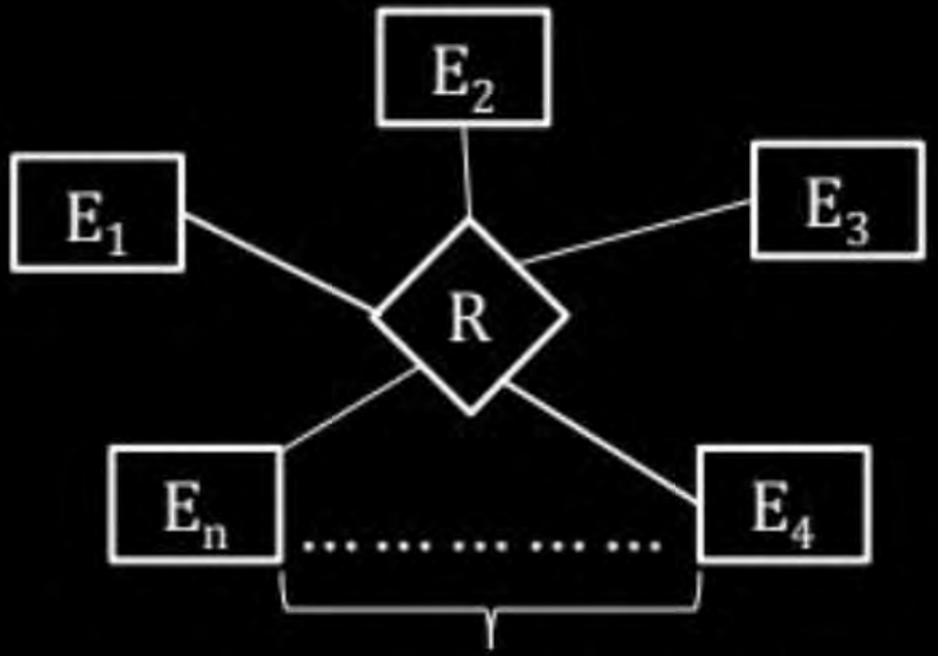
Ternary Relationship

Relationship Set:

Used to relate two or more entity set.

Represented by:

3.



N-ary Relationship

Participation:

If every entity of entity set (E1) must participate with relationship set than Total Participation.

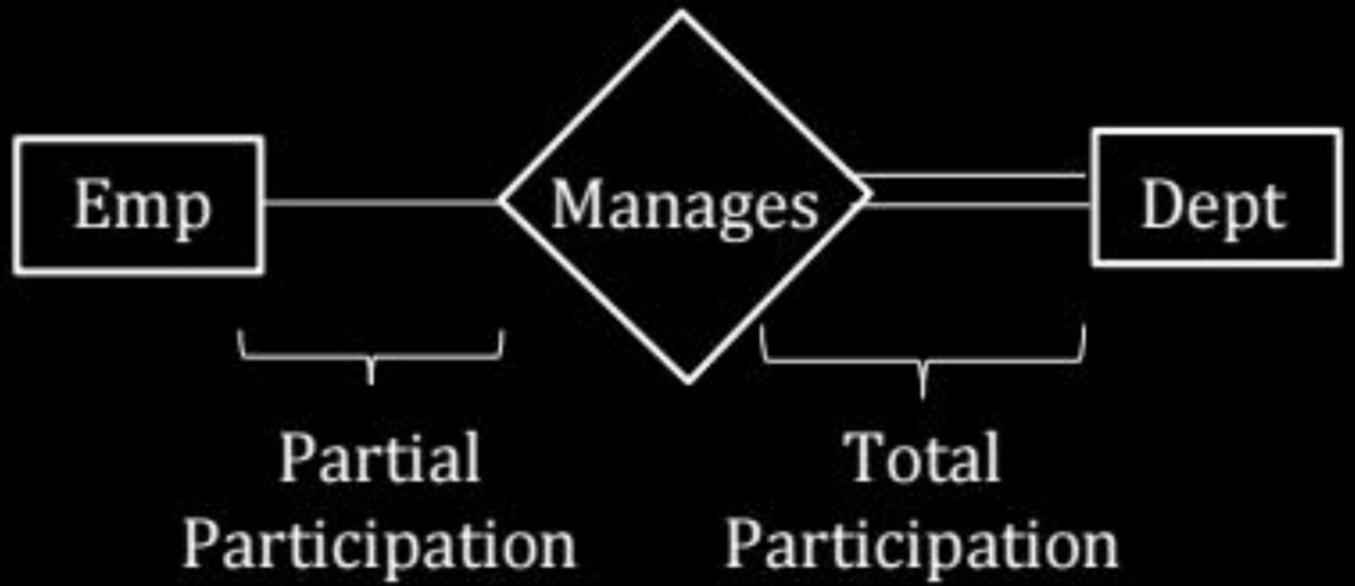
[must be 100% participation]

Otherwise:

Partial Participation:

May or may not 100% participation

Example: "Emp" & "Dept" Entity Set.
"Manages" Relationship Set such that each dept there must be a manager.



Mapping:

Mapping [cardinality of Relationship set]:

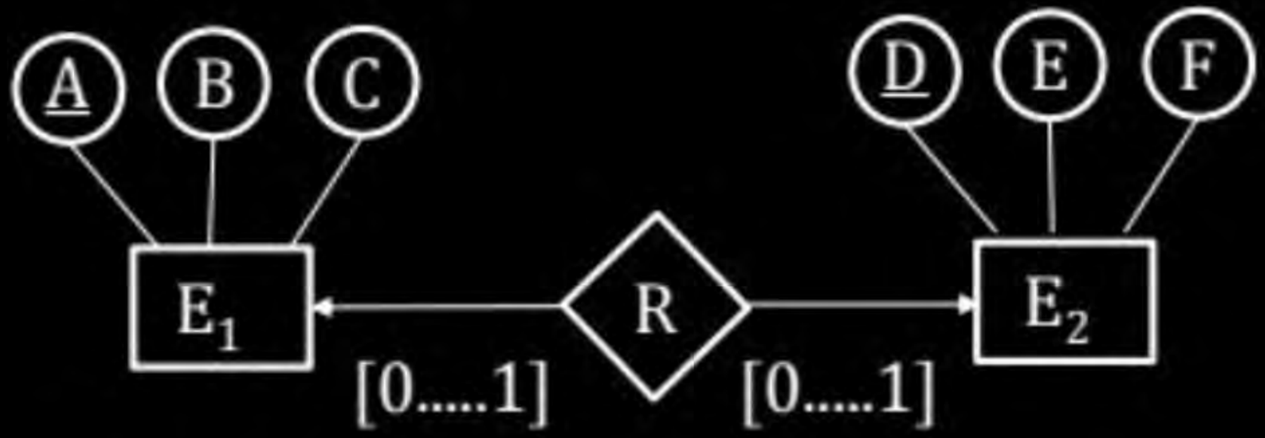
One: [At most one] [0.....1]
Many: [0 or more] [0.....M]

Possible Mapping of binary relationship sets are:

1) One : One
2) One : Many
3) Many : One
4) Many : Many

Candidate key's of Relationship set is Based on mapping

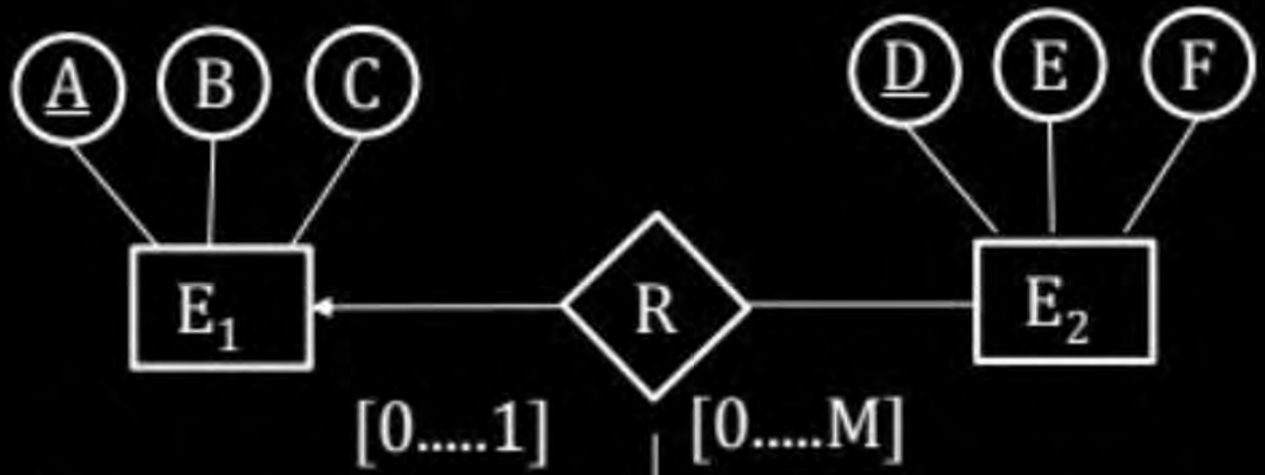
One to One:



R (A D) ≡ {A, D}

a_1	d_1	1 : 1 mapping
a_2	d_2	candidate key of
a_3	d_5	Relationship set

One: Many:



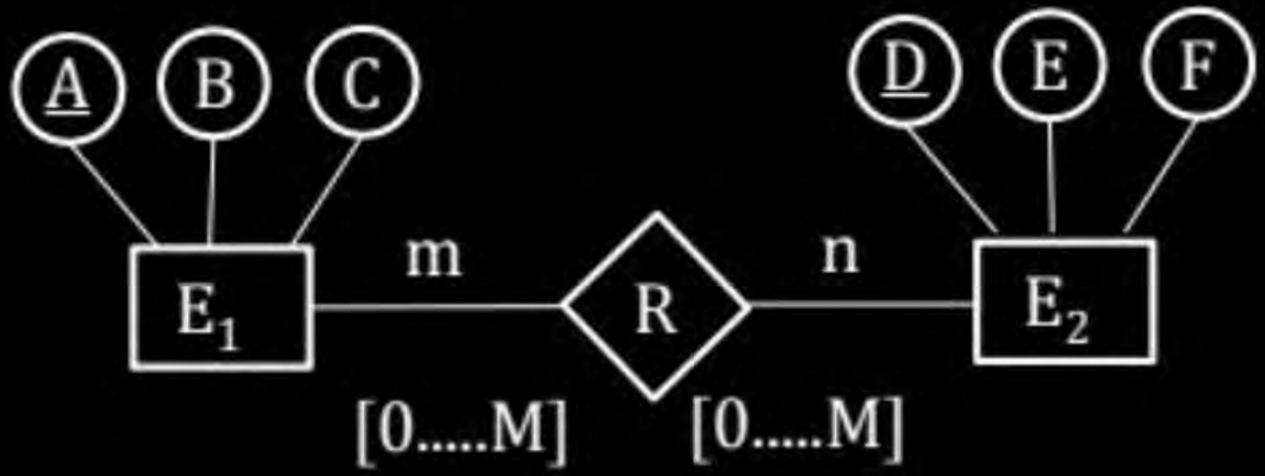
Each object of E_2 allowed to pair by at most one entity of E_1

Each entity of E_1 can pair with many E_2 entity.

Candidate key of R (A D) ≡ {D}

a_1	d_1	: for 1: M
a_1	d_2	Relationship
a_2	d_3	

Many to Many:

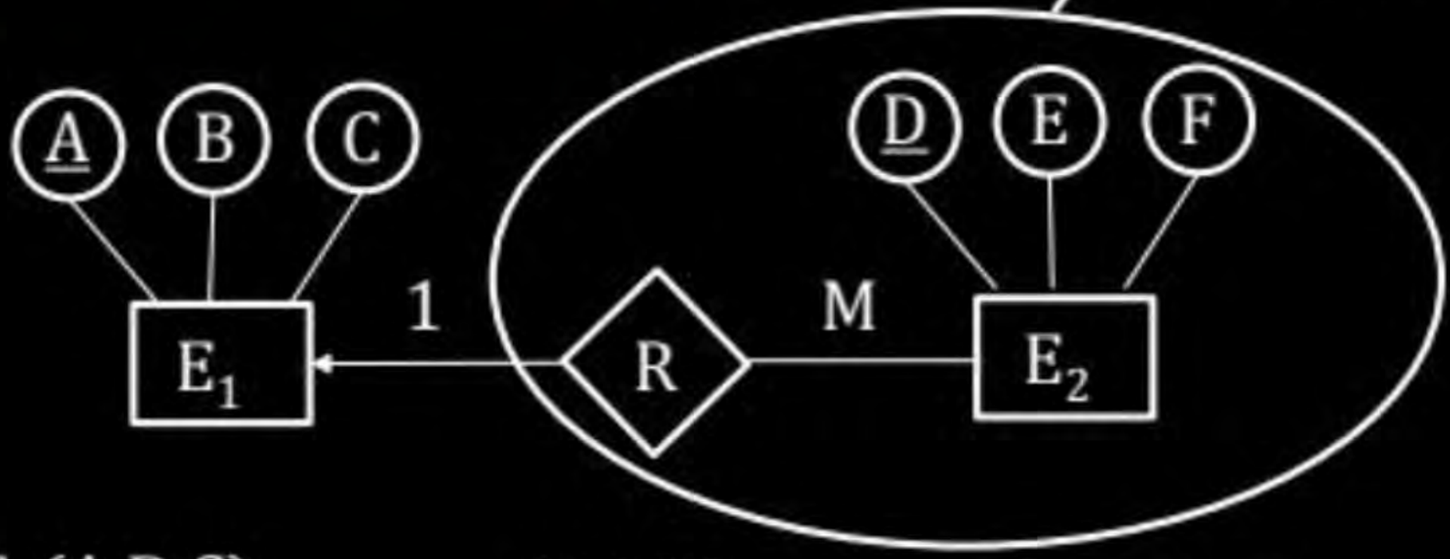


R (A D) ≡ {AD}

a_1	d_1	M:N ⇒
a_1	d_2	for many to many mapping
a_2	d_2	Candidate Key for
a_3	d_3	Relationship Set is
		{AD}

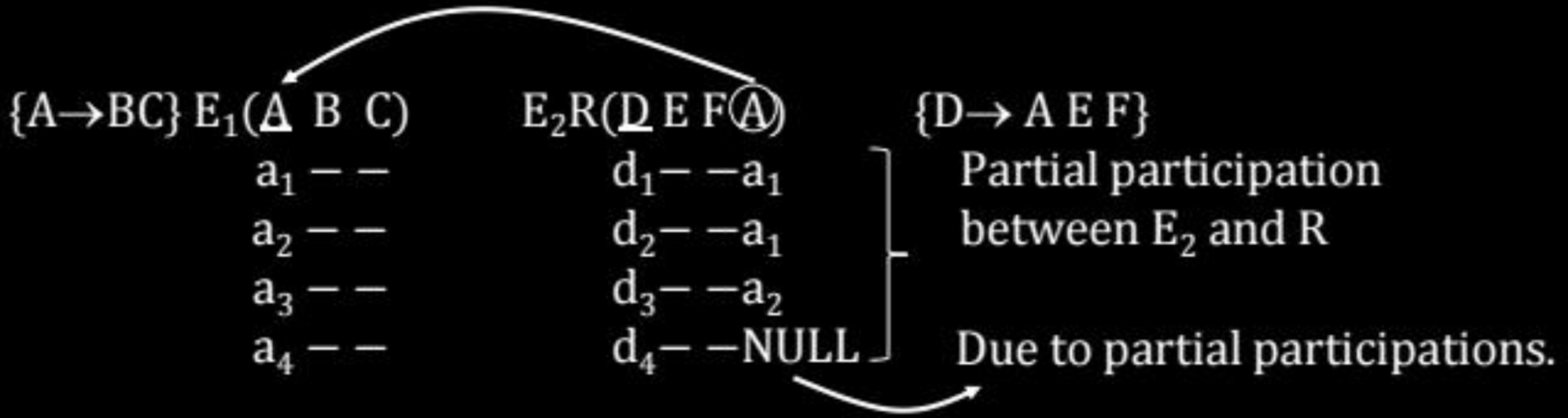
RDBMS Design of Given ERD:

1 : M Relationship:



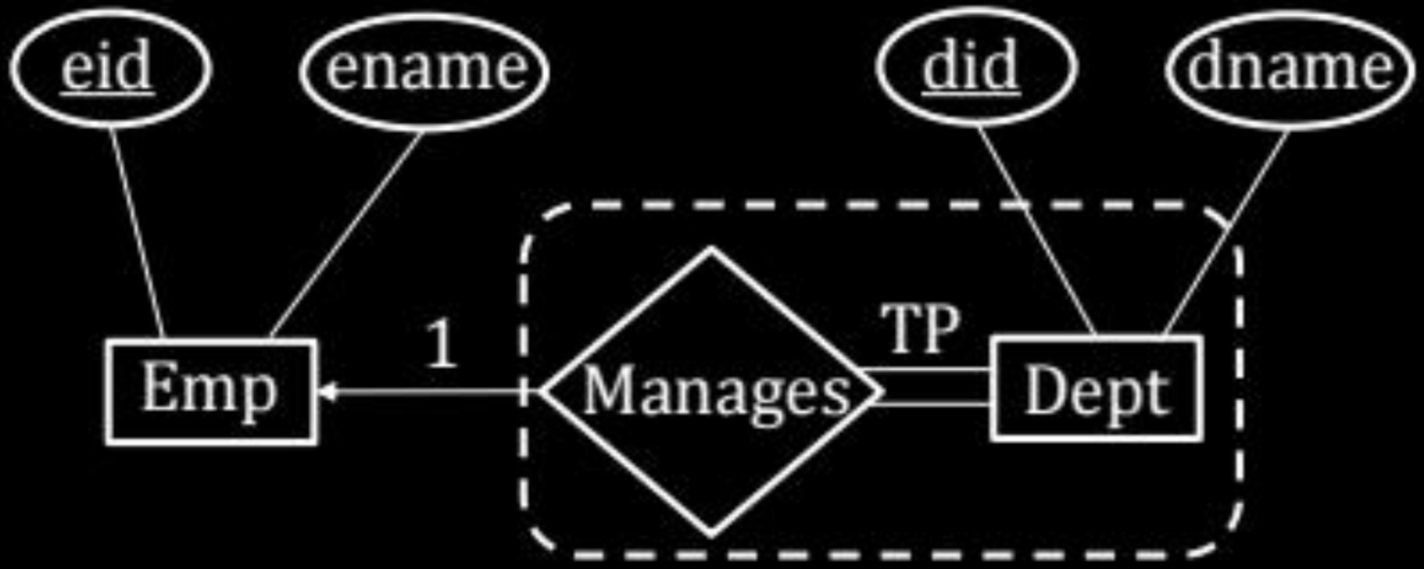
$E_1(\underline{A}\ B\ C)$ $R(A\ \underline{D})$ $E_2(\underline{D}\ E\ F)$

a_1 – –	$a_1\ d_1$	d_1 – –
a_2 – –	$a_1\ d_2$	d_2 – –
a_3 – –	$a_2\ d_3$	d_3 – –
a_4 – –		d_4 – –
$A \rightarrow BC$	$D \rightarrow A$	$D \rightarrow EF$
$\{\underline{A}\}$	$\{\underline{D}\}$	$\{\underline{D}\}$



∴ minimum 2 relational Table Required and 1 Foreign Key required for given ERD

Given ERD
Example:



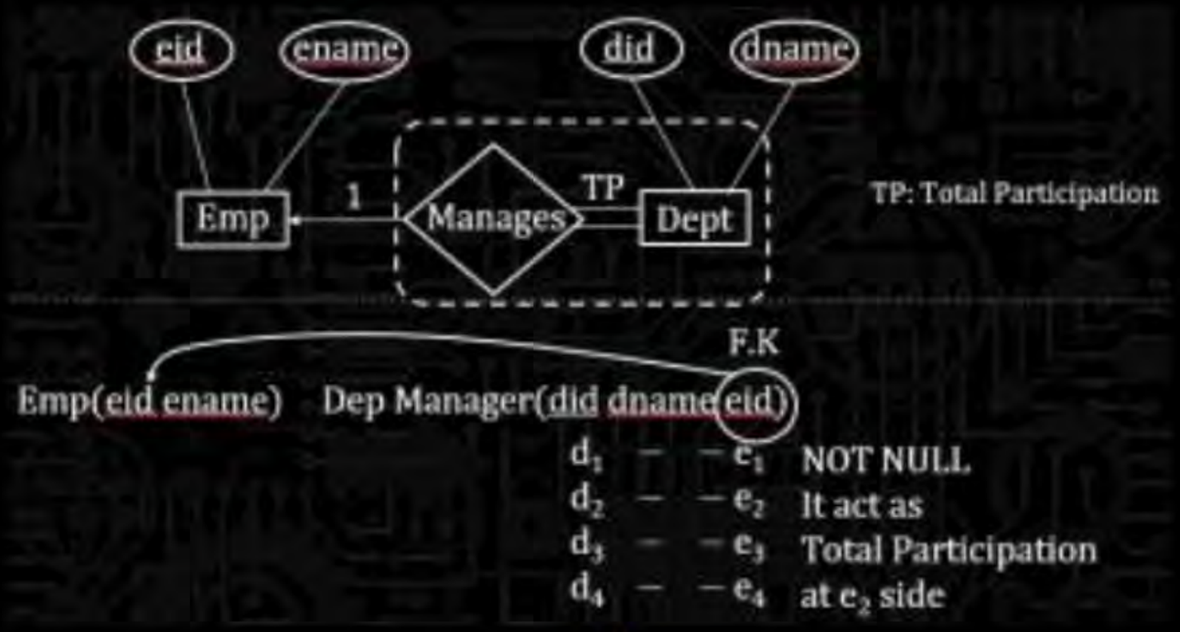
TP: Total Participation

F.K

Emp(eid ename) Dep Manager(did dname eid)

d_1	–	– e_1	NOT NULL
d_2	–	– e_2	It act as
d_3	–	– e_3	Total Participation
d_4	–	– e_4	at e_2 side

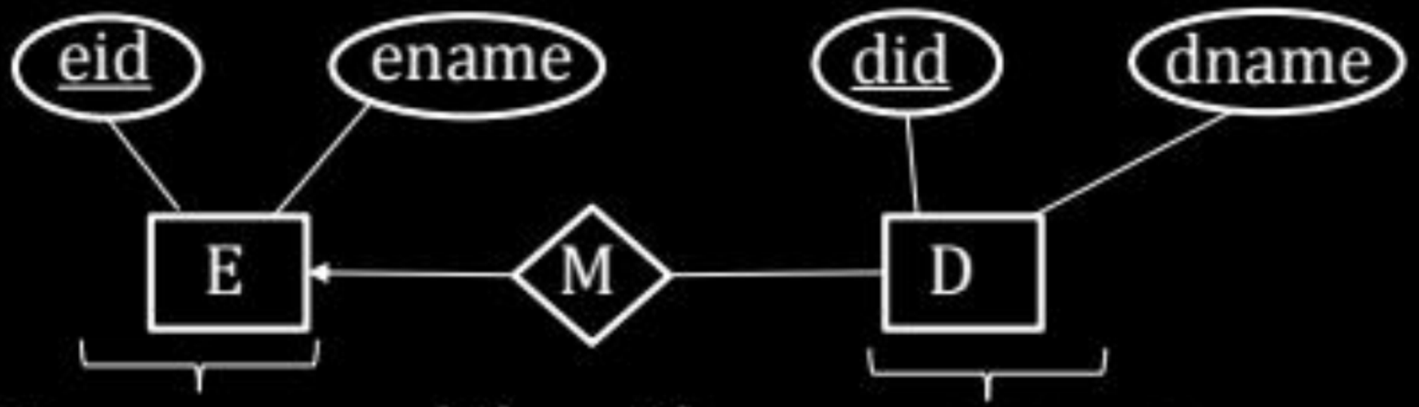
Given ERD



Emp_Dept_Manages
(did dname eid ename)
did → dname
did → eid
(_____ e_5 A)
Not allowed because e_5 not in relationship

CREATE TABLE Dept_manages
(did varchar(10) primary key,
dname varchar(30),
eid varchar(10) NOT NULL,
FOREIGN KEY(eid)
REFERENCES Emp);

If 1 : M relationship set merges into left side Entity set:



eid → ename did → eid did → dname

E_M(eid ename did)

D(did dname)

e_1	A	d_1
e_1	A	d_2
e_1	B	d_2
e_1	C	d_3
e_1	D	Null

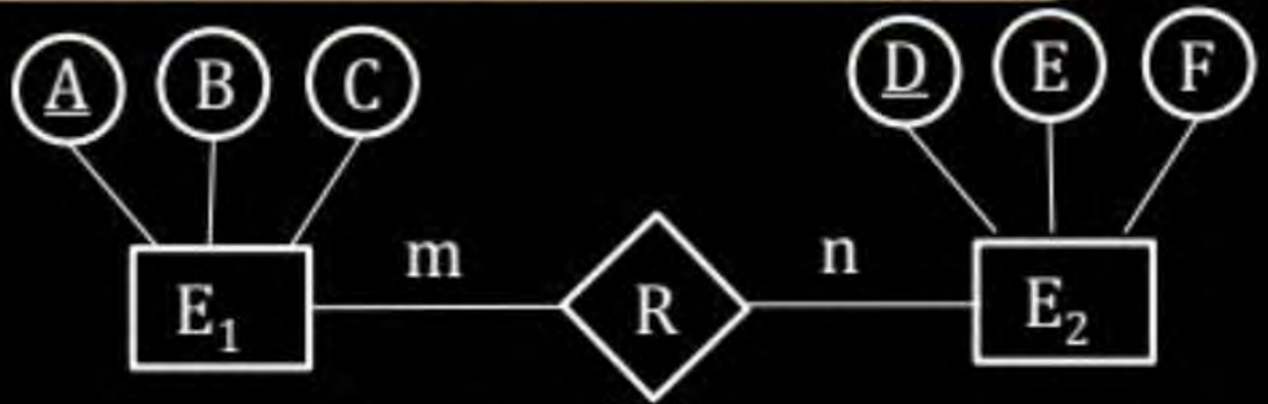
Not valid as did is key of E_M
(Partial Participation)
[lost at E side]

Disadvantage:

1) Data Redundancy Occurs
   eid → ename
   Not Super Key(S.K)

2) Partial Participation will be lost
   [Not possible to insert employees who are not manager of dept.]

Many : Many Relationship:



E_1 (A B C)

A
a_1
a_2
a_3
a_4
⇑
key

R (A D)

A	D
a_1	d_1
a_2	d_2
a_2	d_2
⇑	⇑
Not key	

E_2 (D E F)

D
d_1
d_2
d_3
⇑
key

Minimum 3 relational table required and 2 foreign key required.

M:N relationship set not allowed to merge with any entity set.

One : One Relationship:

E_1, E_2 entity sets & R relationship set related between E_1 and E_2 with 1:1 cardinality and partial participation(pp) at both side.

E_1 (A B C)

a_1
a_2
a_3
a_4
⇑
key
[A→BC]

R (A D)

a_1 d_2
a_2 d_3
a_3 d_4
⇑ ⇑
key key
[A→D
D→A]

E_2 (D E F)

d_1
d_2
d_3
d_4
⇑
key
[D→EF]

If all merge with single Table:

E_1RE_2

A	B	C	D	E	F
a_1	-	-	d_2	-	-
a_2	-	-	d_3	-	-
a_3	-	-	d_4	-	-
a_4	-	-	Null	Null	Null
Null	NULL		d_1	-	-

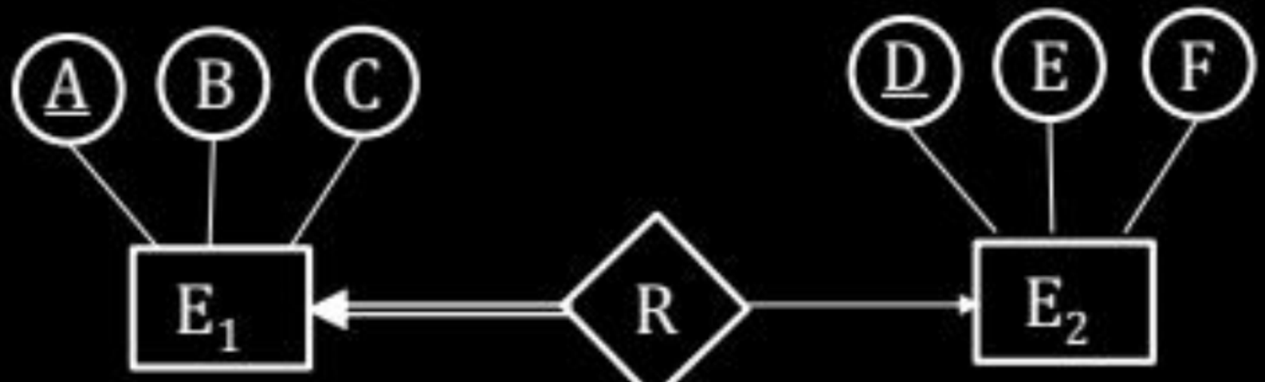
Candidate key = {A, D}

No Candidate key is present, & No primary key

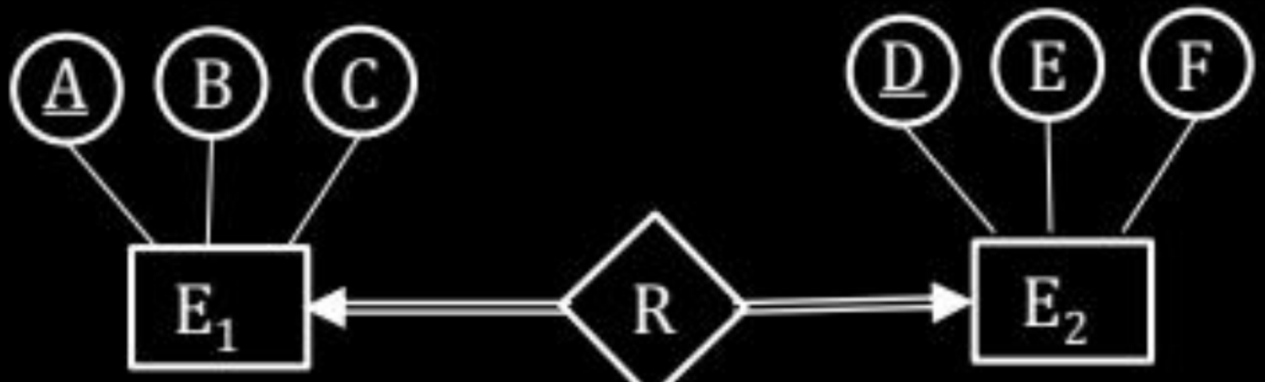
A relational table in which no attribute having "NOT NULL" values are "NOT" allowed in RDBMS . So,

- minimum 2 Relation Table Required and 1 Foreign key.

E_1 E_2 Entity set R Rel set between E_1E_2
With 1:1 mapping and at least one end having total participation.



E_1 R E_2 (A B C D E F)

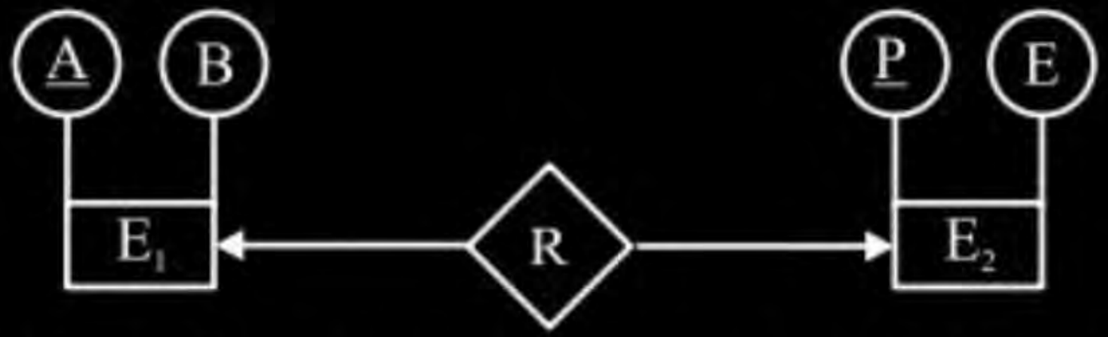


E_1 R E_2 (A B C D E F)

Primary Key

UNIQUE & NOT NULL (Alternative Key)

Q.



70% participation at E_1 end & 40% participation at E_2 end.
Which is best possible design?

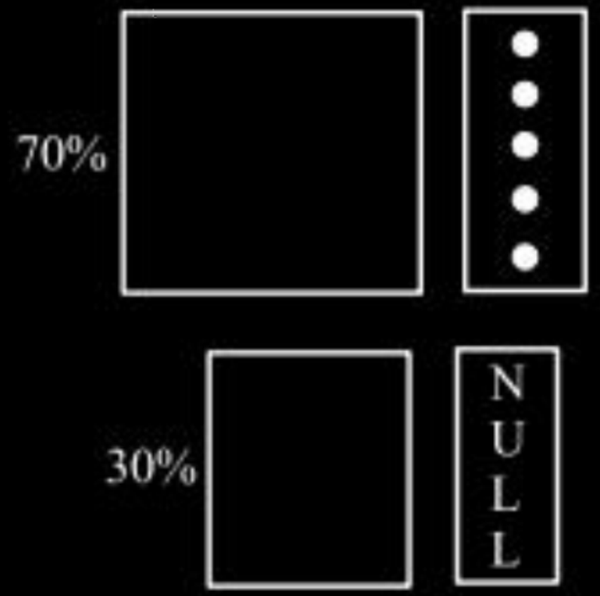
A. E_1 E_2 entity set kept separate with F.K at E_1

B. E_1 E_2 entity set kept separate with F.K at E_2

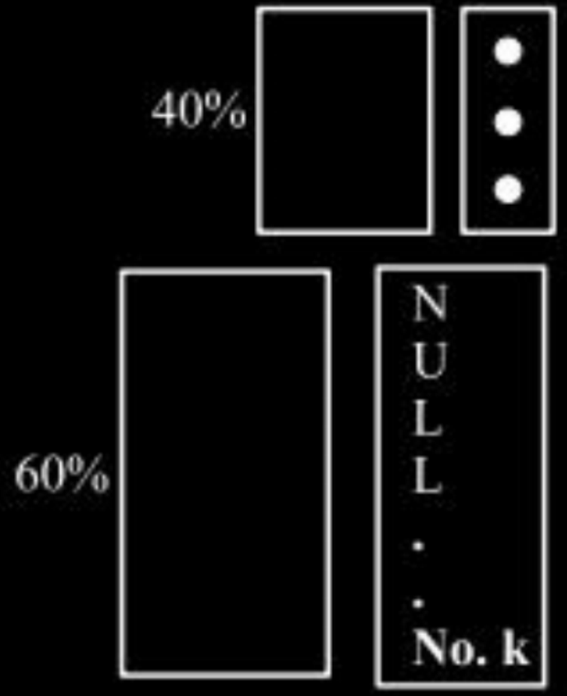
C. E_1 E_2 entity set kept separate with F.K at both E_1 E_2

D. E_1 E_2 merges into single table with No F.K.

(a) E_1 R (A B D) E_2 (D E)

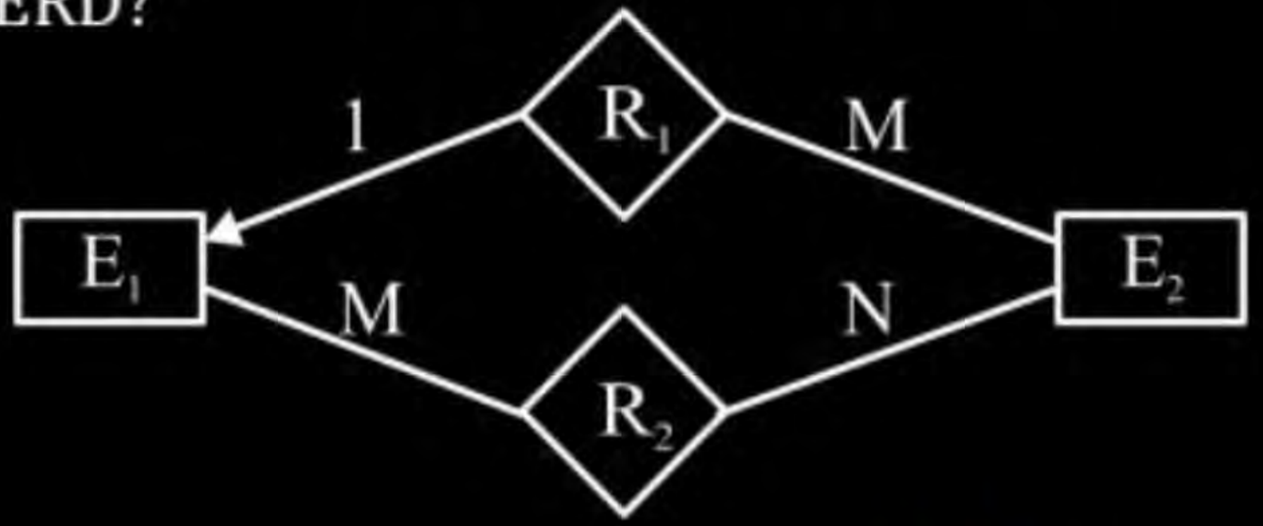


(b) E1(A, B) E_2 (D E A)



Q.

E_1 E_2 entity set R_1 R_2 Relationship set related between E_1 and E_2 with 1:M and M : N mapping min Relational Table required in ERD?



A. 2

B. 3

C. 4

D. 5

Q.

$E_1E_2E_3$ entity set R_1 Relation between E_1 E_2 with 1 : M, R_2 Relations between E_2 E_3 with M : 1, R_3 Relationship between E_1 & E_3 with M : N

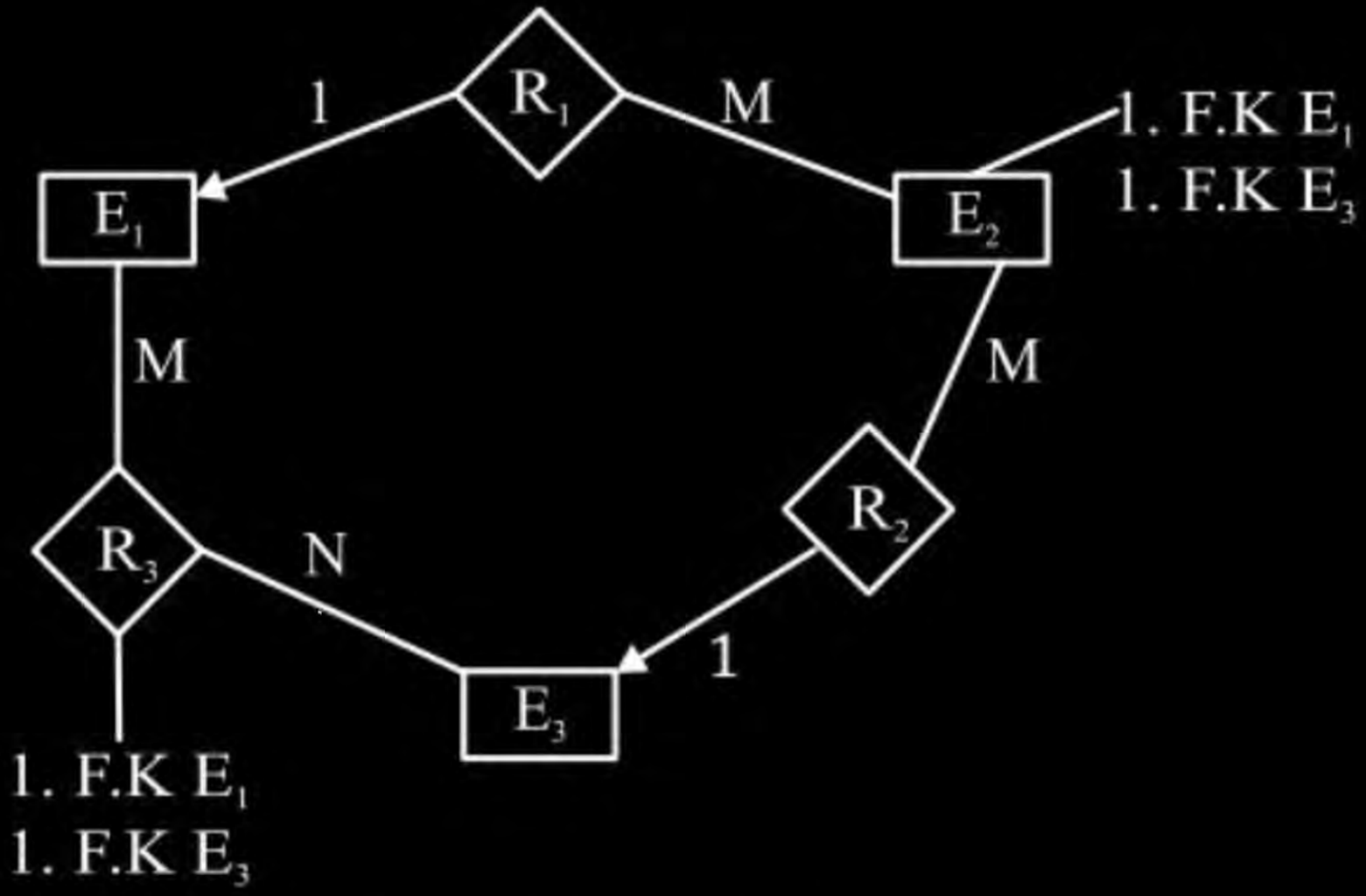
How many minimum relational tables required for given ERD?

A. 2

B. 3

C. 4

D. 5



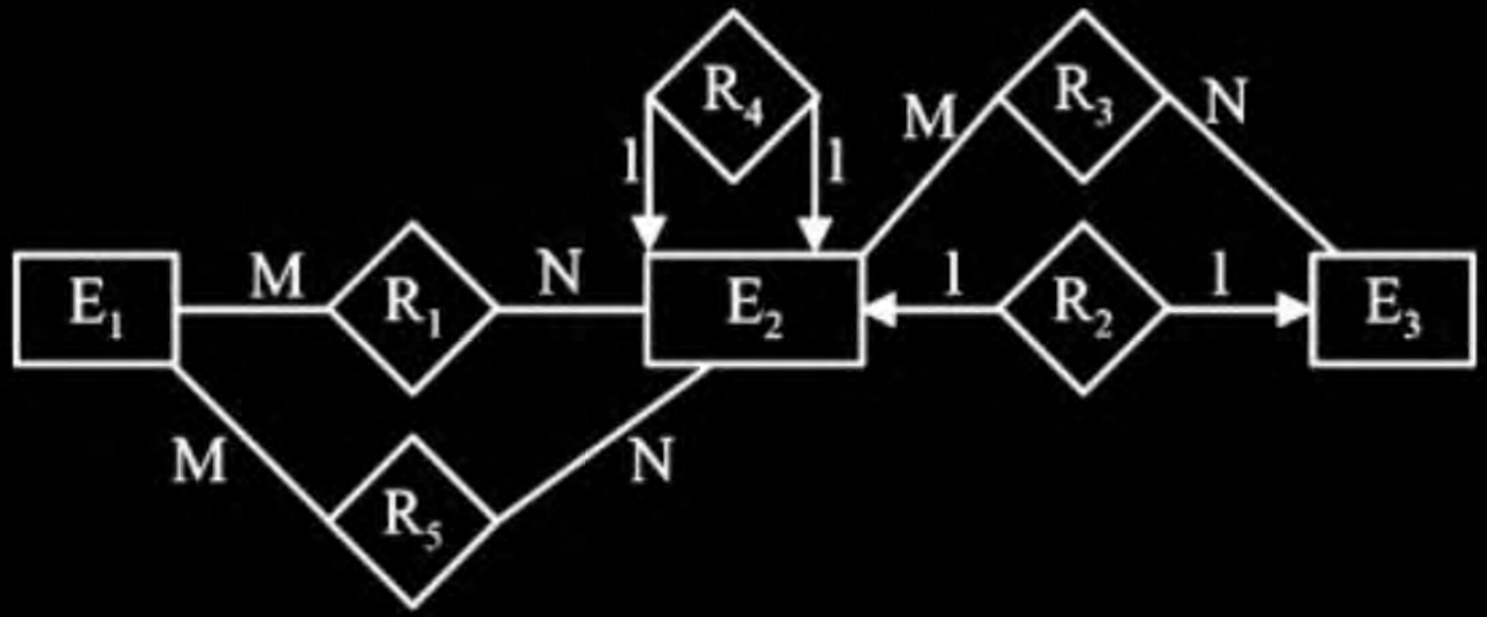
Min 4 Rel Table and 4 Foreign key.

Q.

[NAT]

Consider the following ER diagram

Total number of RDBMS table in the above diagram?



Self Referential Relationship set:

[Recursive entity set]
Entities of entity set (E) related to some other entity of same entity set (E)

} Recursive Entity set

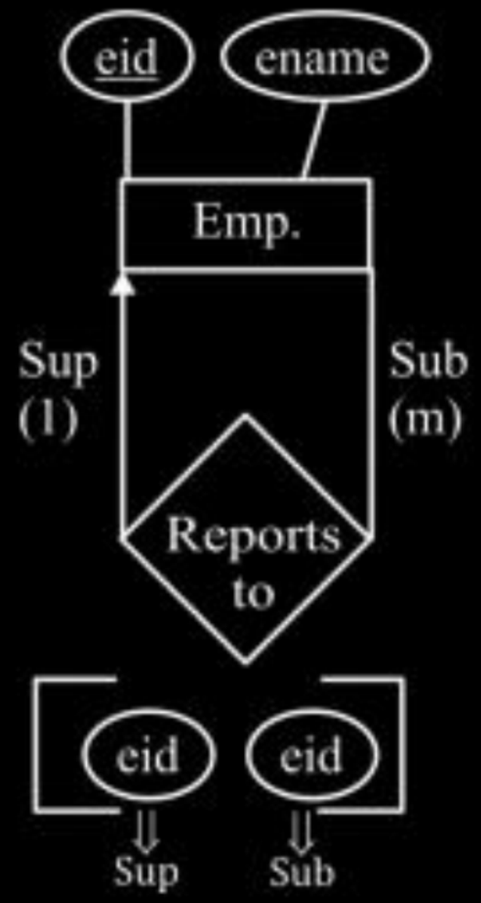
} Self Referential Relationship set.

- Also Binary Relationship set
- 1:M, M :1, M :1, 1:1, N: N be any of the relationship

⇒ Emp entity set.

Reports to Relationship Set Related between Supervisor and Subordinate

(i) Each supervisor can supervise many subordinates and each subordinate reports to one supervisor.



Emp.	(eid	ename)
	e1	–
	e2	–
	e3	–
	e4	–

Reports to	(Sup		Sub)
	e1	–	e2
	e1	–	e3
	e2	–	e4

Emp.	(eid	ename)
	e1	–
	e2	–
	e3	–
	e4	–

Reports to	(Sup		Sub)
	e1	–	e2
	e1	–	e3
	e2	–	e4

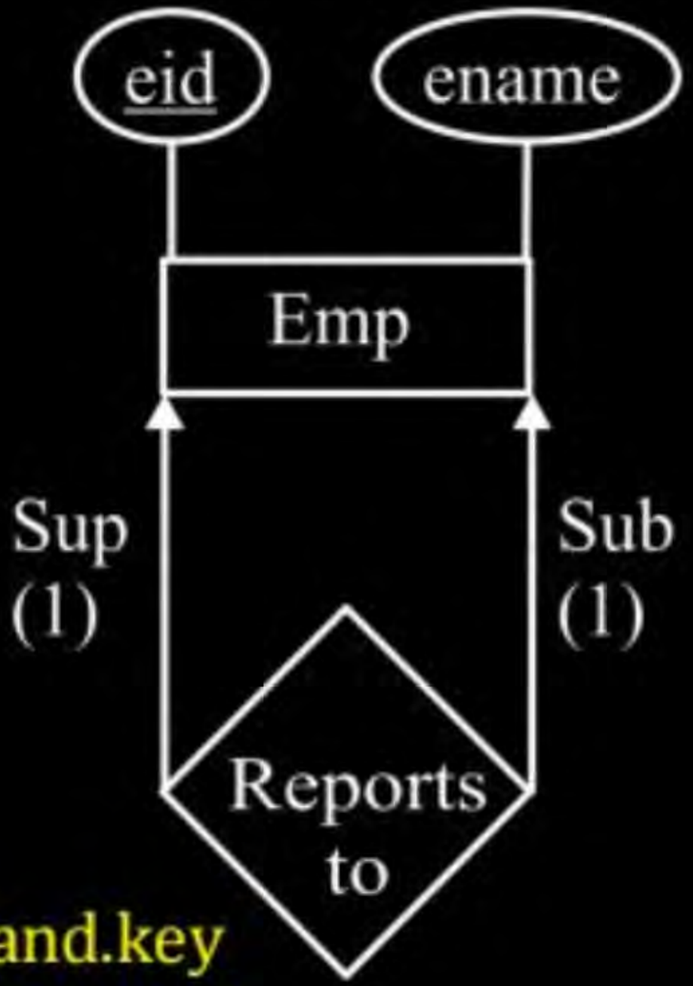
(eid + sub) ⇓ Combine

Cand. Key; {eid}
"Sup" Foreign key Ref.
to same table

Emp. Reports to	(eid		ename Sup)
	e_1	→	Null
	e_2	→	e_1
	e_3	→	e_1
	e_4	→	e_2

Min 1 RDBMS table required with 1 F.K refer to same table

(ii) Each supervisor can supervise one subordinates and each subordinate reports to one supervisor



Cand.key
{sup, sub}

Emp. (<u>eid</u> ename)

e1 –
e2 –
e3 –
e4 –

Reports to (Sub Sub)

e1	–	e2
e2	–	e3
e3	–	e4

Emp_Report to — Merge — Emp_Reports to (eid, ename, Sup)

eid		Sup
e_1	→	Null
e_2	→	e_1
e_3	→	e_2
e_4	→	e_3

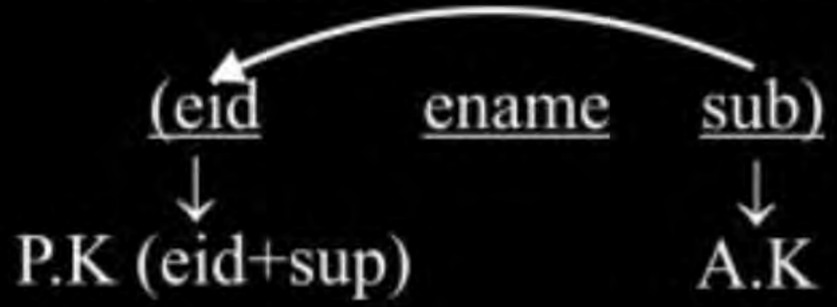
Can. Key : {eid, sub}

eid ⇓ P.K. (eid + sub)

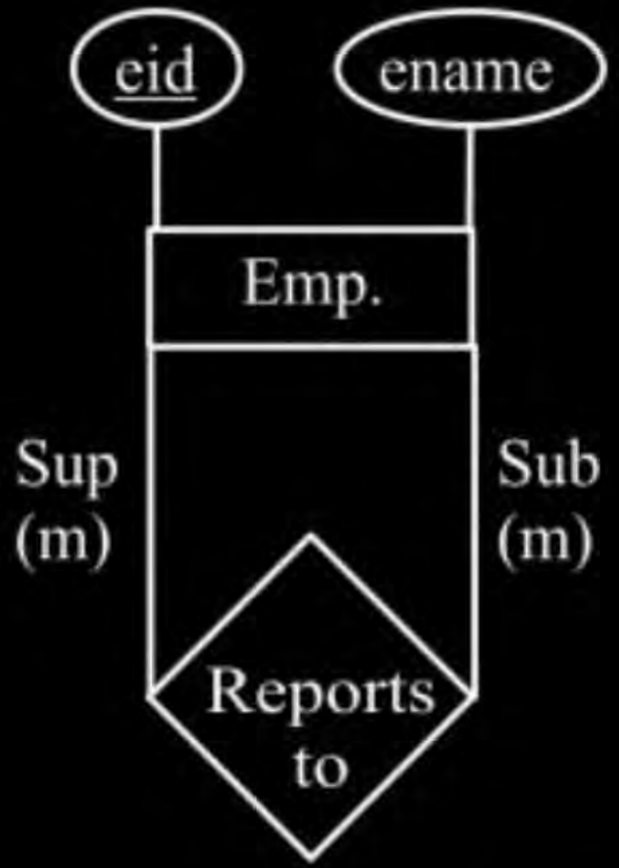
sub ⇓ A.K

"Sup" foreign key Refers to same Table eid.

Or one more possibilities



(iii) Each supervisor can supervise many subordinate and each subordinate reports to many supervisor.



Emp. (eid, ename)

eid	ename
e1	–
e2	–
e3	–
e4	–

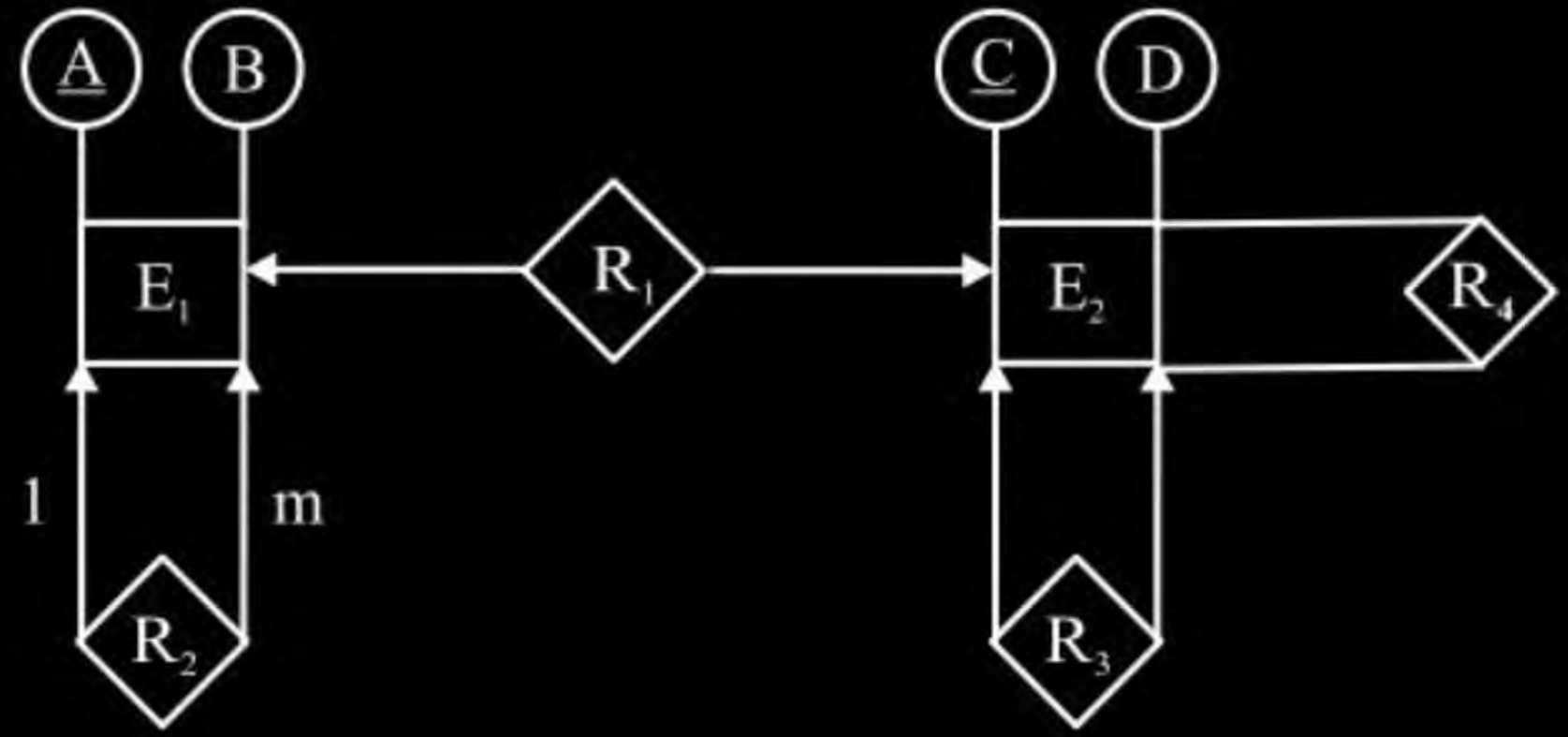
Reports to (Sub, Sub)

Sub		Sub
e2	–	e2
e1	–	e3
e2	–	e3

Cand.key {sup sub}

Minimum 2 relational table and 2 foreign keys.

Q.



(I) $E_1\ R_2\ (\underline{A}\quad B\quad A)$

(II) $E_2\ R_1\ R_3\ (\underline{C}\quad D\quad A\quad C)$

(III) $R_4\ C_3\ C_4$

Q.

[MCQ]

Consider the following ER diagram:

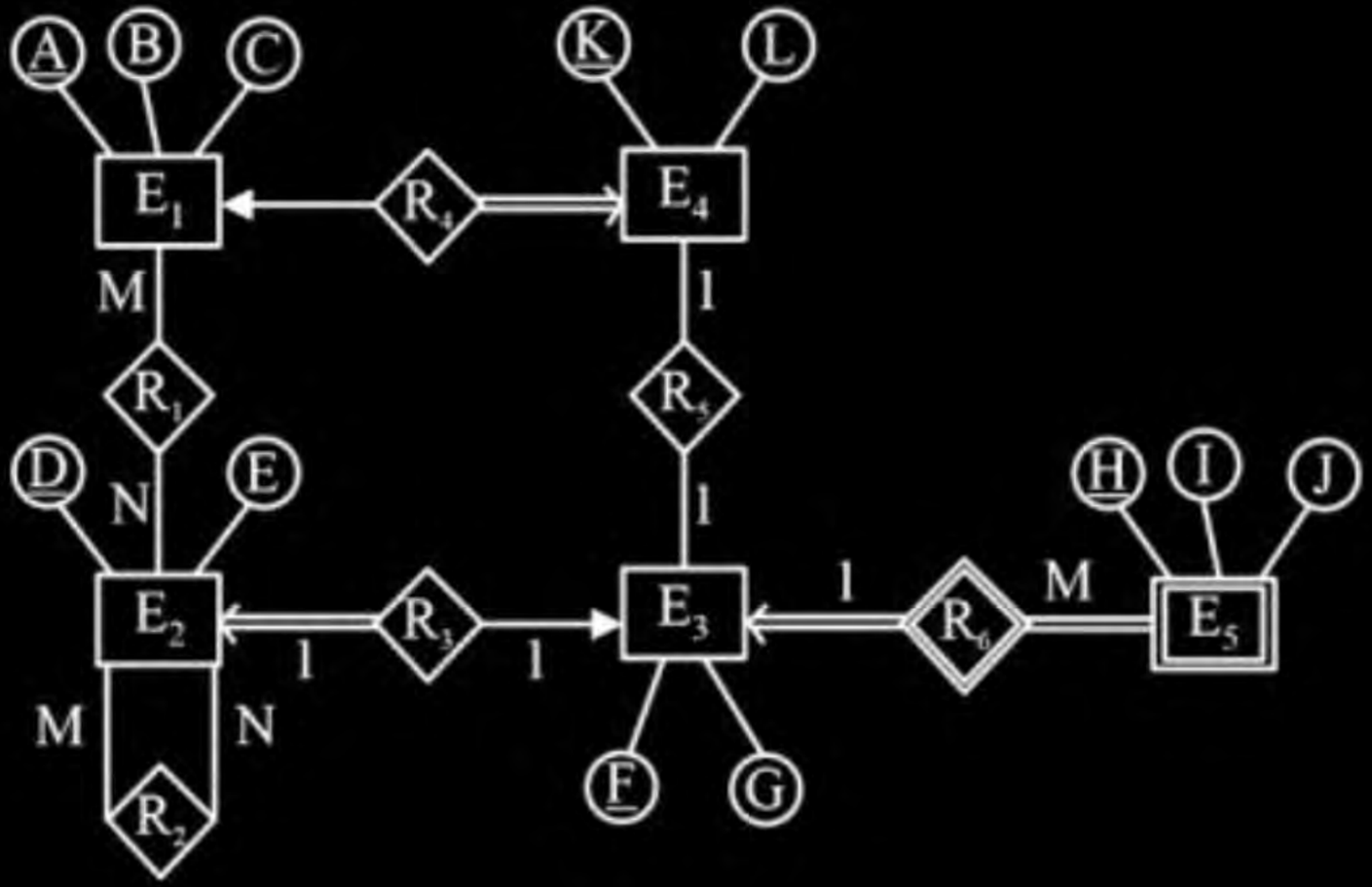
How many total attributes required for the minimized relations of the above ER diagram?

A. 14

B. 15

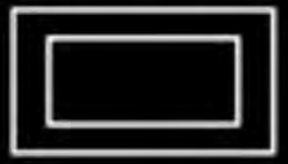
C. 18

D. None of these

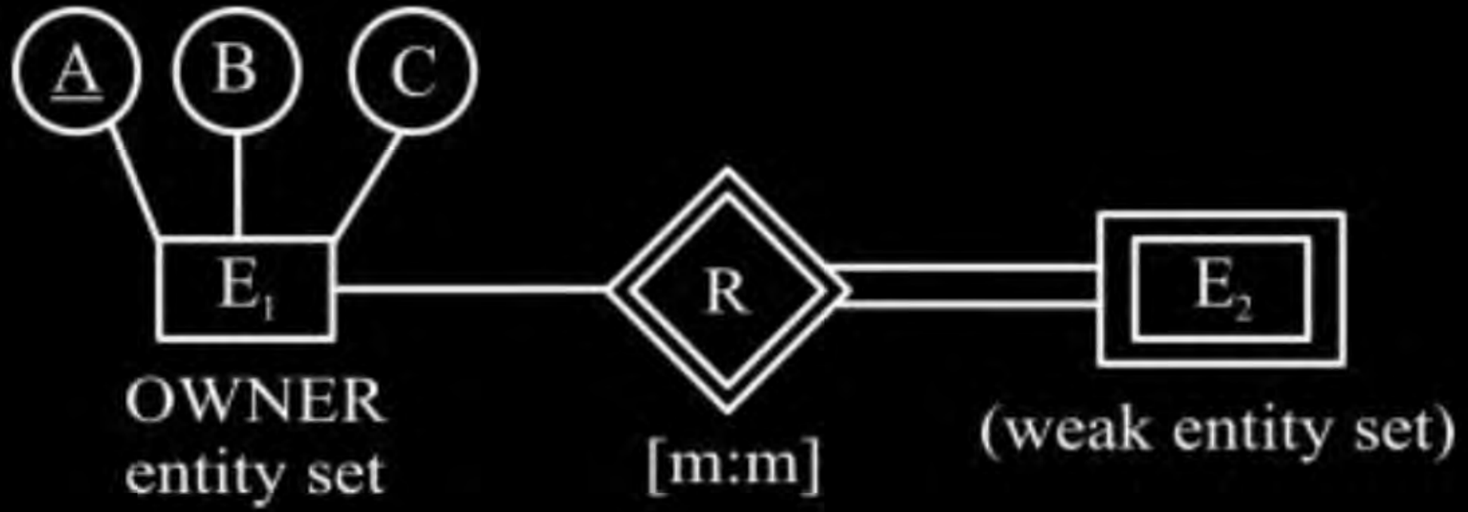


WEAK ENTITY SET:

⇒ Entity set with no key.
[Attributes of weak entity set not sufficient to differentiate entities uniquely]

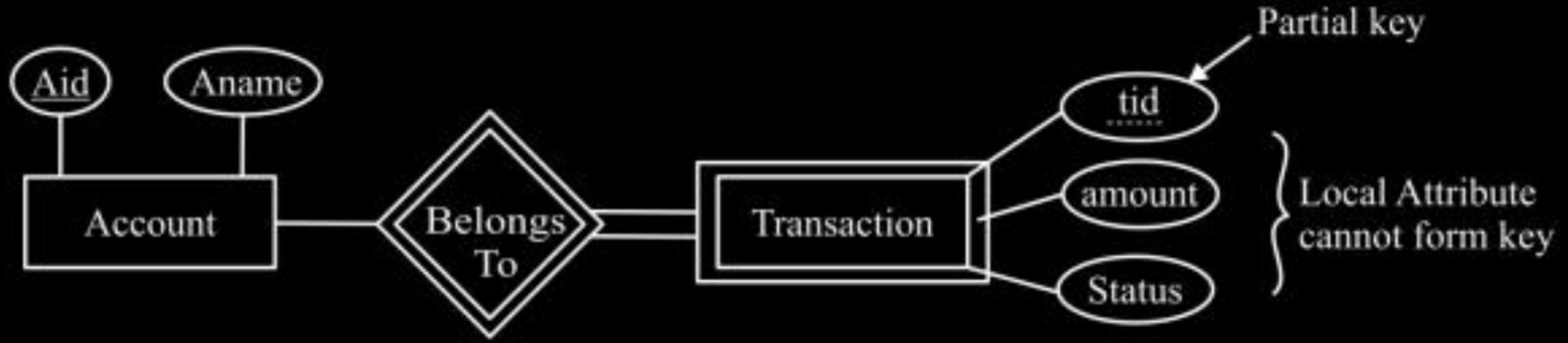
⇒ 

⇒ For each weak entity set there must be OWNER entity set which is strong entity.



⇒ Entities of weak entity set are depending entities.

Ex.



Aid tid

Aid	tid
A_1	t_1
A_2	t_1
A_2	t_2
A_3	t_2

Aid	Aname
A_1	
A_2	
A_3	
A_4	

Transaction

tid	amount	Status
t_1	5000	Debit
t_1	4000	Credit
t_2	5000	Debit
t_2	5000	Debit

⇑

[1: m]

Ambiguity

- Relationship set between weak entity set and identifier entity is also weak relationship set.

- Participation towards weak entity set end must be TOTAL PARTICIPATION.
- Mapping between identifier set must be one: many (1: m)
- RDBMS Design:
  Transaction belongs (Aid tid amount state)
  Account (Aid Aname)

NOTE: Weak entity set and multivalued attributes allowed to represent in ERD, but NOT allowed in RDBMS Table.

THANK YOU!