GATE CRASH COURSE COMPUTER SCIENCE

Database Management System

ER Model & Foreign key Concept

Lecture_08

Vijay Agarwal sir

Topics to be Discuss

- ER MODEL Concept
- Foreign key Concept
- ER to RDBMS Conversion
- Finding Number of super key

Recap:

File Org & Indexing

- Spanned & Unspanned Org
- ORDER & Unordered file
- Indexing
- P.I, C.I, S.I
- Multilevel Indexing
  - B Tree
  - B+ tree

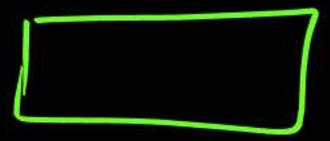
Entity – Relationship Model (Conceptual Design)

Entity : Object
- Physical ⇒ Student, Book
- Logical → Account

Relationship → Asso.

Attribute : which Decribe the Entity.

Entity Set



Collection of Similar Entities

Entity Set	Entity
Schema	Instance
PERSON (Name, Age, Gender)	(Ankul 25 Male)

Entity

An entity is an object that exists and is distinguishable from other objects.

- Example: Specific person

Entity Set

Collection of Similar Entities.

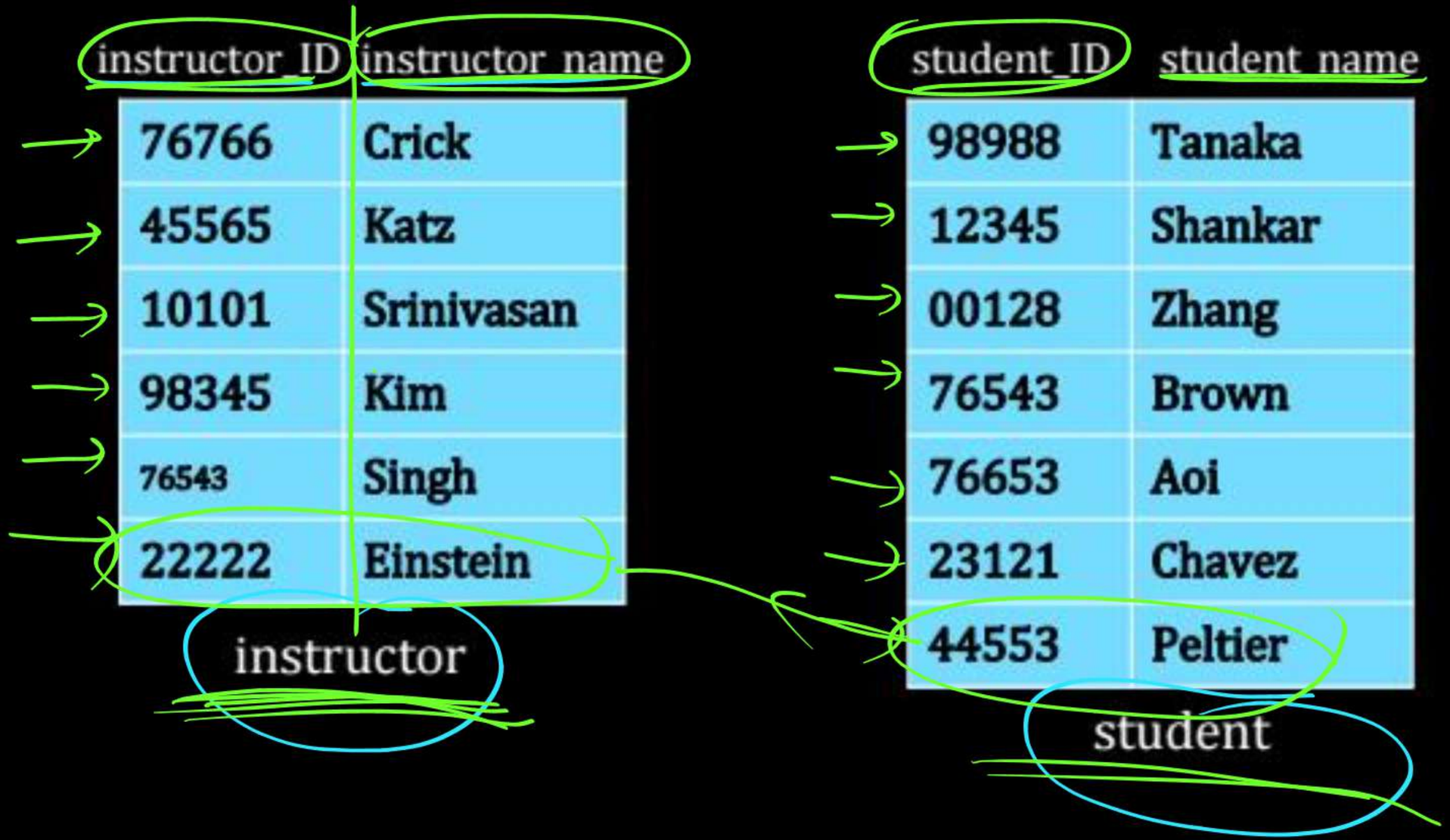
- An entity set is a set of entities of the same type that share the same properties.
  - Example: set of all persons, companies

PERSON (Name, Age, Gender)

- Entities have attributes
  - Example: people have names and addresses

Amitabh	25	M
Nisha	26	M
Abhay	29	M
Neha	22	F

Entity sets instructor and student



instructor_ID	instructor_name
76766	Crick
45565	Katz
10101	Srinivasan
98345	Kim
76543	Singh
22222	Einstein

instructor

student_ID	student_name
98988	Tanaka
12345	Shankar
00128	Zhang
76543	Brown
76653	Aoi
23121	Chavez
44553	Peltier

student

Relationship Sets

- A relationship is an association among several entities
  - Example:

44553(Peltier) advisor 22222(Einstein)

student entity relationship set instructor entity

- A relationship set is a mathematical relation among n ≥ 2 entities, each taken from entity sets

$$\{(e_1, e_2, \ldots e_n) \mid e_1 \in E_1, e_2 \in E_2, \ldots, e_n \in E_n\}$$

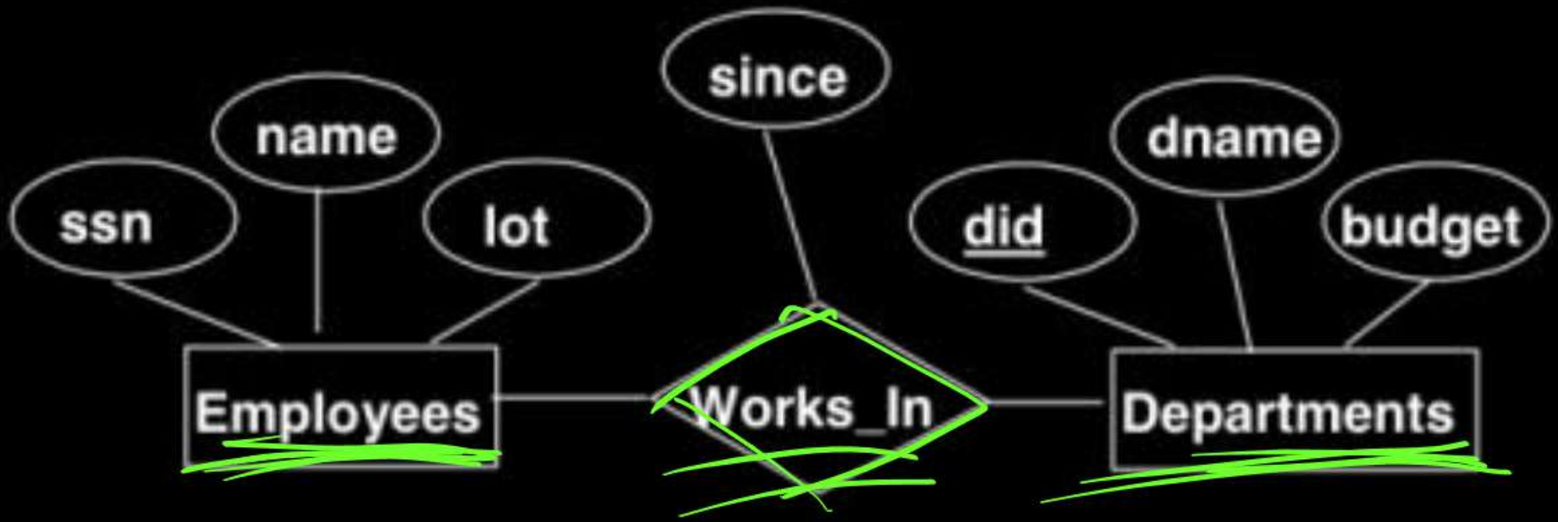
where $(e_1, e_2, \ldots, e_n)$ is a relationship

  - Example:

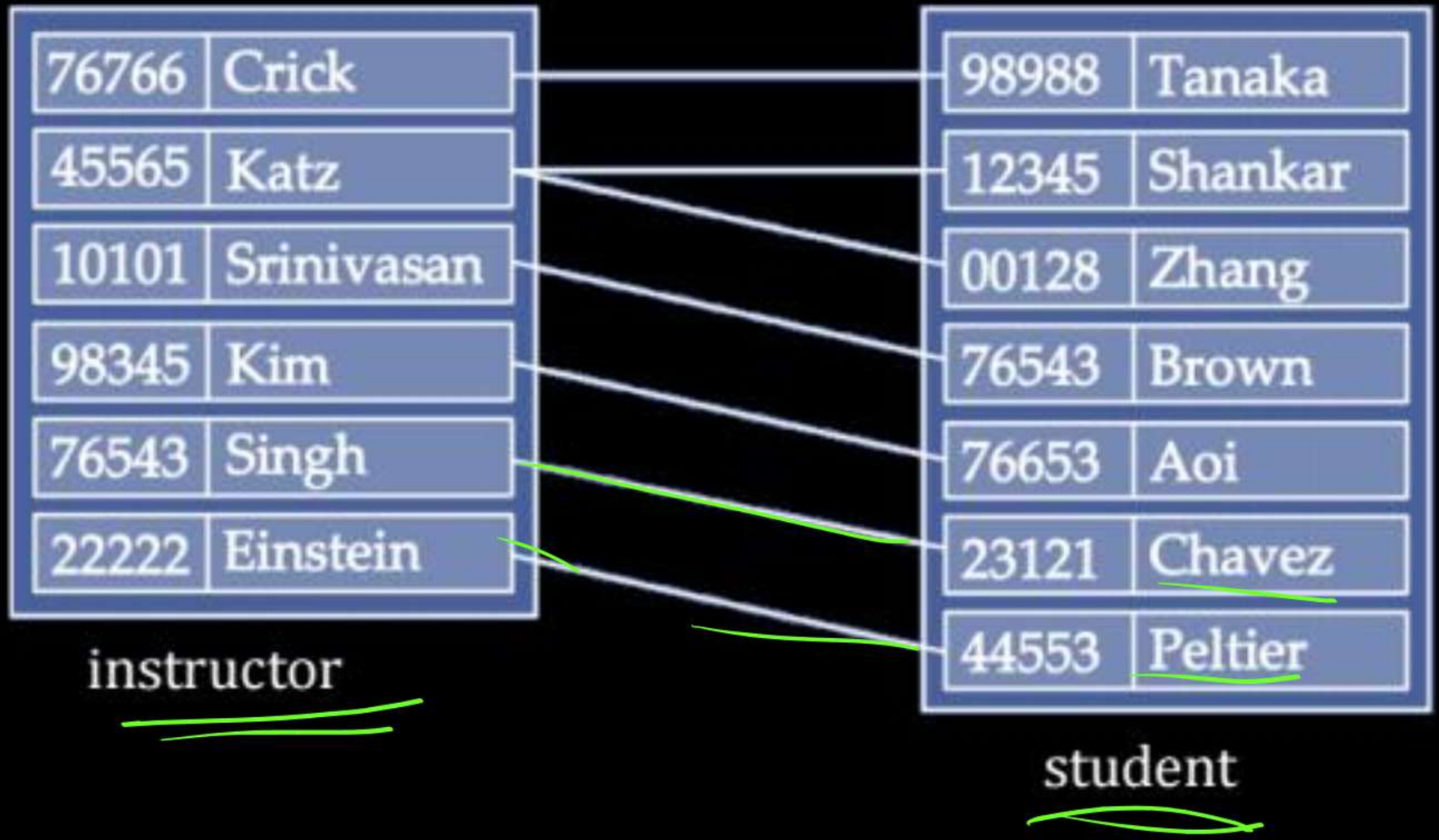
(44553, 22222) ∈ advisor or

Relationship Sets

- Collection of similar relationships.

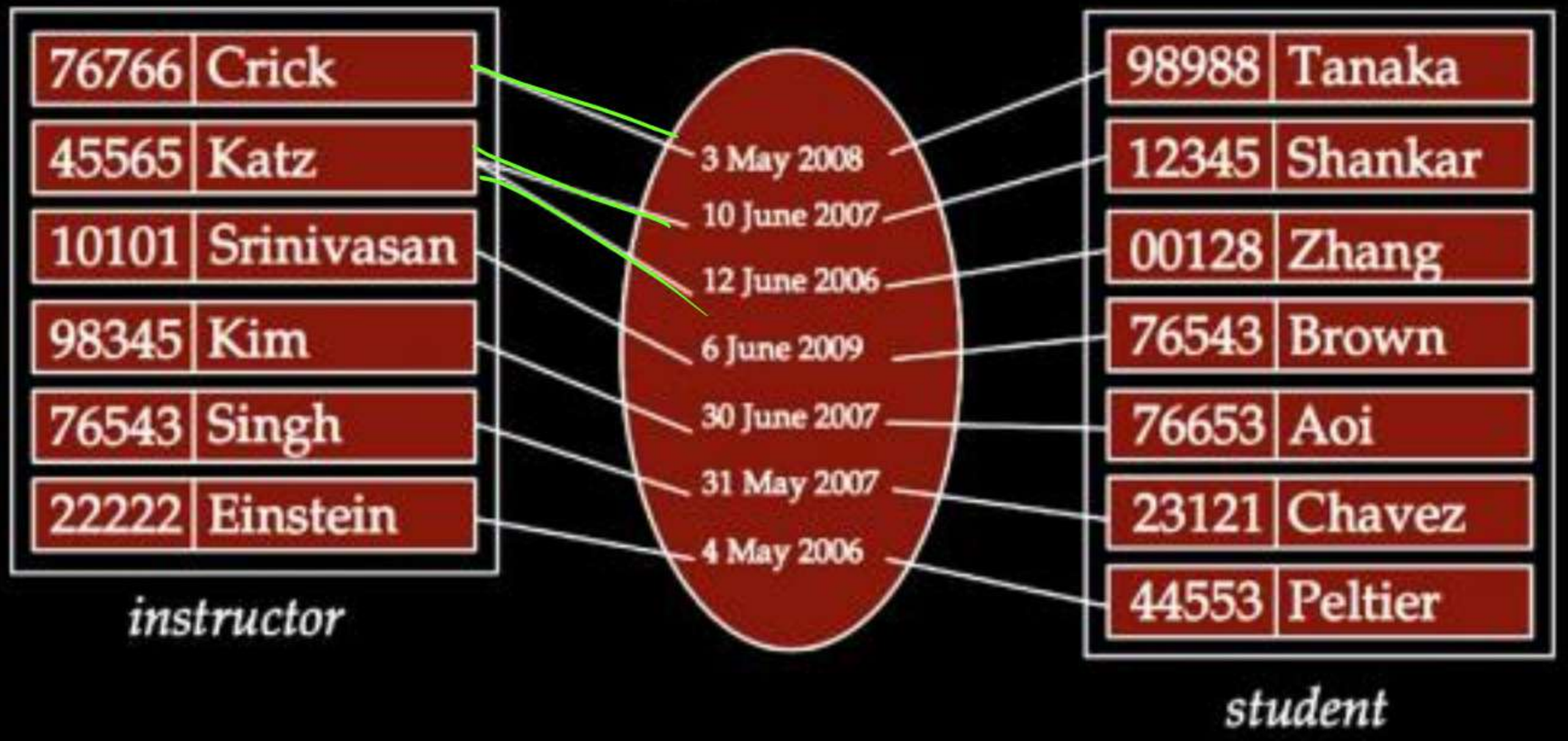


Relationship Set advisor



Relationship Sets

- An attribute can also be property of a relationship set.
- For instance, the advisor relationship set between entity sets instructor and student may have the attribute date which tracks when the student started being associated with the advisor

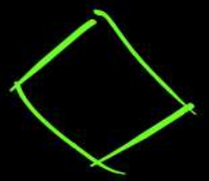


Entity : Object

Entity Set : 

Rectangle.

Relationship ⇒ (verb) ⇒ Read Work

Relationship Set 

Diamond

Attributes

Attributes are properties used to describe an entity.

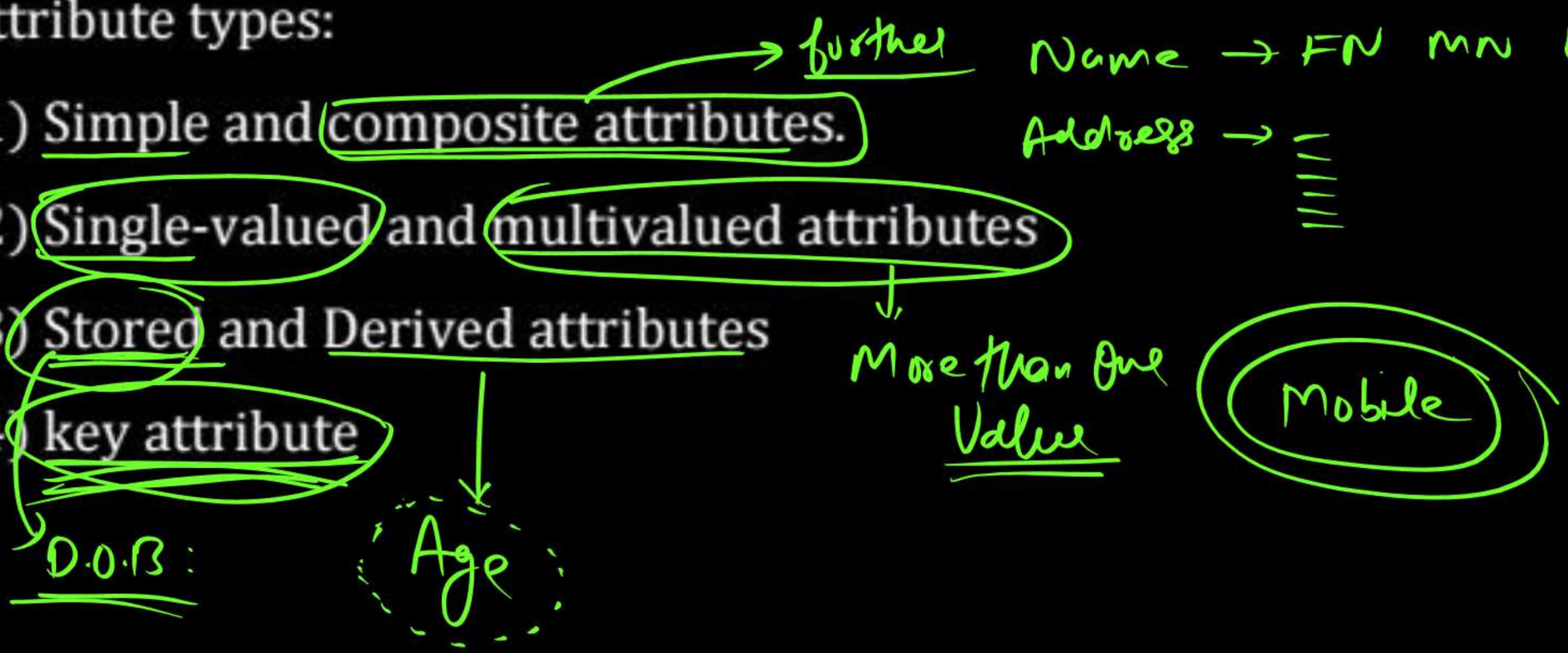
Attribute types:

(1) Simple and composite attributes.

(2) Single-valued and multivalued attributes

(3) Stored and Derived attributes

(4) key attribute

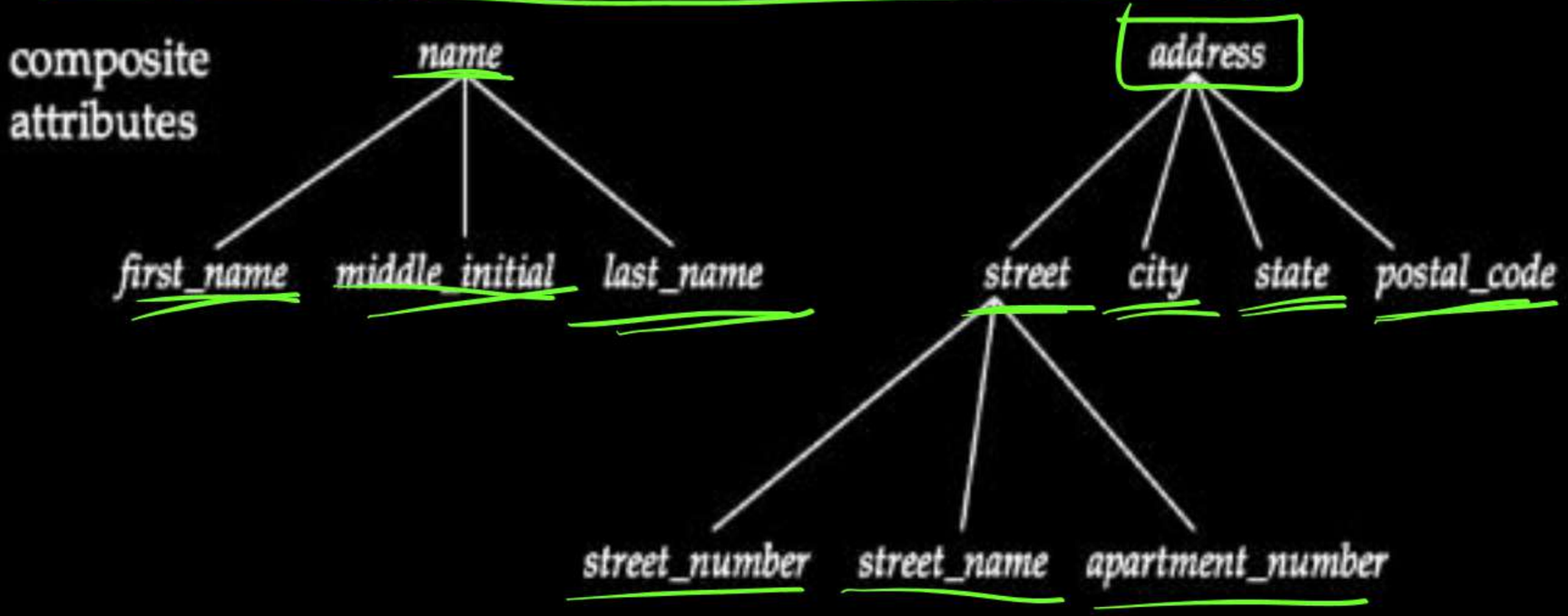


1) Simple & Composite attribute

- Simple

  Each entity has a single atomic value for the attribute. For example, SSN or Sex.
- Composite

  The attribute may be composed of several components. For example



2) Single-valued and multivalued attributes

One Value Per entity

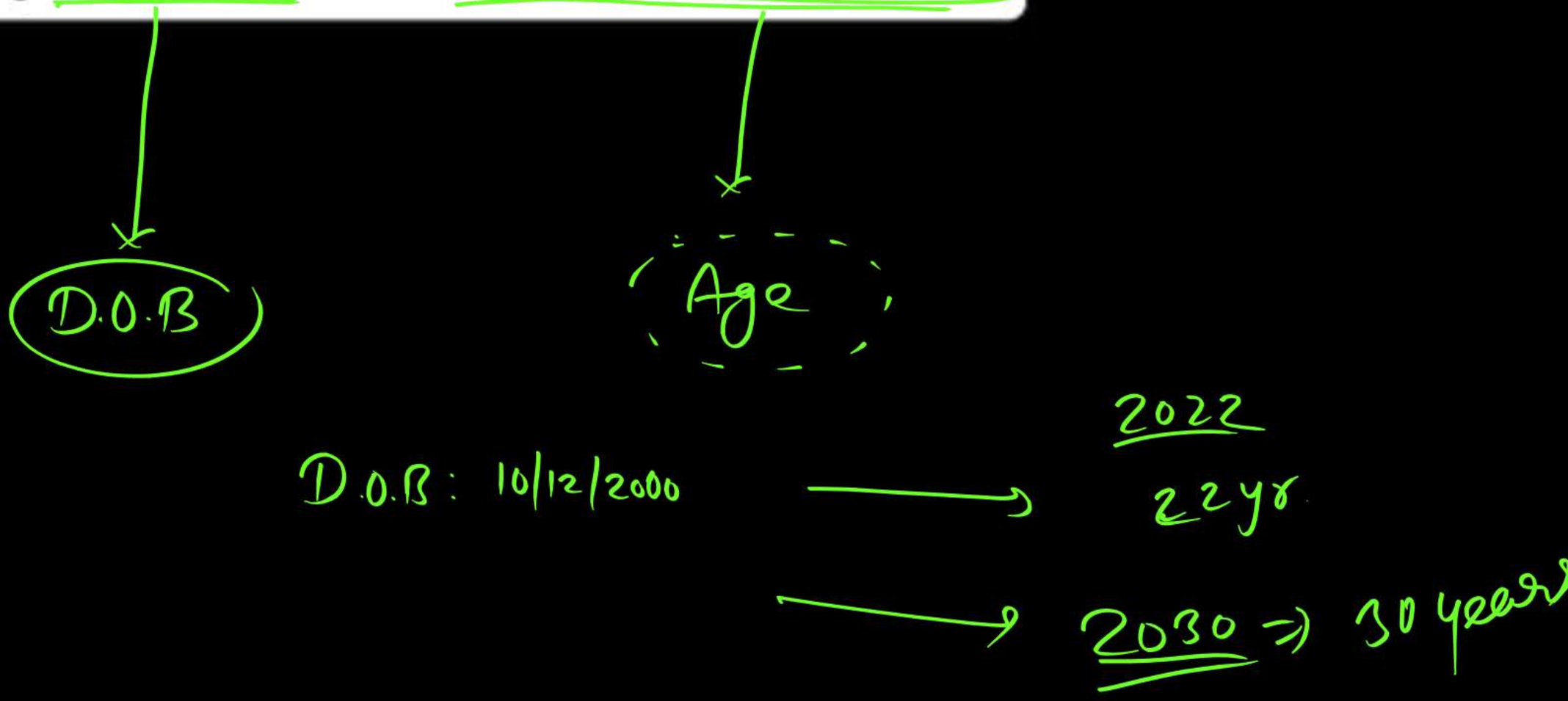
Roll No

Aadhaar

More than One Value Per entity

Mobile

3) Stored and Derived attributes



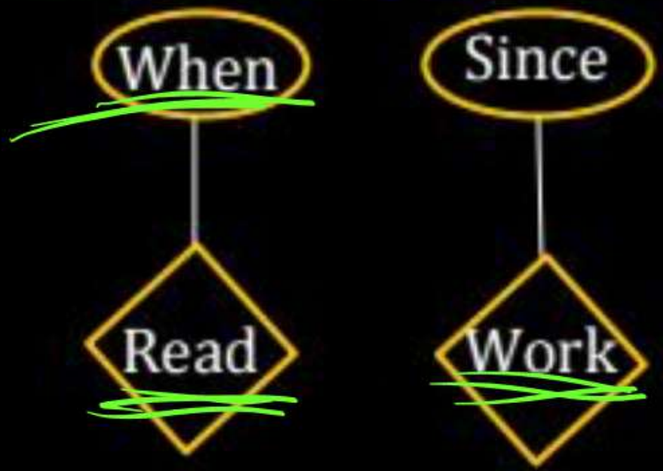
4) Key and Descriptive attributes

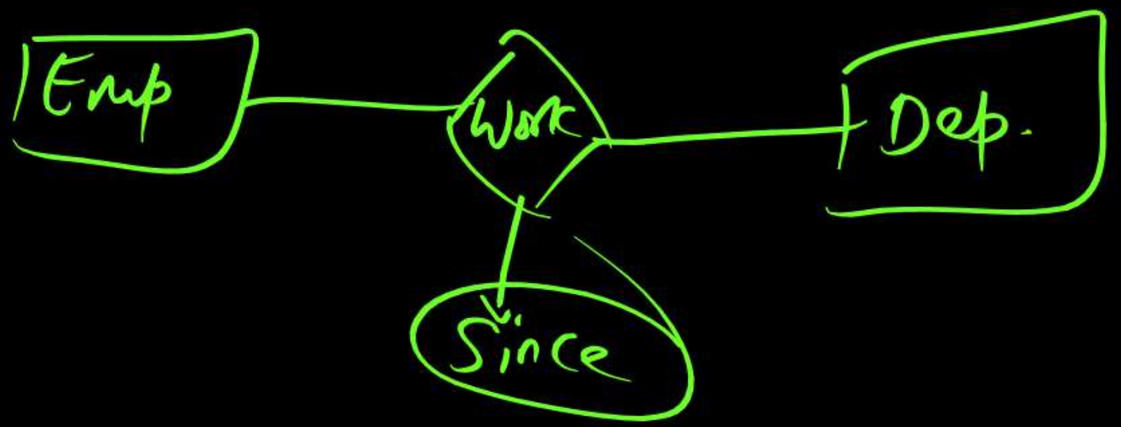
Key Attribute:

Which uniquely Identify an entity in the entity set.

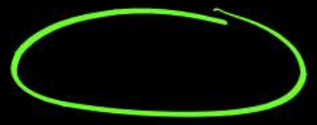
Descriptive Attribute:

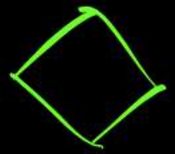
Which gives information about the relationship set





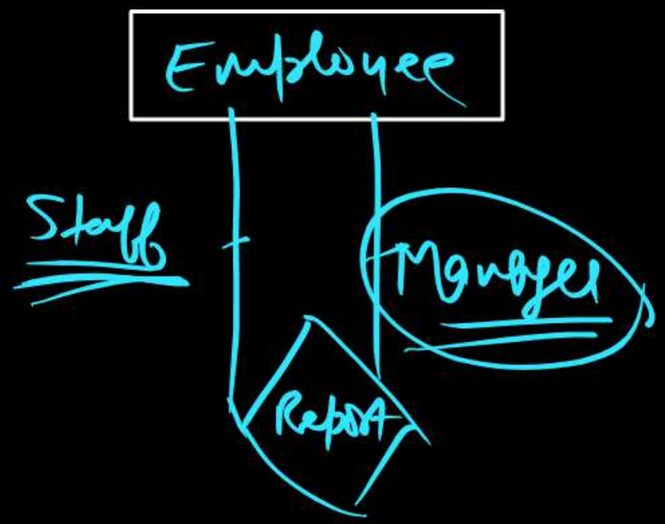
① Entity Set : 

② Attribute : 

③ Relationship set : 

Degree of Relationship set : How many Entity Set

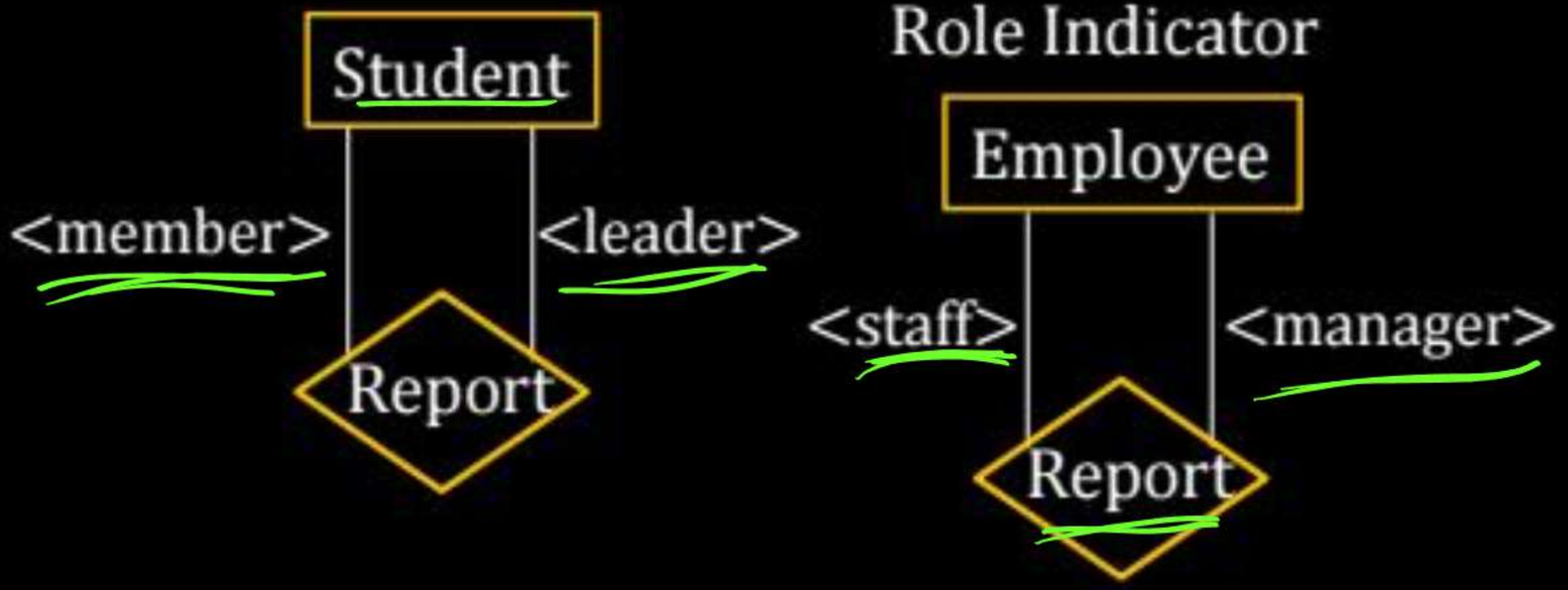
1. Unary
2. Binary
3. Ternary
4. n-ary



Degree of Relationship Set

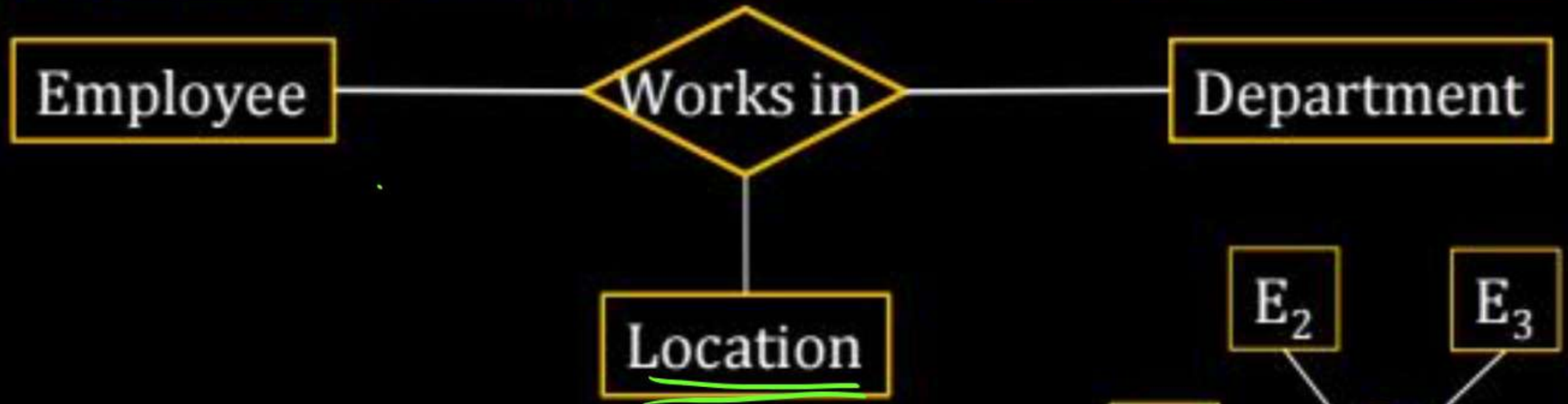
Degree of Relationship Set: Specifies the numbers of Entity set participate in a relationship set

1) UNARY: Relationship among two entities of the same entity set
[Recursive Relationship Set]



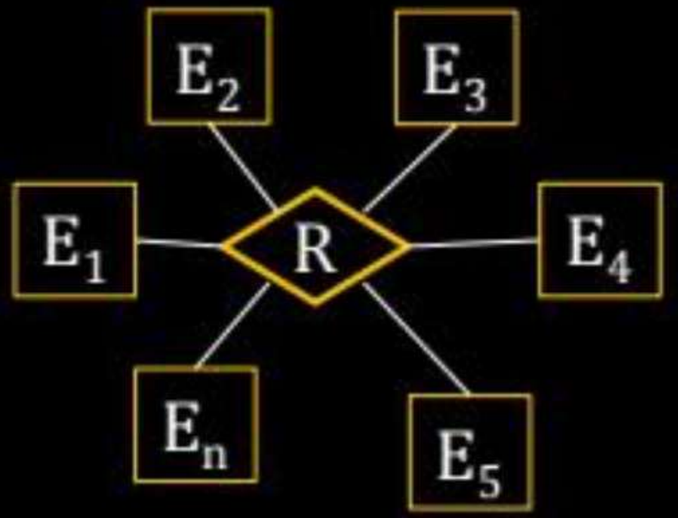
2) Binary Relationship: The relationship among two entity set

2) Ternary Relationship: The relationship among three entity set

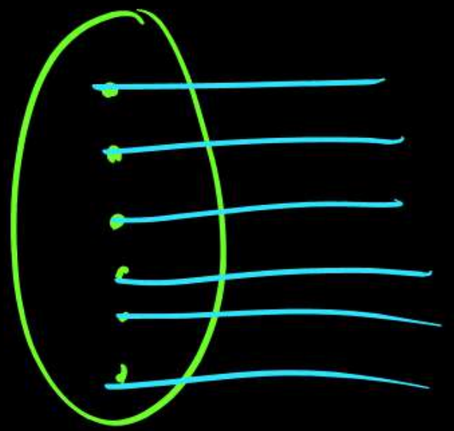


3) n-ary Relationship:

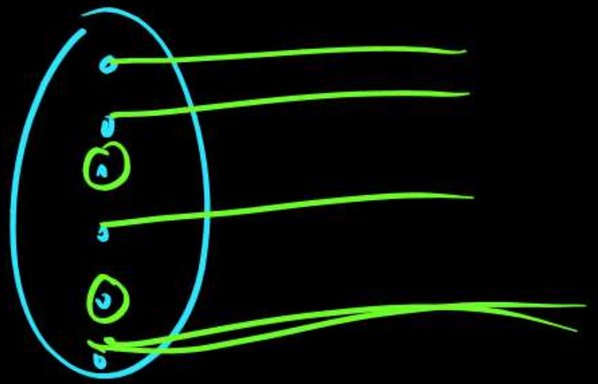
The relationship among n-entity set



Total



Partial



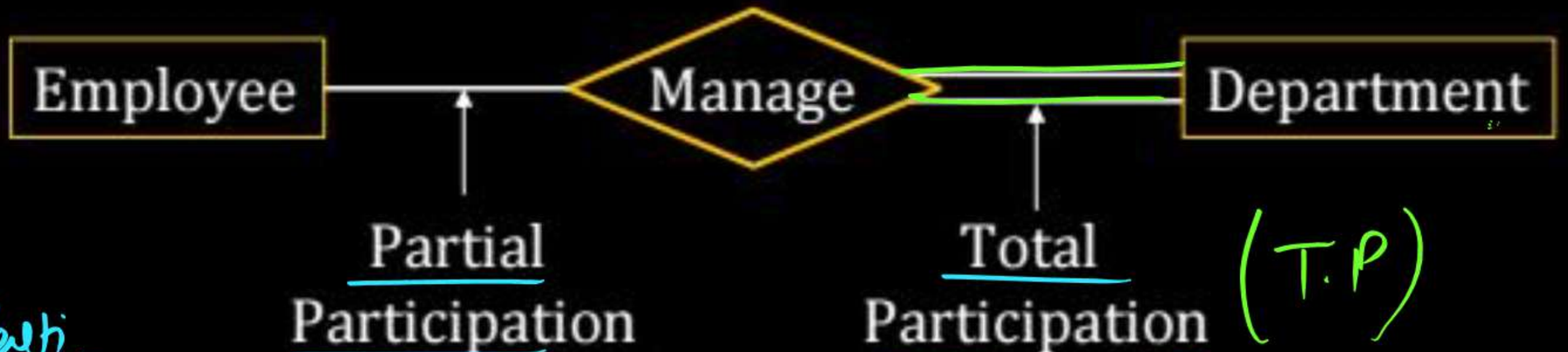
Participation Constraint

If every entity in the entity set participates in a relationship set is called

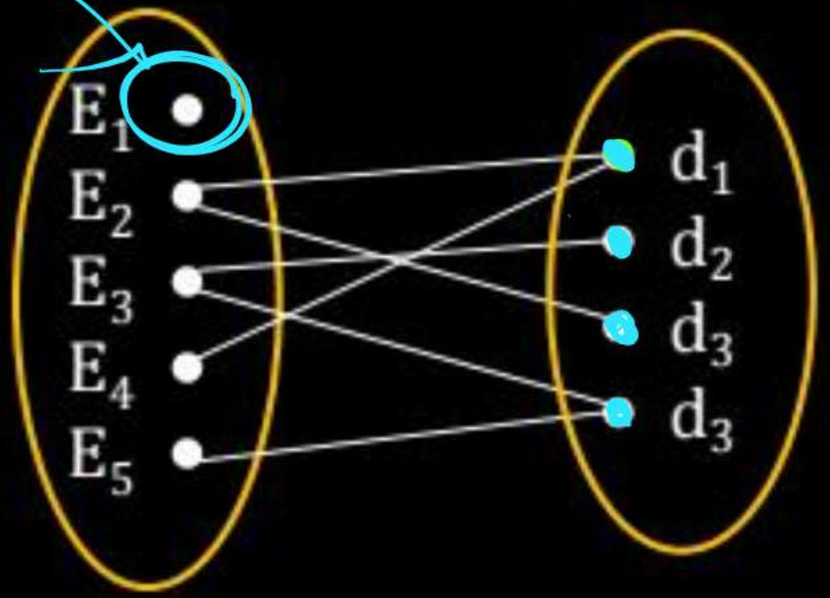
Total participation denoted by double ~~the~~ line (thick line)

otherwise it is called partial participation (thin line or single line)

Q. Each department is managed by at least one employee



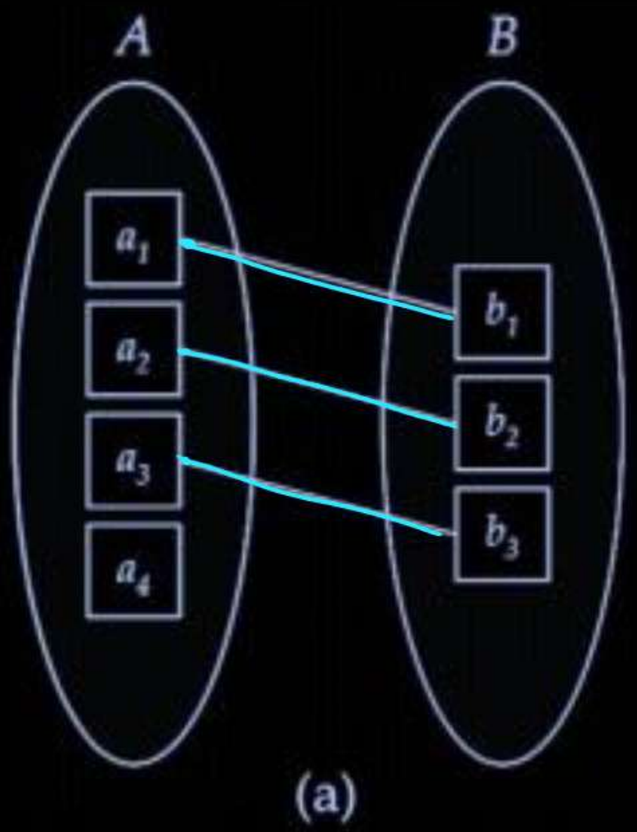
Not Reqd.



Mapping Cardinality Constraints

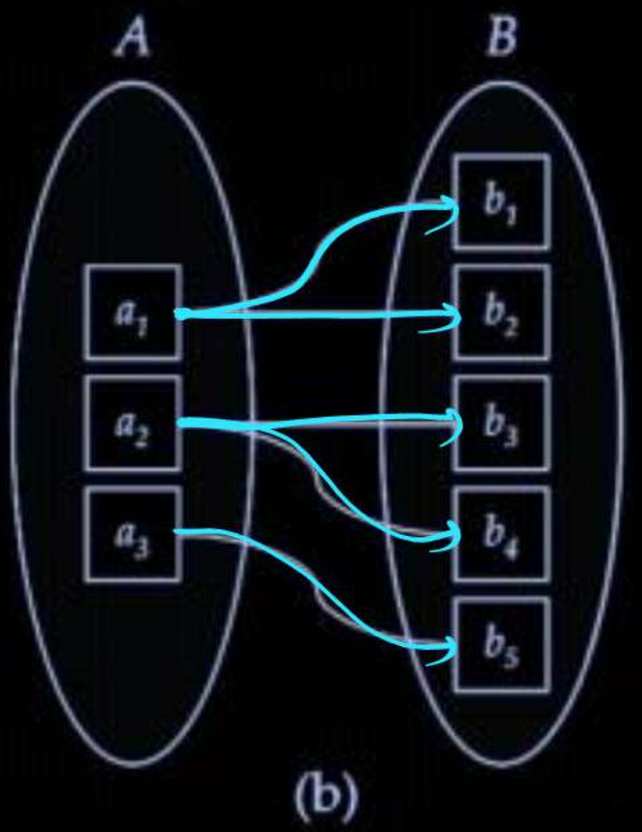
- Express the number of entities to which another entity can be associated via a relationship set.
- Most useful in describing binary relationship sets.
- For a binary relationship set the mapping cardinality must be one of the following types:
  1. One to one
  2. One to many
  3. Many to one
  4. Many to many

Mapping Cardinalities



(a)

One to one

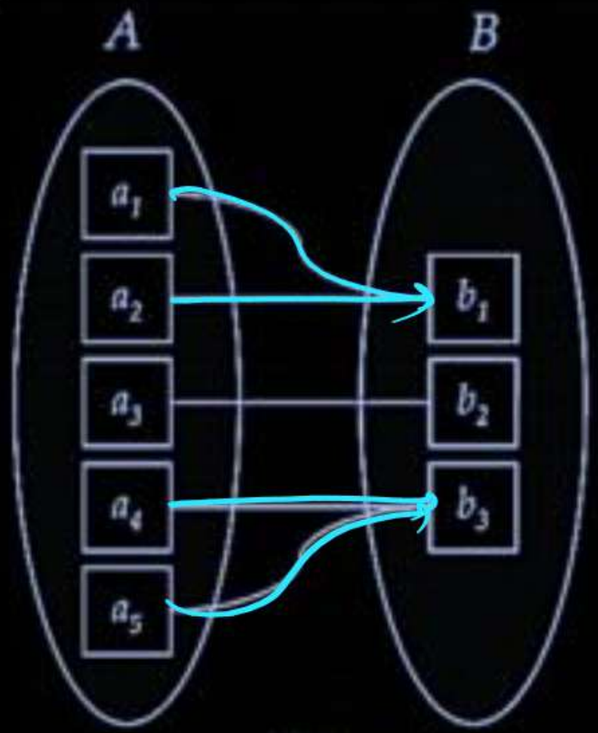


(b)

One to many

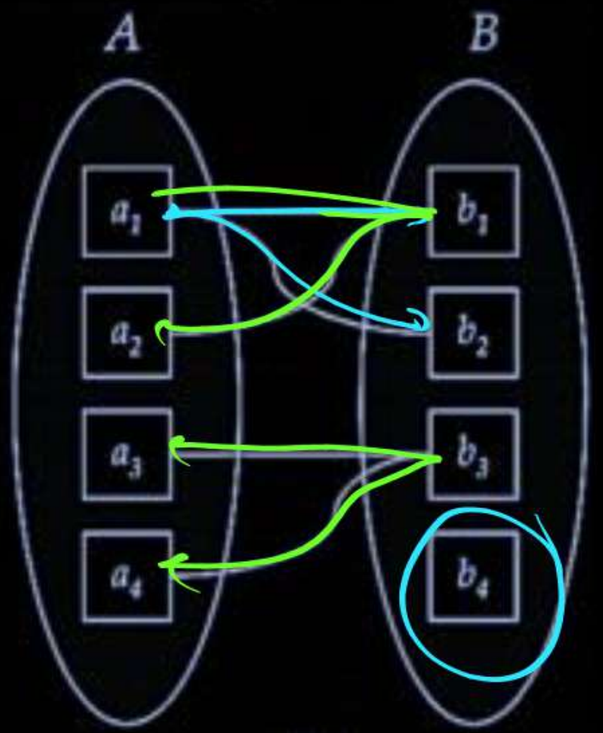
Note: Some elements in A and B may not be mapped to any elements in the other set

Mapping Cardinalities



(a)

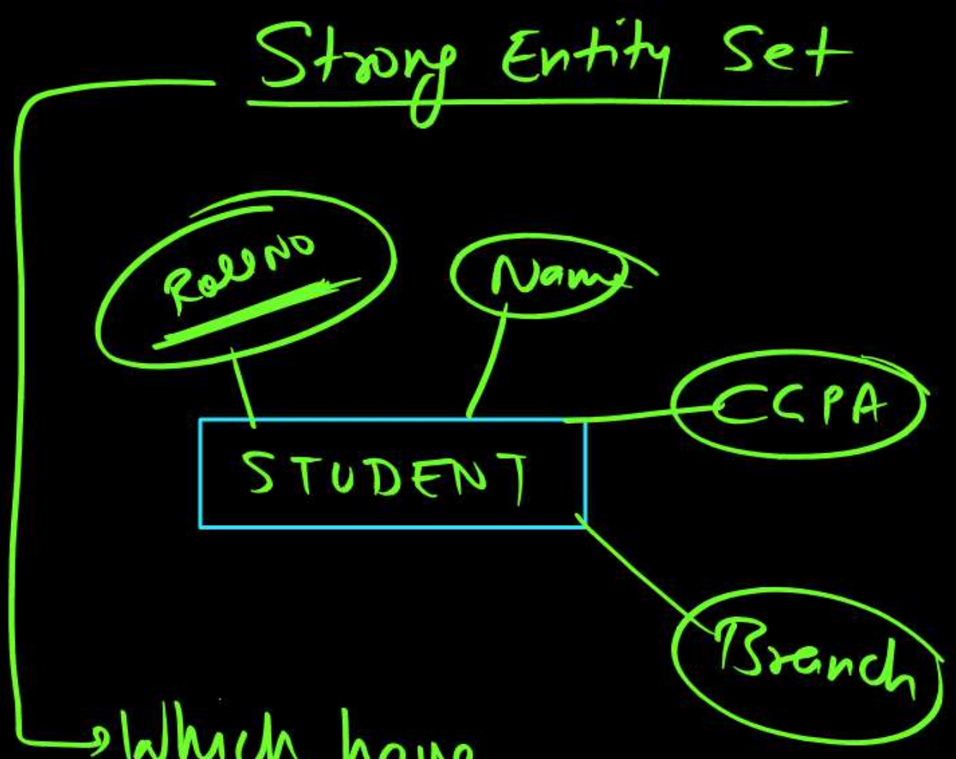
Many to one



(b)

Many to many

Note: Some elements in A and B may not be mapped to any elements in the other set

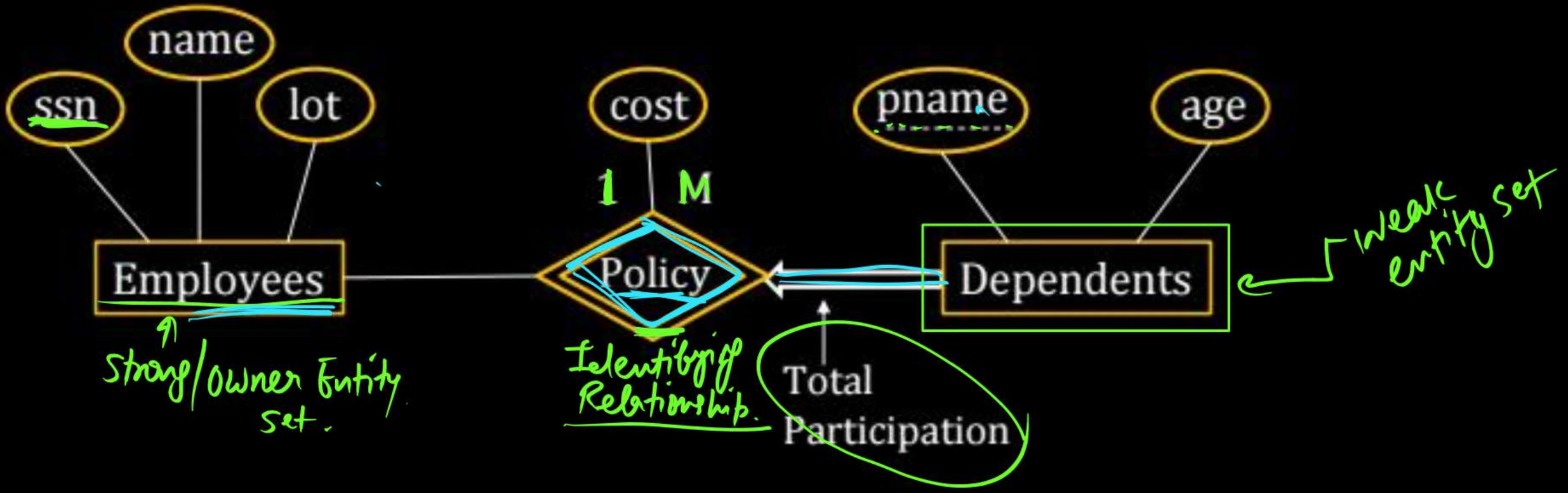

Strong Entity Set
RollNO
Name
CCPA
STUDENT
Branch
Which have
Key Attribute.

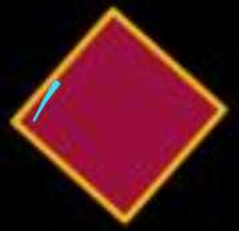
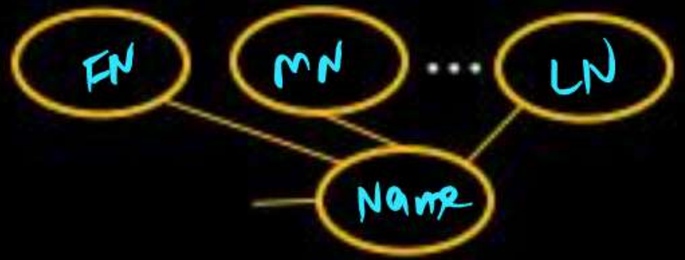

Weak Entity Set
Partial key
Dependent

Weak Entity Sets

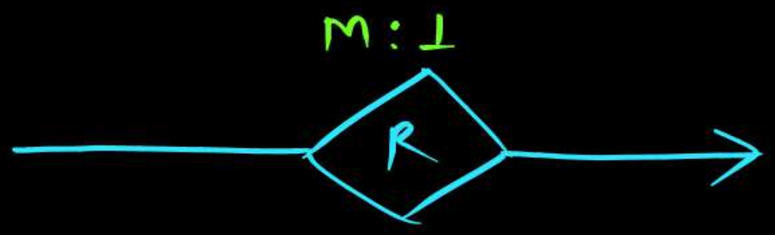
- An entity that does not have a key attribute
- A weak entity must participate in an identifying relationship type with an owner or identifying entity type
- Entities are identified by the combination of:
  - A partial key of the weak entity type
  - The particular entity they are related to in the identifying entity type

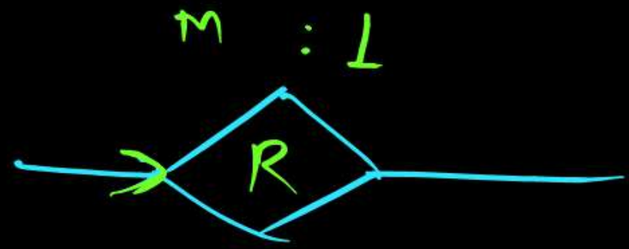
- A weak entity can be identified uniquely only by considering the primary key of another (owner) entity.
- Owner entity set and weak entity set must participate in a one-to-many relationship set (one owner, many weak entities).
- Weak entity set must have total participation in this identifying relationship set.

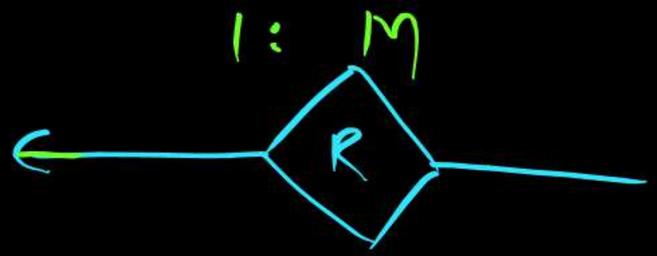


Symbol	Meaning
	Entity
	Weak Entity
	Relationship
	Identifying Relationship
	Attribute
	Key Attribute
	Multivalued Attribute
	Composite Attribute
	Derived Attribute

Symbol	Meaning
	Total Participation of E_2 in R
	Cardinality Ratio 1:N for E_1:E_2 in R

1. 



2. 

3. 

4. 

Many - to- Many relationship

One - to - One relationship

Many - to - One relationship

Q.1 Given the basic ER and relational models, which of the following is INCORRECT? [GATE-2012 : 1 Mark]

A. An attribute of an entity can have more than one value.

B. An attribute of an entity can be composite.

C. In a row of a relational table, an attribute can have more than one value.

D. In a row of a relational table, an attribute can have exactly one value or a NULL value.

C

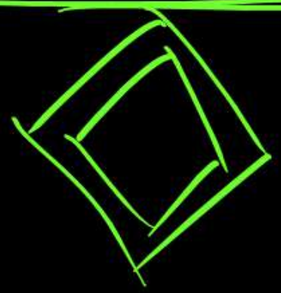
Q.2 Which one of the following is used to represent the supporting many-one relationships of a weak entity set in an entity-relationship diagram? [2020:1 Mark]

(A) Rectangles with double/bold border

(B) Ovals with double/bold border

(C) Ovals that contain underlined identifiers

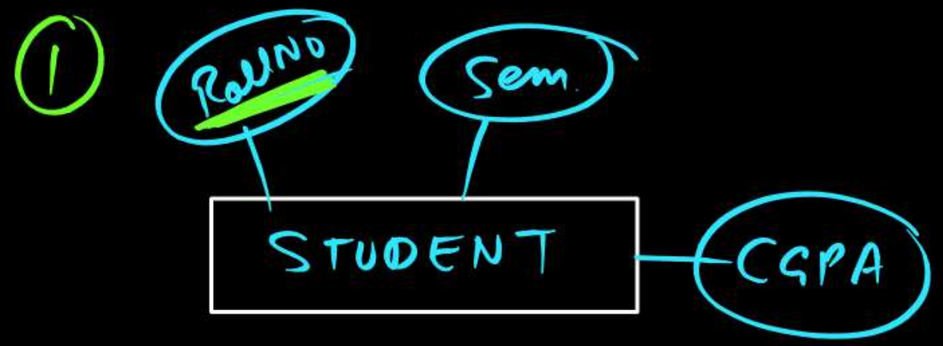
(D) Diamonds with double/bold border



ER to Relational Model Conversion

ER Model to RDBMS

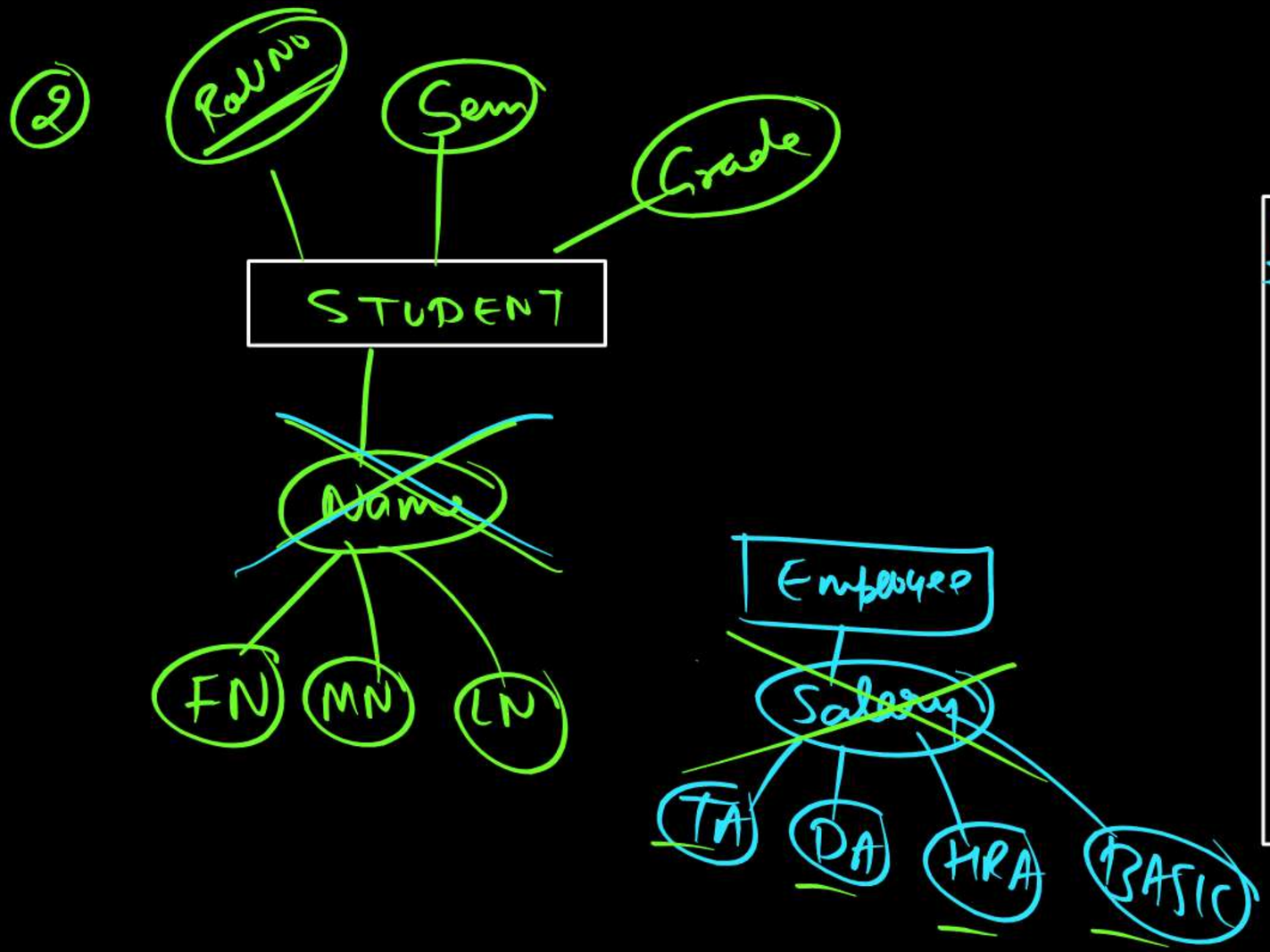
ER MODEL



RDBMS

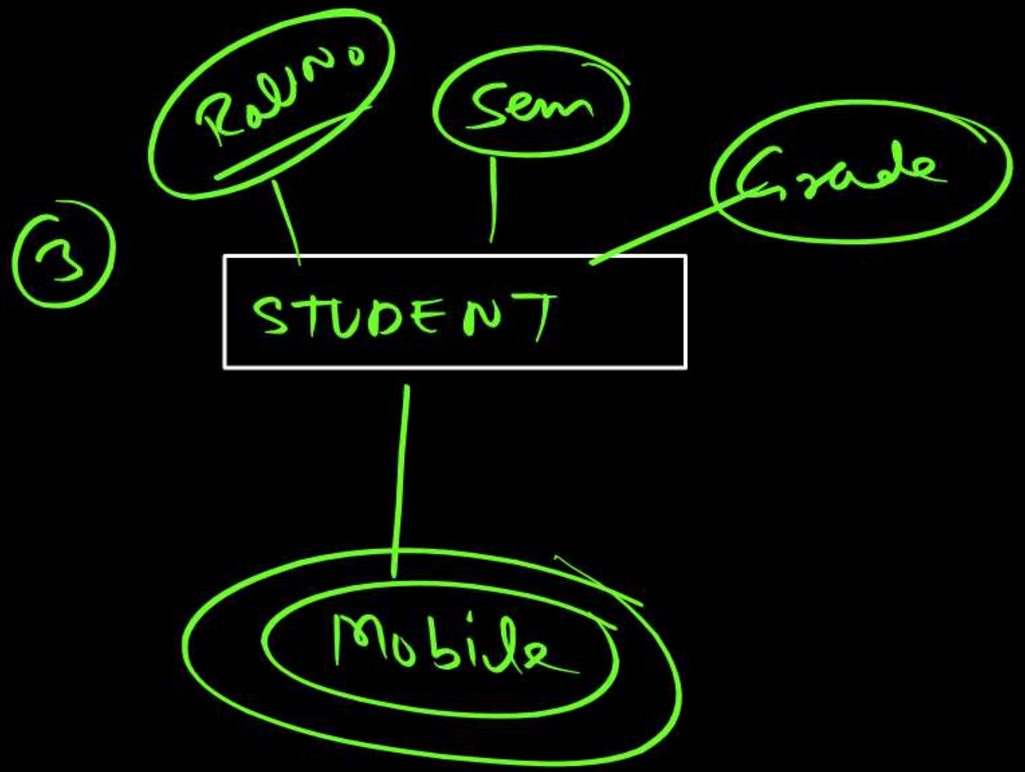
STUDENT

RollNo	Sem	CGPA



STUDENT

RollN	Sem	Gra	FN	MN	LN



1

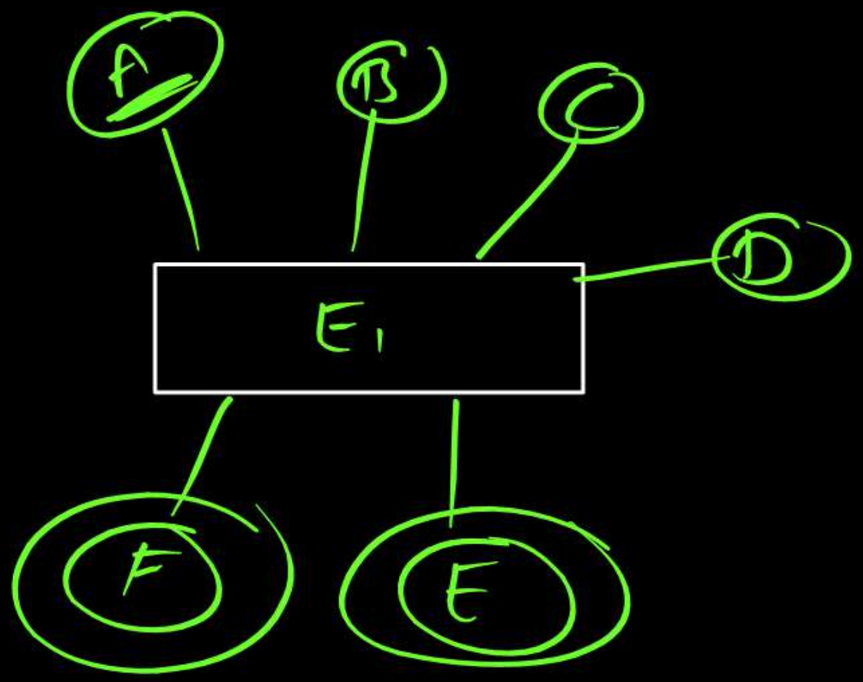
RollNO Sem Grade

2

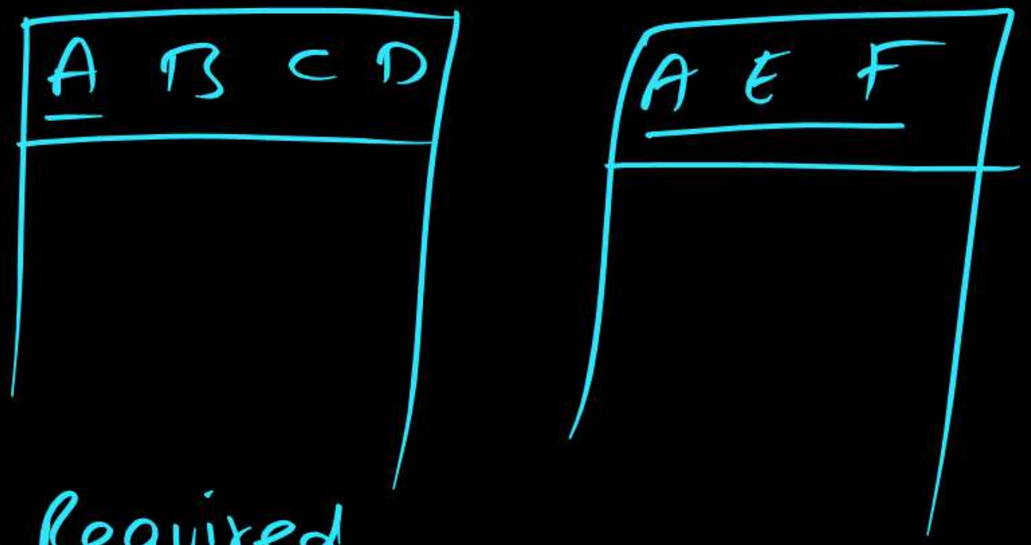
RollNO Mobile

2 Table

3(b)



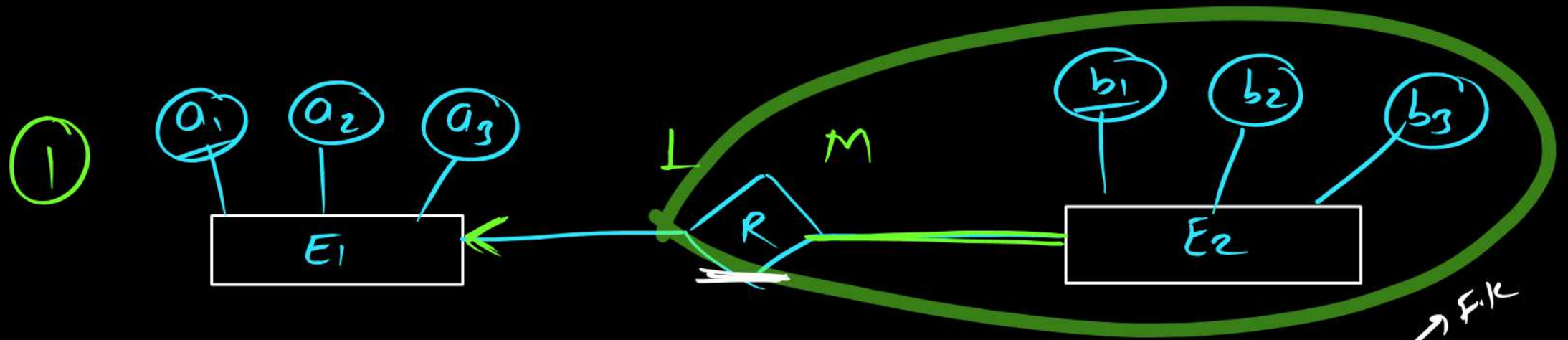
2 Table



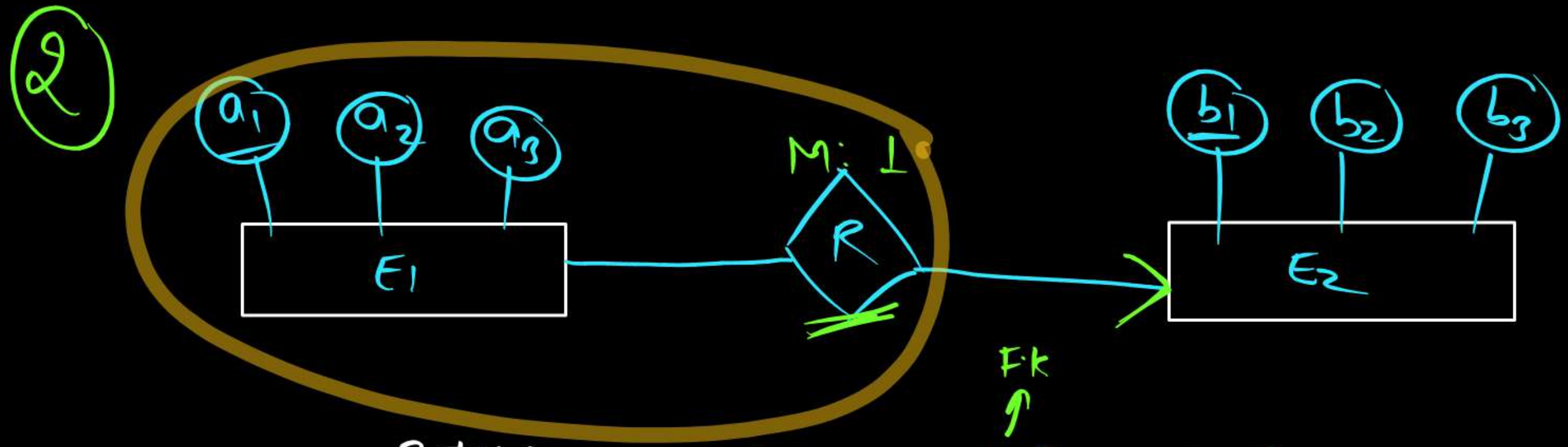
2 Table Required

1 Table for Key & All other Attribute.

2nd Table for Key & All Multivalue Attribute

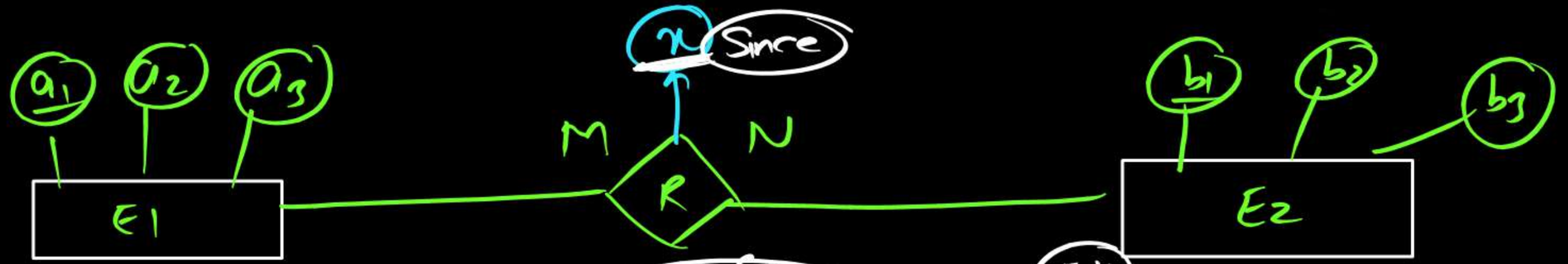


2 Table $E_1(\underline{a_1}\ a_2\ a_3)$ $RE_2(\underline{b_1}\ b_2\ b_3\ a_1)$ F.K



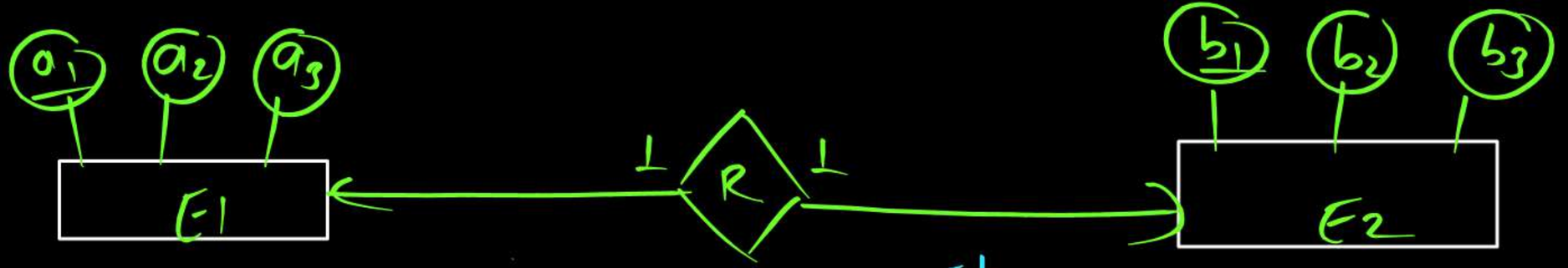
2 Table $E_1R(\underline{a_1}\ a_2\ a_3\ \underline{b_1})$ F.K $E_2(\underline{b_1}\ b_2\ b_3)$

(3)



3 Table $E_1(\underline{a_1}\ a_2\ a_3)$ $RE_1E_2(\underline{a_1\ b_1}\ x)$ $E_2(\underline{b_1}\ b_2\ b_3)$

(4)

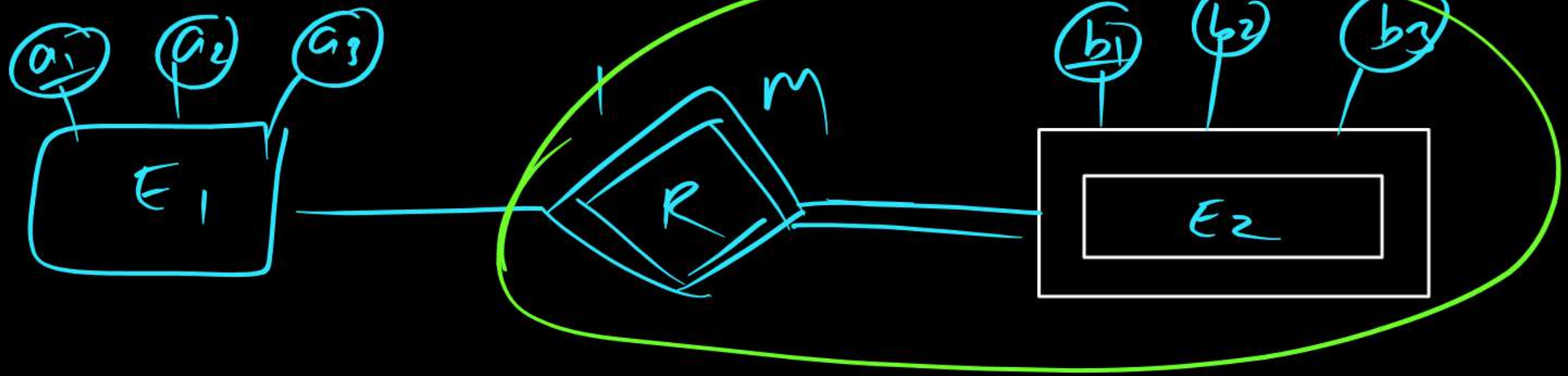


2 Table $E_1R(a_1\ a_2\ a_3\ \underline{b_1})$ & $E_2(\underline{b_1}\ b_2\ b_3)$ (F.K)

(OR)

$E_1(a_1\ a_2\ a_3)$ & $RE_2(\underline{b_1\ b_2\ b_3}\ a_1)$ F.K.

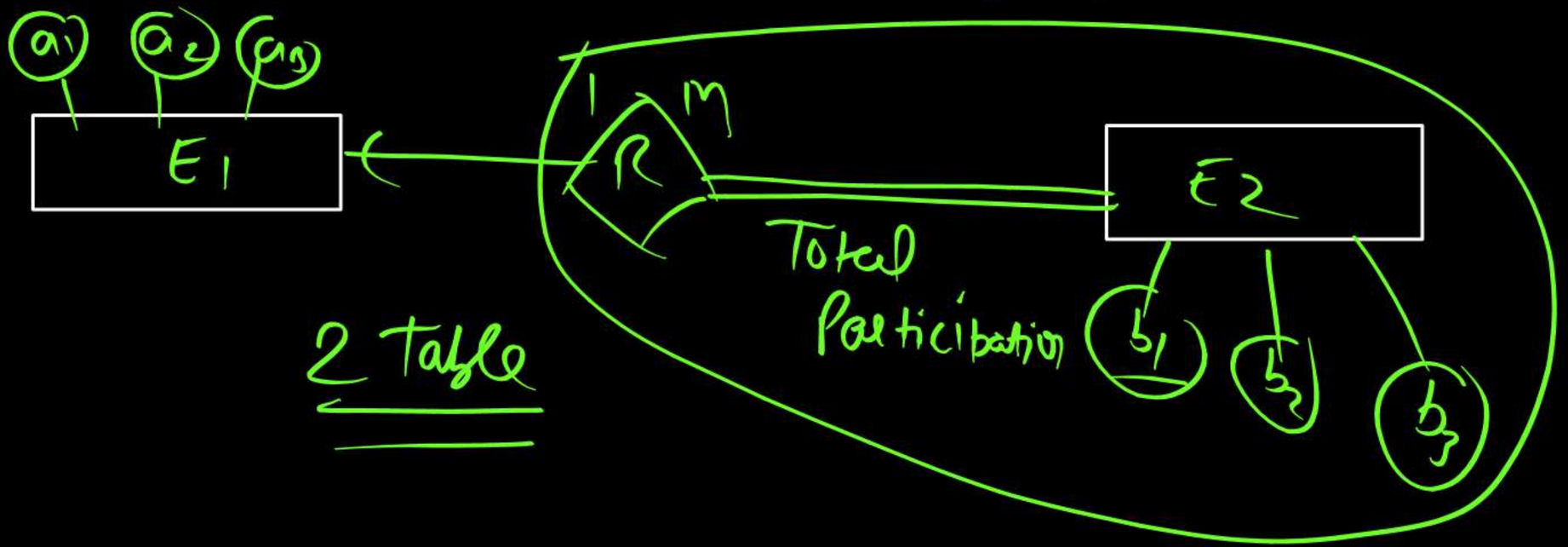
(5)



F.K

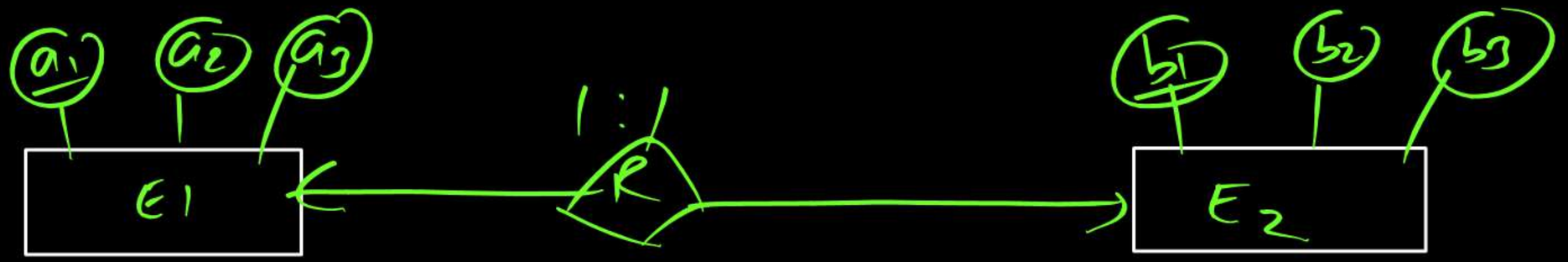
2 Table $E_1(a_1 a_2 a_3)$ & $RE_2(b_1 b_2 b_3 a_1)$

(6)



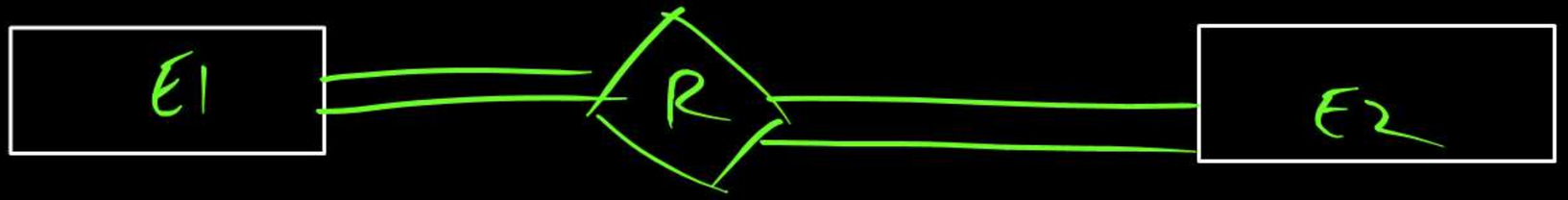
2 Table

(7)



2 Table $E_1 R_1(\underline{a_1} a_2 a_3 b_1)$ & $E_2(b_1 b_2 b_3)$

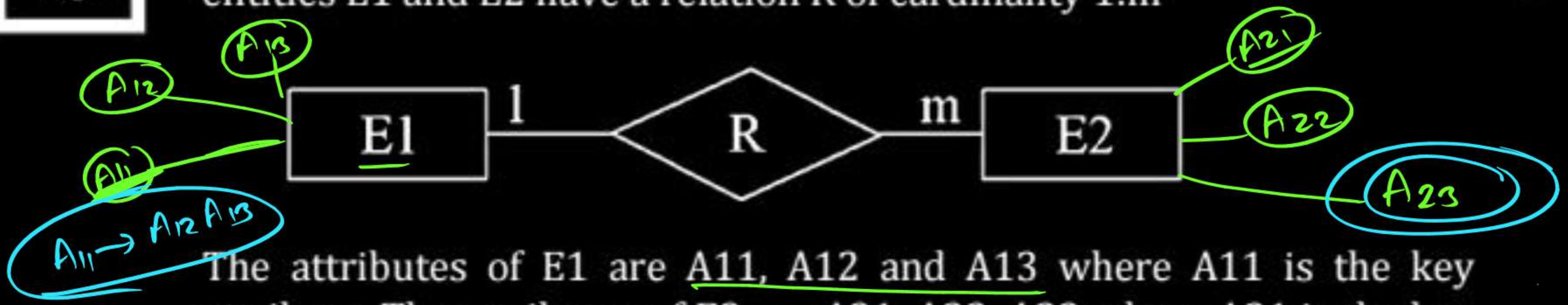
(8)



1 Table $R E_1 E_2$

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

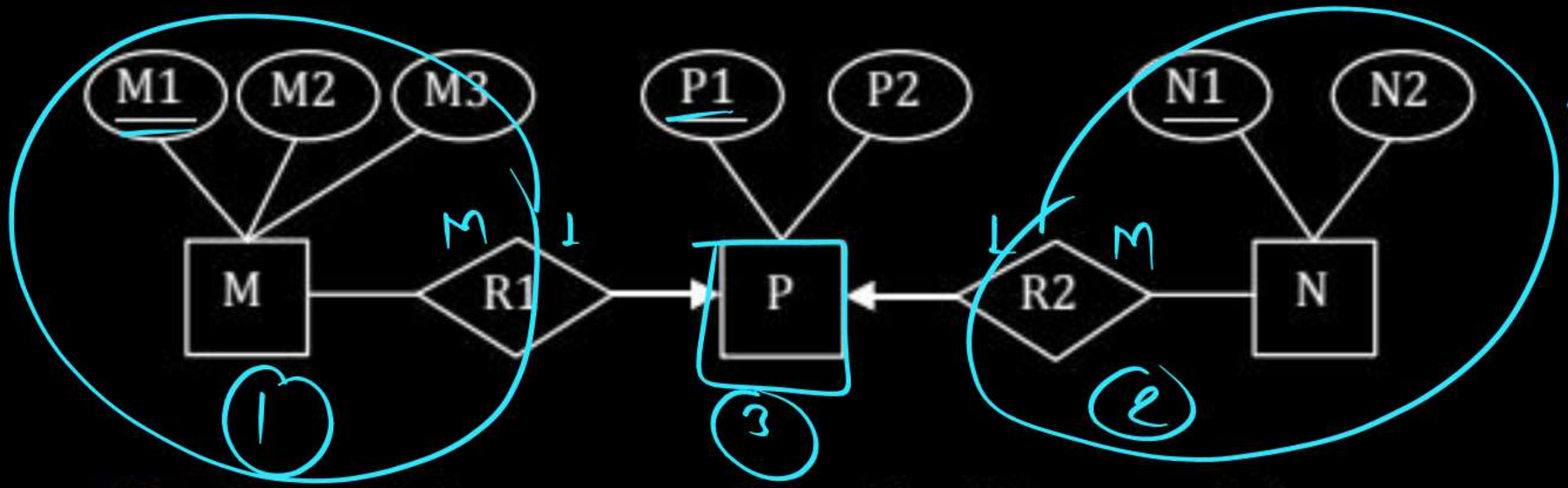
$E_1(a_{11}\ a_{12}\ a_{13})$ $RE_2(A_{21}\ A_{22}\ \underline{a_{11}})$ ← F·K

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

Q.

Common Data for Question

Consider the following ER Diagram



MR1(M1 M2 M3 P1)
F.K
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

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}

Keys

Super key

↳ Candidate key

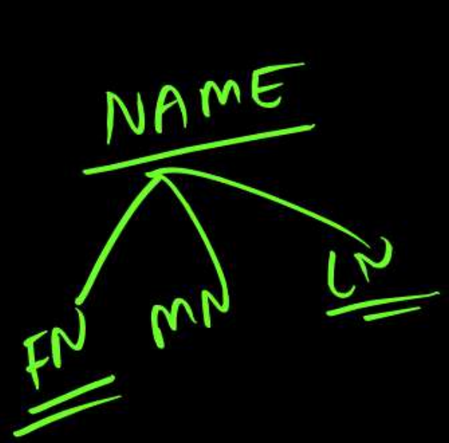
→ Primary key

→ Alternative/ Secondary key

X Surrogate key

Foreign key

'NULL': Unknown / Unexisted /



Not Applicable

Integrity Constraint

Integrity Constraint → Condition → Schema

RollNo	
1	x
2	y
3	z
4	w
4	

1. Domain Constraint (Atomic & Domain)
2. Key Constraint (Unique.)
3. Entity Integrity Constraint (P.k Not Null)
4. Referential Integrity Constraint
   - Foreign key

Finding Number of Super key

Let R be the Relational Schema with Attribute $A_1, A_2 A_3 \ldots A_n$

How many Super key are there?

(i) Candidate A_1.

(ii) C.K A_1, A_2

(iii) C.K $A_1 A_2$, $A_3 A_4$

(iv) C.K $A_1 A_2$, $A_2 A_3$

(v) C.K A_1, A_2, A_3

$(A_1, A_2, A_3, A_4, \ldots, A_n)$

Sum1 Candidate A_1

Super key

A_1

$A_1 A_2$

$A_1 A_2 A_3$

n: # Attribute

A_1 $A_2 A_3 \ldots A_n$ $(n-1)$

$\#\text{Super key} = 2^{n-1}$

GATE $R(ABCD)$ C.K : A

Super keys ?

Sum

$\#\text{Super key} = 2^{n-1}$

$= 2^{4-1}$

$= 8$ Super key

OR

$R(\underline{A}\,B\,C\,D)$

$2^3 \Rightarrow 8$ Super key

A	B	C	D	
0	0	0		→ A
0	0	1		→ AD
0	1	0		→ AC
0	1	1		→ ACD
1	0	0		→ AB
1	0	1		→ ABD
1	1	0		→ ABC
1	1	1		→ ABCD

(2) Calculate $A_1 \cup A_2$

A_1

$A_1\ A_2$

$A_1\ A_2\ A_3$

$A_1\ A_2\ A_3 \dots A_n$ — $(n-1)$

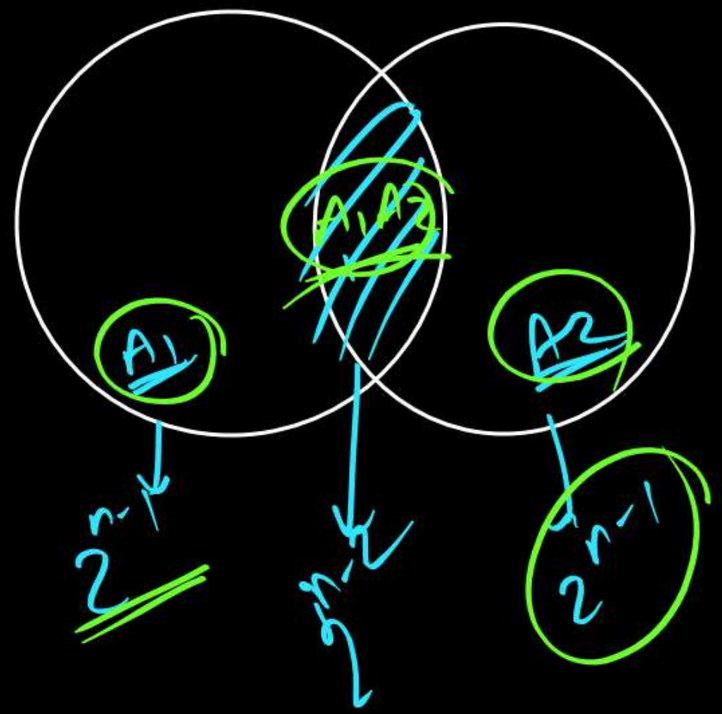
A_2

$A_2\ A_1$

$A_2\ A_1\ A_3$

$A_2\ A_1\ A_3 \dots A_{n-1}$ — $n-1$

$$2^{n-1} + 2^{n-1} - 2^{n-2}$$



$R(ABCD)$ C.K : $[A, B)$

$$\#\text{Subsequences} = 2^{4-1} + 2^{4-1} - 2^{4-2}$$

$$\Rightarrow 8 + 8 - 4$$

$$= 12 \text{ Subsequences}.$$

2M

Q $R(ABCDE)$ C.K $[\underline{A}, BC)$

Sol

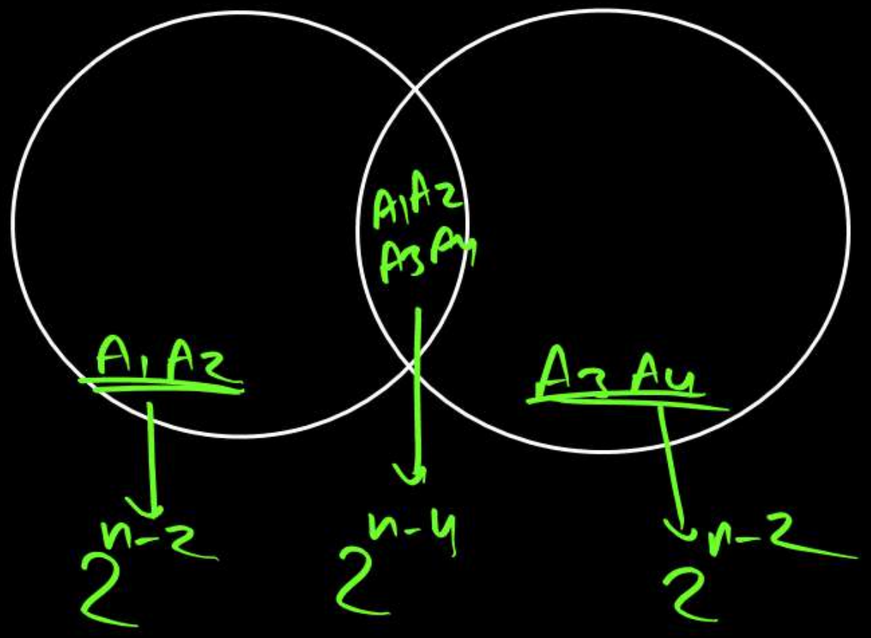
$$\#\text{Subsequences} = 2^{5-1} + 2^{5-2} - 2^{5-3}$$

$$\Rightarrow 2^4 + 2^3 - 2^2$$

$$\Rightarrow 16 + 8 - 4$$

$$= 20 \text{ Subsequences}$$

(iii) A_1A_2, A_3A_4



$$\#\text{Subkeys} = 2^{n-2} + 2^{n-2} - 2^{n-4}$$

(Q) $R(ABCDE)$ $C: IC(AB, CD)$

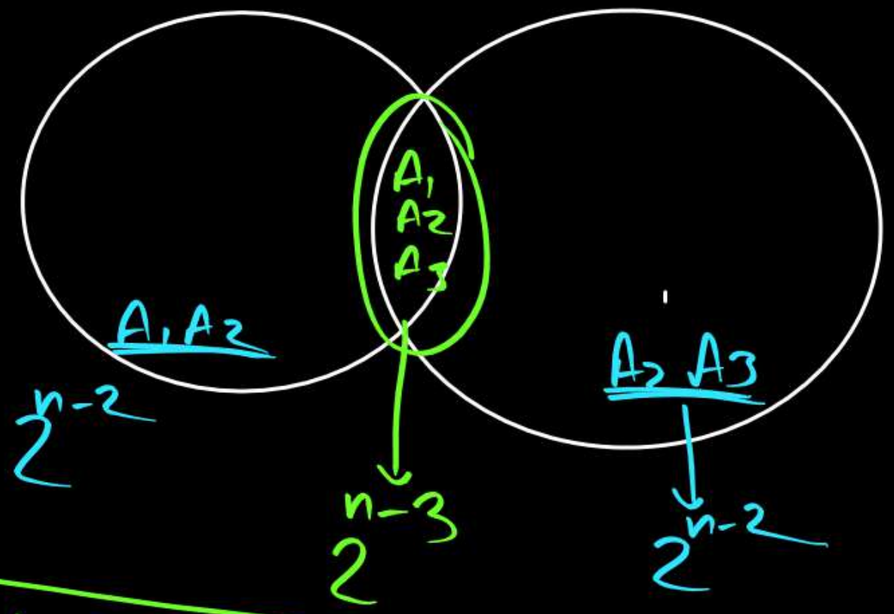
$$\#\text{Subkeys} = 2^{5-2} + 2^{5-2} - 2^{5-4}$$

$$\Rightarrow 2^3 + 2^3 - 2^1$$

$$\Rightarrow 8 + 8 - 2$$

$$= 14 \text{ Ans}$$

(iv) A_1A_2 , A_2A_3



$$\#\text{Subkey} = 2^{n-2} + 2^{n-2} - 2^{n-3}$$

Q $R(ABCDE)$ C.K $[AB, BC]$

$$\#\text{Subkey} = 2^{5-2} + 2^{5-2} - 2^{5-3}$$

$$\Rightarrow 2^3 + 2^3 - 2^2$$

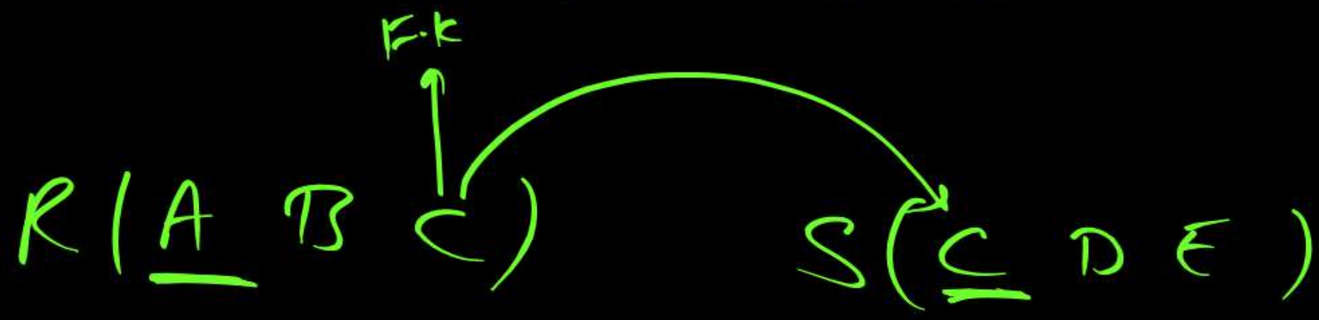
$$= 8 + 8 - 4$$

$$= 12$$ Ans

A_1, A_2, A_3

$$n(A_1 \cup A_2 \cup A_3) \Rightarrow 2^{n-1} + 2^{n-2} + 2^{n-1} - 2^{n-2} - 2^{n-2} - 2^{n-2} + 2^{n-3}$$

Foreign key :: Ref. to Primary key / Alternative key of Same Table or other Table



R(A B C) S(D E F)

Referencing Relation : Table Which Contain foreign key is called Referencing Relation.

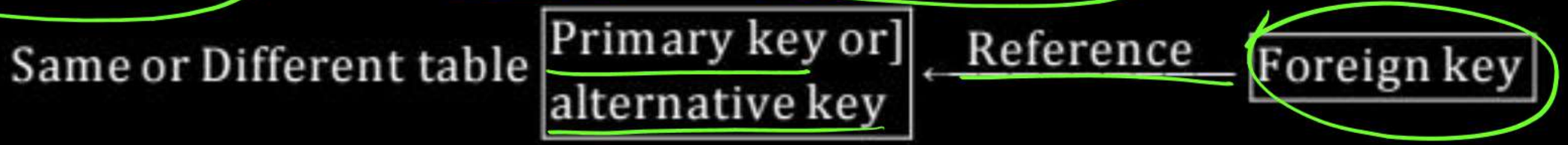
(CHILD Table)

Referenced Relation

↳ Parent Table

Foreign Key

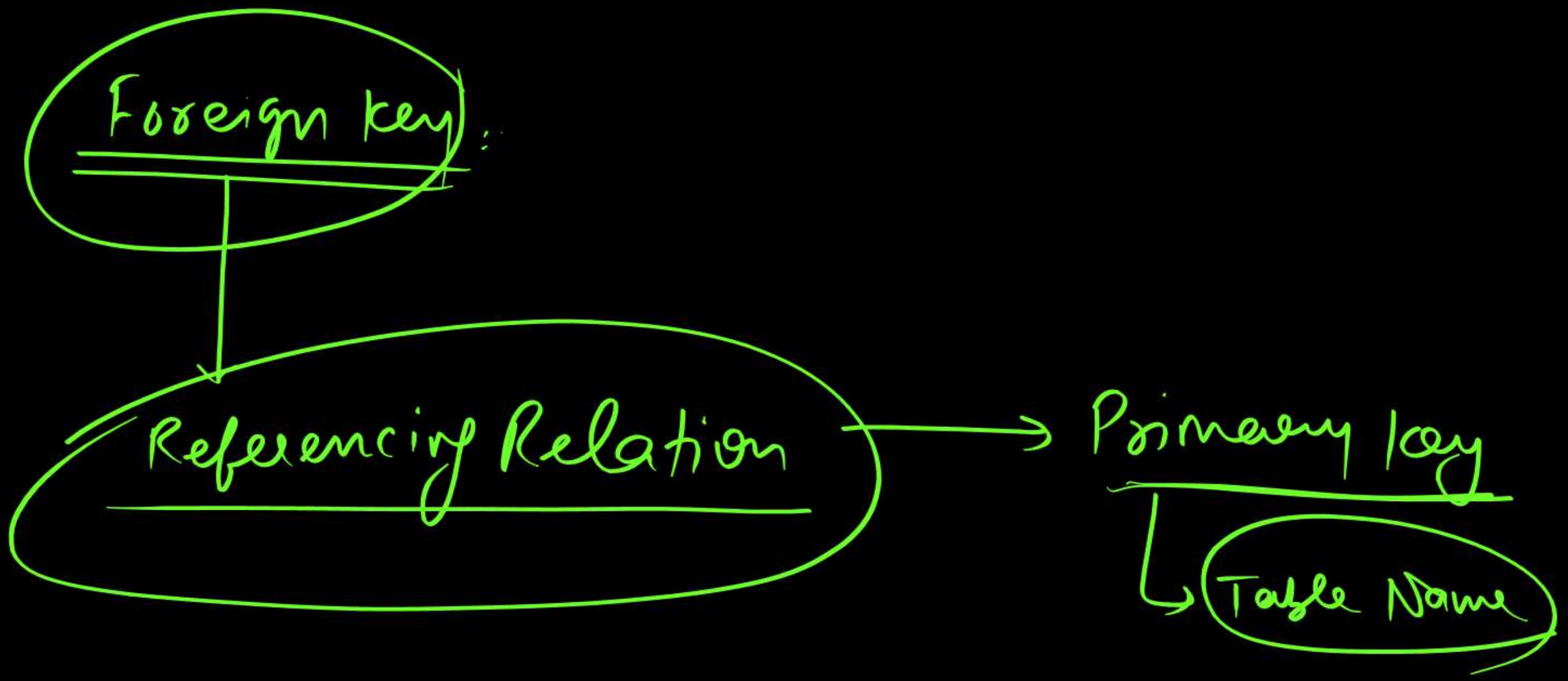
Foreign Key: is a set of Attribute reference to the primary key or alterative key of the same table or same other table.



It is used to relate or relation (table) with other or same relation (table)

Referencing Relation: Table which contain the foreign key is known as Referencing Relation [CHILD Relation].

Referenced Relation: Table which is referenced by foreign key is referenced relation.


Foreign key :
Referencing Relation
Primary key
Table Name

Foreign Key Constraint
[Referential Integrity Constraint]

STUDENT		
Sid	Sname	Login
S_1	A	
S_2	A	
S_3	B	
S_4	C_1	

[Sid: Primary Key]

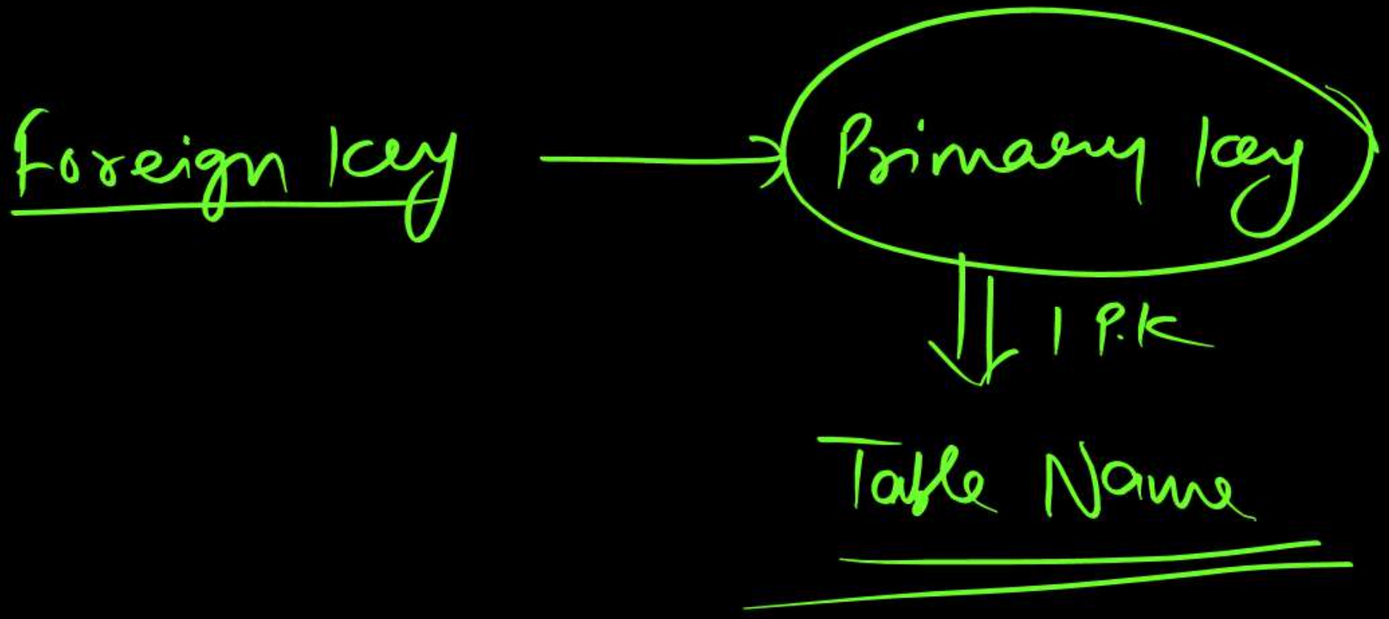
Referenced Relation (Parent)

Enrolled		
Sid	Cid	Fed
S_1	C_1	5K
S_1	C_2	6K
S_2	C_1	7K
S_3	C_2	8K

[Sid, Cid: Primary Key]

Referencing Relation (CHILD)

Sid of Enrolled table is the foreign key referencing to the primary key of student table.


Foreign key
Primary key
I P.K
Table Name

CREATE TABLE ENROLLED

Sid Varchar (10)

Cid Varchar (10)

Fees Integer (11)

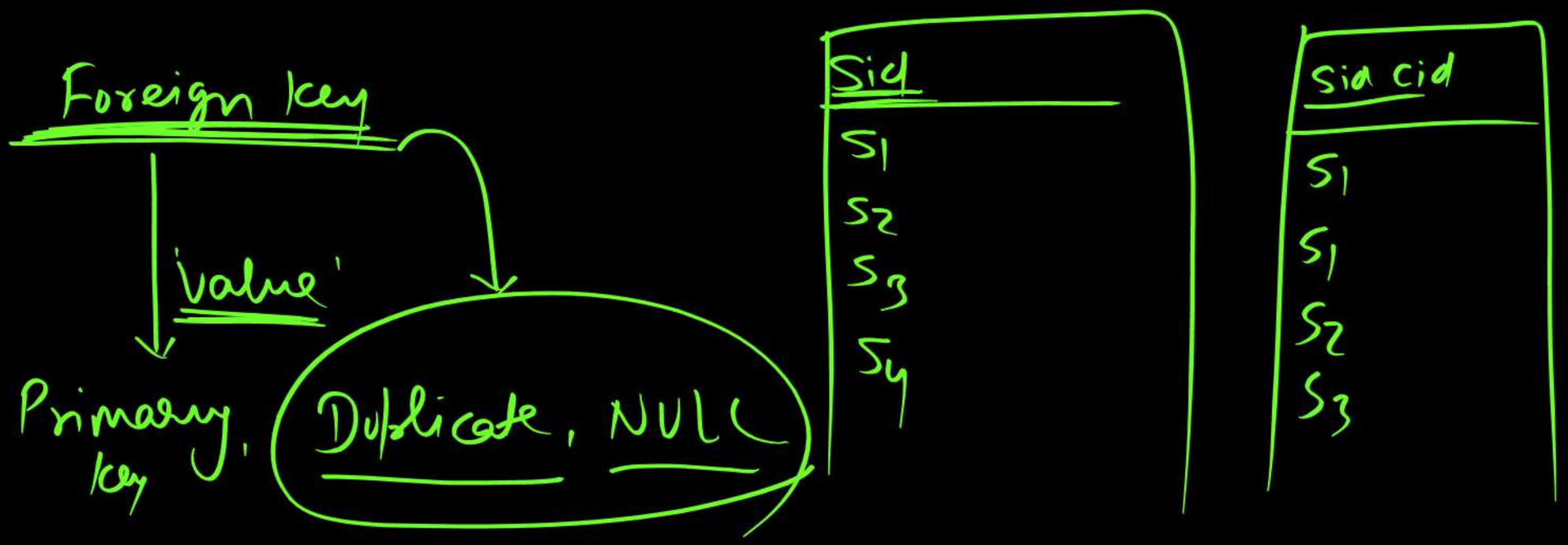
Primary key (Sid Cid)

Foreign Key (Sid) Reference Student → By Default foreign key Reference to Primary key.

When Sid is the primary key of Student

Let login is primary key & Sid is alternative key then

Foreign Key (Sid) Reference Student (Sid) → When Sid is not primary key.


Foreign key
'value'
Primary key
Duplicate, NULL
Sid
S1
S2
S3
S4
Sid Cid
S1
S1
S2
S3

Foreign Key Constraint
[Referential Integrity Constraint]

P →

STUDENT		
Roll No	Name	Branch
1	A	CSE
2	B	IT
3	C	CSE

Registration		
CNo	Cname	Roll No
101	DBMS	1
102	OS	1
103	CD	3
104	TOC	-

← F.K

Referenced Relation
(Parent)

Referencing Relation
(CHILD)

Referential Integrity Constraint

(Parent Table
Referenced Rel^n

[CHILD)
Referencing Relation

Insert <4, D, IT>

Delete <1, A, CSE>

May Cause Violation if Primary key Used in Referencing Relation

X Insert <105, DSA, 4>

Delete <104, TOC, >

F.K ⇒ Duplicate, NULL.

But Value Present in Foreign Key
Must be present in Primary Key.

Note: The value present in Foreign key must be Present in Primary key of Referenced relation

Foreign key may contain duplicate & NULL values.

Parent table	CHILD table
Referenced table	Referencing Relation
✓ Insert < 4 D ECE>	✗ Insert < 105 DSA 67
✗ Delete < 1 A CSE>	✓ Delete < 103 CD 3>

Note: Deletion from the Referenced Relation and Insertion into Referencing Relation may violate Foreign key constraint.

Note: A Relation can Act as Parent & CHILD i.e. Relation may contain a primary key & a Foreign key that Refer to the same Relation.

Q) R(A, B) A is P.K, B is F.K Reference to P.K A in Same table

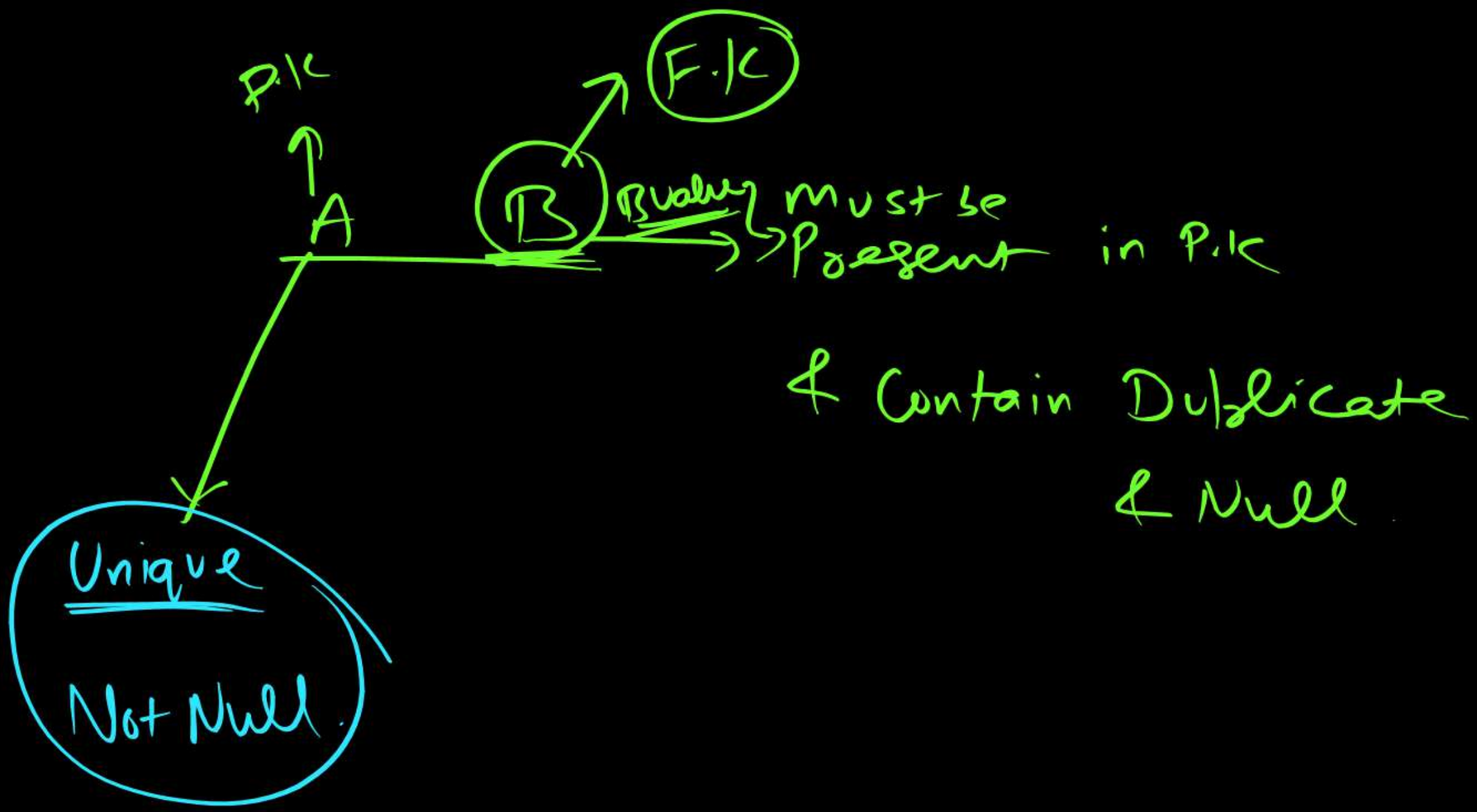
Which of the following Row Sequence is Not allowed ?

Not allowed (4) (1, 2) (2, 3) (3, 4) (5, 5) (4, 3) (5, 2)

(5) (1, 2) (2, 4) (NULL, 3) (3, 4) (4, #) (5, 2)

allowed (6) (1, 2) (2, 2) (3, NULL) (4, 2) (5, 3) (6, 4)

Not allowed (7) (1, 2) (2, 3) (3, 4) (4, 5) (5, 6) (6, 7)


P.K
A
F.K
B
B value must be present in P.K
& Contain Dublicate & Null
Unique
Not Null

Referential Integrity Constraint

(1) Referenced Relation

(i) Insertion : No Violation

(ii) Deletion : May cause Violation if Primary key is used by referencing relation

I. ON DELETE NO ACTION.

II. ON DELETE CASCADE.

III. ON DELETE SET NULL.

① ON Delete No Action : Restrict the Deletion.

Foreign key (Sid) Reference Student(Sid)
ON DELETE No ACTION

② ON Delete Cascade : if Violation occur, then Delete the that Related DATA Tuple from Both Table.

⇓

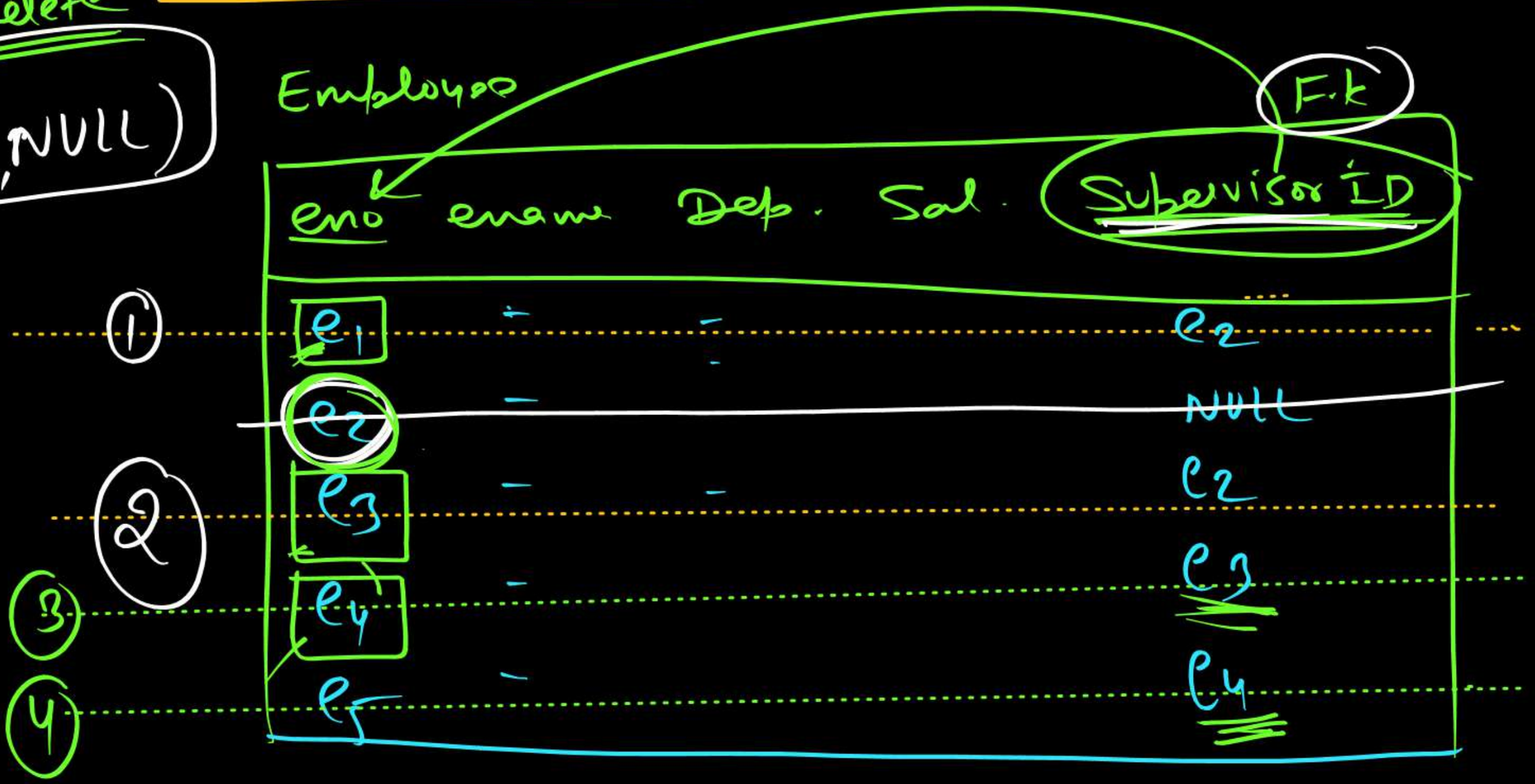
Referenced & Referencing.

Foreign key (Sid) Reference STUDENT7(Sid)
ON Delete Cascade

ON Delete Cascade

If Delete

$(e_2, NULL)$



Q.

The following table has two attributes A and C where A is the primary key and C is the foreign key referencing A with on-delete cascade.

The set of all tuples that must be additionally deleted to preserve referential integrity when the tuple (2, 4) is deleted is:

[GATE 2 Marks]

A (,3 4) and (6, 4)

B (5, 2) and (7, 2)

C (5, 2), (7, 2) and (9, 5)

D 1

A	C
2	4
3	4
4	3
5	2
7	2
9	5
6	4

5, 7, 9

Q.

Let R (a, b, c) and S(d, e, f) be two relation in which d is the foreign key of S that refers to the primary key of R. Consider the following four operations on R and S.

R = Referenced

S = Referencing

S(Referencing)

(i) Insert into R (ii) Insert into S

(iii) Delete from R (iv) Delete from S

[GATE]

Which of the following is true about the referential integrity constraint above?

A. None of (i), (ii), (iii), or (iv) can cause its violation

B. All of (i), (ii), (iii), and (iv) can cause its violation

C. Both (i) and (iv) can cause its violation

D. Both (ii) and (iii) can cause its violation

Any Doubt ?

THANK YOU!